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Sustainability Challenges and Potential Solutions

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University Campuses in Saudi Arabia

Sustainability Challenges and Potential Solutions

Naif Alghamdi

University campuses in Saudi Arabia
Sustainability challenges and potential solutions

Dissertation

for the purpose of obtaining the degree of doctor
at Delft University of Technology
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by

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FOREWORD

My journey with higher education facilities started soon after my Bachelor degree. Immediately after my appointment as a teaching assistant at King Saud University, Riyadh, I was involved in the planning and design of a building within the institution at which I trained, putting knowledge into practice. The building was for the Deanships of the Admission and Registration, and the Graduate Studies. Both Deanships needed more space to accommodate the ever increasing numbers of students. The Rector at this time Prof. Abdullah Al-Othman appointed Dr. Faisal Al-Mazi (may God have mercy upon his soul) as a project leader. I was fortunate enough to be selected by Dr. Al-Mazi as one of the project team members. I learnt so much from this experience especially as the team had many issues such as the project brief, space program, site selection, initial and the developed building design, shop drawings, and the documents for the tender process for construction. This involvement led me to see potential in the university facilities that could communicate important messages for the campus users and beyond.

This, among other reasons, has motivated me to do more, but on a larger scale. In the last decade, the Kingdom of Saudi Arabia has experienced a huge investment from the government on many sectors such as health, education, infrastructure, and so on. A special focus has been given to the higher education sector. This is because education, and higher education in particular, is key for the development of any country. To realise this, the government is spending almost a quarter of the national budget on higher education. The numbers of universities have risen from 8 to 28 public universities. Every province in the Kingdom has at least one public university and other private tertiary education organisations. To accommodate all these institutions, campuses are built in phases. I saw an opportunity to positively influence both the existing and new facilities of universities. That is what motivated me to go forward with such a huge interest in sustainability.

I came to know the Campus Research Team at the Department of Management in the Built Environment, Delft University of Technology from their extensive publications and long experience in managing higher education facilities. I then decided to join the team to undertake my study. This research officially started in January 2014 and ended in January 2018. The study investigated sustainability aspects in Saudi Arabian university campuses. It examined some sustainability practices and operations that are and will always be of great importance to higher education institutions. I found myself dealing with practically the same issues that I had already experienced in the planning and design of the Deanships' building, but at a much larger scale. The investigation involved scientific methods of collecting data in which around 40 interviews were conducted, 2,000 questionnaires were collected, and 12 campuses were observed. I was greatly helped by the Ministry of Education, Higher Education Division, which supported me with all the necessary data and materials needed to carry out this study. Universities in the Kingdom of Saudi Arabia, United States of America, and the Netherlands have also kindly assisted me in conducting this research.

Furthermore, during the course of these four years, much has been proudly accomplished. Book reviews, journal articles, conference papers, book chapters, and my nomination as one of the finalists for the 2017 AASHE Sustainability Awards by the Association for the Advancement of Sustainability in Higher Education are all cases in point. Another achievement includes extending my professional network which keeps me aware of the current and future trends in the area of sustainability in university campuses.

Benjamin Franklin once said ‘either write something worth reading or do something worth writing about.’ In this book, the attempt was to highlight the importance of sustainability in higher education institutions so that policy- and decision-makers are fully aware of the great benefits of becoming more sustainable. This research has documented the recent developments in higher education facilities in the Kingdom. It also attempted to not only assess and report sustainability aspects in university campuses, but also to suggest potential solutions.

I therefore proposed planning guidelines and an implementation plan. The planning guidelines shed some light on key issues in campus planning and design, as well as on sustainability policies, practices, and operations in universities. The implementation plan is a practical six-step plan that universities in Saudi Arabia need to take into account in order to approach sustainability holistically. The plan consists of steps and each step has a number of actions to be taken by certain individuals, agencies, and university departments within a specific time framework. The planning guidelines and the implementation plan were developed for both existing and future universities. They were not only grounded principally on evidence-based results derived from this research, but also on policies emulated from well-known best practices worldwide. This means that some policies were developed based on scientific findings of this study, whereas others were adopted from supplementary literature of existing cases. This indicates that lessons were drawn from both local and international contexts for the sake of advancing sustainability aspects in Saudi Arabian universities and elsewhere.

The Saudi Vision 2030 aims to green the economy of the Kingdom, while the proposed planning guidelines and the implementation plan, which are in line with the Vision, aim to green the campuses and beyond. This is what this book is all about, and implementing it is a dream that, I hope, will come true soon.

Naif Alghamdi
Delft University of Technology
Delft, the Netherlands
April 9th, 2018

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LIST OF ABBREVIATIONS

AAPPA	Australian Association of Higher Education Facilities Officers
AASHE	Association for the Advancement of Sustainability in Higher Education
ABU	Al Baha University
ACTS	Australasian Campuses Towards Sustainability
ACUPCC	American College and University Presidents' Climate Commitment
AIA	American Institute of Architects
AISHE	Assessment Instrument for Sustainability in Higher Education
AJU	Al Jouf University
AMAS	Adaptable Model for Assessing Sustainability in Higher Education
APPA	Association of Higher Education Facilities Officers
ARWU	Academic Ranking of World Universities
ASU	Arizona State University
BIQ - AUA	Benchmarking Indicators Questions – Alternative University Appraisal
BLCC	Building Life-Cycle Costs
BOT	Build, Operate, & Transfer
BREEAM	Building Research Establishment Environmental Assessment Method
BU	Bisha University
CAT	Climate Action Tracker
CCC	Campus Carbon Calculator
CCUS	Carbon Capture Utilisation and Storage
CDSI	Central Department of Statistics and Information
CEDA	Council of Economic and Development Affairs
CGUN	China Green University Network
CREM	Corporate Real Estate Management
CSLF	Carbon Sequestration Leadership Forum
CSNJ	Campus Sustainability Network in Japan
DAS	Designing an Accommodation Strategy
DBPA	Danish Building and Property Agency
EAUC	Environmental Association for Universities and Colleges
FAO - UN	Food and Agriculture Organization - United Nations
FM	Facility Management
FTE	Full-Time Equivalent
GASU	Graphical Assessment of Sustainability in University
GBC	Green Building Council
GBCS	Green Building Certification System
GDP	Gross Domestic Product
GG	Green Globes
GHESP	Global Higher Education for Sustainability Partnership
GM	Green Mark
GM - UI	Green Matric – UI's GreenMetric University Sustainability Ranking
GMI	Global Methane Initiative
GP	Green Plan
GRC	Glass-Reinforces Concrete
GS	Green Star
GSBC	German Sustainable Building Certificate
HE	Higher Education
HEFCE	Higher Education Funding Council for England
HEIs	Higher Education Institutions
HVAC	Heating, Ventilation, Air Conditioning
IARU	International Alliance of Research University
IAU	University of Dammam (Imam Abdulrahman Al Faisal)
IFMA	International Facility Management Association
IGBC	Indian Green Building Council
IGCA	International Green Campus Alliance
IMSIU	Imam Muhammad Ibn Saud Islamic University
INDC	Intended Nationally Determined Contribution
ISCN	International Sustainable Campus Network

IUM	Islamic University of Medina
JNU	Jazan University
KACARE	King Abdullah City for Atomic and Renewable Energy
KACST	King Abdulaziz City for Science and Technology
KAU	King Abdulaziz University
KAUST	King Abdullah University for Science and Technology
KFU	King Faisal University
KFUPM	King Fahd University for Petroleum and Minerals
KKU	King Khalid University
KSA	Kingdom of Saudi Arabia
KSAUHS	King Saud bin Abdulaziz University for Health Sciences
KSU	King Saud University
LEED	Leadership in Energy and Environmental Design
MI	Masdar Institute
MU	Majmaah University
NACUBO	National Association of College and University Business Officers
NAO - UK	National Audit Office UK - United Kingdom
NBU	Northern Border University
NEEP	National Energy Efficiency Programme
NSCN	Nordic Sustainable Campus Network
NU	Najran University
OECD	Organisation for Economic Co-operation and Development
PCFC - UK	Polytechnics and Colleges Funding Council - United Kingdom
PDCA	Plan, Do, Check, and Act
PM	Project Management
PNU	Princess Nora bint Abdulrahman University
PRT	Personal Rapid Transit
PSAU	Prince Sattam bin Abdulaziz University
QU	Qassim University
REM	Real Estate Management
RIBA	Royal Institute of British Architects
SAQ	Sustainability Assessment Questionnaire
SCAS	Sustainable Campus Assessment System
SCUP	Society for College and University Planning
SD	Sustainable Development
SEU	Saudi Electronic University
SIMAP	Sustainability Indicator Management and Analysis Platform
SMG - UK	Space Management Group - United Kingdom
STARS	Sustainability Tracking, Assessment and Rating System
SU	Shaqra University
SUM	Sustainable University Model
TDM	Transportation Demand Management
TFU	Taif University
THU	Taibah University
TKU	Tabuk University
UEMS	University Environmental Management System
UH	University of Hail
UHB	University of Hafr Al Batin
UJ	University of Jeddah
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
UQU	Umm Al Qura University
USA	United States of America
USAT	Unit-based Sustainability Assessment Tool
USF	University of South Florida
USP	University of Sao Paulo
WEF	World Economic Forum

This book is dedicated to all public and private colleges and universities in the Kingdom of Saudi Arabia and elsewhere

SUMMARY

Background

The Kingdom of Saudi Arabia (KSA) has adopted a long-term strategic plan for its higher education. The strategic plan, known as 'The Horizon 2030', aims to build a 'knowledge society' by investing in human resources through secondary, vocational, technical, and higher education. This plan can be considered as part of the Saudi Vision 2030, which aims at a 'vibrant society', 'thriving economy', and an 'ambitious nation', flourishing without depending on exporting natural resources such as oil, gas, and minerals. The Horizon plan's strategic dimensions are: expansion, quality, and diversity. The plan identifies and focuses on eight main areas, one of which is infrastructure. The focus on physical settings, such as facilities, infrastructure, and grounds, includes both the planning for the transformation of existing university campuses and the construction of new ones. To implement such a plan, the government of Saudi Arabia is investing heavily in the education sector with a special focus on the higher education sector. In recent years, almost one-quarter of the national budget is spent on education and training. In the last decade alone, 20 new universities were established. This boom in expanding the higher education system has led to the construction of 20 new campuses and other satellite campuses (extensions to existing campuses). In order to speed up the process of building these projects, the Ministry of Education took the responsibility of managing centrally the first stage of planning, designing, and constructing the main campuses and satellite campuses of these recently established universities. The task was described by many as enormous, by any standard. That is because most campuses were designed as a city-like development, in which each main campus includes not only college buildings, but also a hospital, science park, sport and recreational facilities, staff housing, student dormitories, and other supporting facilities. The construction was undertaken in phases, in which each phase a couple of college buildings and some supporting facilities were built. Facts and figures of newly established university campuses suggest that there is a huge investment in the infrastructure and facilities of higher education in the Kingdom. Such figures send a clear message that these megaprojects should be handled with extreme caution for the sake of a sustainable future.

Research focus

Research has indicated that there are five aspects of sustainability in university campuses to address: management, environment, engagement, academia, and innovation. These aspects were a result of a systematic review of 12 well-known sustainability assessment frameworks, tools, and systems. In order to assess how sustainable the institution is, performance indicators are used to evaluate each sustainability aspect. This research assessed only the following aspects: management (using indicators such as vision, policy, planning, and commitments), engagement (using indicators such as attitude, knowledge, awareness and willingness to change), and environment (using indicators such as location, physical accessibility, climate considerations, flexibility, and space utilisation). These three aspects and the ten indicators were chosen by considering their importance and their consequence on the users and on the resources in Saudi Arabian universities, now and in the future. This research gave more attention to the recently established universities, since they are still under construction and hence improvement in phase two can be more appropriate, affordable, and feasible.

Research question and methodology

With all this in mind, this research is set to answer the main research question of 'what information, tools, and approaches will allow existing and new college buildings and

campuses in Saudi Arabia to become more sustainable?' In order to answer such a question, three main stages were taken: exploration, explanation, and conclusion. Each stage has its own data collection phases and techniques. First stage (the exploration) identifies relevant sources and maps the scholarly literature in four domains: campus planning and design; campus management; sustainable campuses; and higher education in Saudi Arabia. Reviewing literature also involved professional documents such as architectural drawings of colleges and campuses, sustainability reports, and strategic plans of universities and masterplans of campuses. It includes developing a conceptual framework and an analytical tool. The next step was a field trip to Saudi Arabia to visit eight selected cases and collect data through interviews, focus group, questionnaires, and observations. These cases were Al Baha University, Jazan University, King Abdullah University for Science and Technology, King Saudi University, Najran University, Prince Sattam Bin Abdulaziz University, University of Hafr Al Batin, and University of Hail. The following step was to process the large data collected and analyse it. This phase explained many issues in the Saudi cases and hence the research problems were redefined, the focus was sharpened, and the research questions were reformulated. The second stage (Explanation) started by a desk study looking for some potential cases to be studied as best practices for sustainable campuses that are suitable for Saudi Arabia. The selection was based on developed criteria. Two cases were selected and studies and lessons were drawn. These cases were both from the United States of America (USA), namely Arizona State University (Tempe Campus) and the University of South Florida (Tampa Campus). This step, however, did not go according to plan, because of an inability to acquire a visiting visa. Instead, only face-to-face interviews were conducted through some telecommunications application software (e.g. Skype and Facetime). What followed was to process and analyse the data from the scholarly literature and from the interviews so that lessons could be drawn. The final stage (Conclusion) started by summarising the research findings and then developing planning guidelines and implementation approach to advance sustainability in Saudi Arabian university campuses. In order to review the preliminary guidelines and implementation approach, interviews with sustainability experts from Saudi Arabia and United States were conducted. The feedback was used to improve the proposed planning guidelines and the implementation approach to sustainability.

Research findings

The analysis was based on studying ten cases (8 from the KSA and 2 from the USA), 38 interviews (31 from the KSU and 7 from the USA), 1,901 questionnaires were collected from the KSA, and 12 campuses were visited and observed in the KSA. The overall findings suggest that Saudi Arabian university campuses are lagging far behind the rest of their counterparts in Europe and North America with regards to the sustainability aspects in universities. In spite of the fact that these universities show a common vision to create a learning environment that is appealing, smart, and sustainable, they lack defined policies to achieve such a vision. There is a noticeable absence of leadership in relation to sustainability as well as a comprehensive sustainability approach in the vast majority of public higher education institutions in the Kingdom. Most universities have no documented sustainability commitments for their campuses. They have neither developed tools to measure their advancement in sustainability nor adopted existing tools. At the national level, there is a lack of strategic planning for higher education facilities in terms of supply and demand. Feasibility study has not been undertaken for these massive developments (e.g. 20 new large-sized campuses). There is a lack of supply and demand policy to manage physical spaces in higher education institutions at the national level in Saudi Arabia. This was accompanied by the absence of a long-term study of the youth population in the Kingdom. This is of a vital importance, given that the United Nations projection of the youth population aged between 14 and 24 suggests a serious fluctuation. It shows an increase of the youth population up until the year 2035 followed by a sharp decline in such a segment of the society. The findings also show that the majority of students in public universities in Saudi Arabia have little knowledge about the sustainable development. Additionally, no public university assesses its students about their knowledge and awareness of sustainability on a regular basis. There is a lack of policies to integrate sustainability into the existing education courses. Students showed a lack of interest and willingness to take part in some of the sustainable initiatives on-campus. Most of the Saudi Arabian policy- and decision-makers have inadequate knowledge and awareness about the recent sustainability developments in university campuses. The analysis highlights that a large number of Saudi university campuses, especially new ones, are located far away from their own cities. The vast majority of surveyed people indicated that they live off campus and few of them prefer to live on-campus. On average, Saudi students, academics, and supporting staff commute some 44 kilometres distance between their place of living and their university campuses. The vast majority of participants use their own cars to come to the university campus. That is obvious given that the Kingdom is a car-oriented country. Other issues with location and accessibility are the absence of public transportation, incompleted infrastructure projects, and the challenging topographies of some sites such as rocky mountain (e.g. Al Baha University), and hilly (e.g. As Sulayyil Campus), sandy (e.g. Najran University), or low-line ground (e.g. Prince Sattam bin Abdulaziz University). As for the climate considerations, the findings show when analysing the master plans of new campuses as well as the college buildings, it can be noticed that the issue of compactness has not been considered. Compactness has a number of advantages especially for the Saudi context given the extreme climate. The idea to occupy as little space as possible was not realised. In fact campuses and college buildings are large in size. This negatively impacts the density, outdoor walking distance, and the amount of exterior envelope to be exposed to the sun, among others. There are issues with the environmental quality including the orientation of buildings, shading and day-light, passive ventilation strategies, and other energy free facilities (e.g. solar panels and wind turbines). Regarding flexibility (in terms of time, space, and furniture), the findings suggest that over a half of the academics have a flexible schedule and are willing to deliver lectures in the evening (between 5 pm and 9 pm), whereas around a quarter of students and supporting staff favour the evening period instead of morning. Two-thirds of participants indicated that the spaces in their college buildings can be used for multiple purposes, whereas one-third pointed out that spaces can easily adopt new functions. Physical flexibility in the layout of college buildings in campuses of recently founded universities has been highlighted as an issue. This limits the prospect for adjustment in college buildings now and in the future. Over one-third of surveyed people pointed out that the furniture is flexible. In terms of space utilisation of facilities in campuses, the findings show that the surveyed people indicated that more than two-thirds of classrooms in Saudi campuses are either half-filled or even have plenty of seats available. More than a half of people are pleased with the overall size of classrooms in their college buildings. The assessment of space utilisation in some college buildings in public universities indicates a low rate of utilisation. It is noticeable that almost all public sectors in the Kingdom, including higher education, are not familiar with space utilisation studies. The lack of expertise and knowledge are just two reasons for not undertaking such study.

Conclusions and recommendations

This research has concluded by proposing planning guidelines which consist of policies and actions to advance sustainability in public universities in Saudi Arabia and elsewhere. These proposed policies were not only grounded principally on evidence-based results derived from this research, but also on policies emulated from well-known best practices worldwide. To help universities not only to 'talk the talk', but also to 'walk the walk'; this research has also proposed a six-step implementation plan: Commit, Evaluate, Plan, Implement, Track, and Review. These steps can be taken through following a number of bold actions by the actors responsible within the timeframe proposed to ensure smooth execution and comprehensive approach to sustainability practices and operations in campuses and beyond.

Scientific value

This research makes two scientific contributions to research on sustainability in universities. First, this research bridges the scientific gap in operationalising sustainability tools for universities; ensuring that the existing tools of measuring sustainability in campuses are more intelligible. This was done primarily through highlighting sustainability indicators, so that they clearly communicate only the essential information. In doing so, this research identifies five criteria that can be grouped into a holistic framework, comprising aspects of management, academia, environment, engagement, and innovation. Therefore, the research contribution to the body of knowledge is by simplifying and detailing the structure and contents of existing sustainability tools, which enables universities to recognise key issues and ultimately improve their sustainability policies. In this way, universities, in Saudi Arabia and elsewhere, are helped through utilising the existing assessment tools or maybe developing new tailored tools. The latter is because universities face a variety of challenges and they might lack the ability to measure their sustainability policies and practices. Second, despite the importance of sustainability in university campuses, very little attention has been given to such a topic in Saudi Arabia. In fact, much of the previous research indicates a need for a comprehensive investigation of sustainability in public universities. Therefore, this research fills in this vacuum and provides an extensive study using scholarly literature and a best practices review, combined with field work. This study provides the body of knowledge with information, tools, and an approach through which sustainability aspects can be evaluated and advanced. This research is among a few of its kind in a country where two-thirds of its public university campuses are still under construction.

PART I

BACKGROUND AND ESSENTIALS

Campus gate, University of Hail, Hail

Chapter 1

Introduction

'… rapid and in many ways fundamental change [in Higher Education in Saudi Arabia] will also be accompanied by a range of issues to be addressed, challenges to be overcome, and failures from which to learn'.

Prof. Khalied Al Ankari
Former Minister of Higher Education in Saudi Arabia

1.1 Background

The Kingdom of Saudi Arabia has adopted a long-term strategic plan for its higher education. The strategic plan – known as 'The Horizon 2030' or 'Aafaq' in Arabic and launched on May, 7th, 2011 – aims to build a 'knowledge society' by investing in human resources through secondary, vocational, technical, and higher education (Aafaq 2011). This plan can be considered as part of the Saudi Vision 2030 – launched on April, 25th, 2016 by the Council of Economic and Development Affairs – which aims at a 'vibrant society', 'thriving economy', and an 'ambitious nation' (CEDA 2016). The Horizon plan's strategic dimensions – through which higher education in the Kingdom can advance in achieving a knowledge society – are: expansion, quality, and diversity. The plan identifies eight main areas on which to focus, one of which is infrastructure. The focus on physical settings, such as buildings and facilities, includes both the planning for the transformation of existing university campuses and the construction of new campuses in the public and private higher education institutions (Aafaq 2011). To implement this plan, the government of Saudi Arabia is currently investing heavily in the education sector with a special focus on the higher education sector. In the recent years, almost one-quarter of the national budget is spent on education and training.

When comparing higher education in Saudi Arabia with other nations, the Kingdom's system is relatively young. Only five universities are over 50 years old, as of 2017. Historically, for almost four decades (1960 – 2000), the Kingdom was known to have just eight public universities established between 1957 and 1998. Today, however, it has 28 public universities in which recently founded universities were established between 2003 and 2014. The recently founded universities were in fact satellite or branch campuses of those eight well-established universities, which in recent years have become independent universities. This in turn means that 70% of public universities have been established in the last decade. This high percentage excludes the construction of eleven private universities and twenty private colleges. Although all public universities are funded by the Ministry of Education, sixty three colleges with a technical, vocational, industrial, medical, and administrative focus are managed and financed directly by public institutions rather than from the Ministry itself. Other characteristics of higher education system in the Kingdom are a centralised system of control, gender segregation, funded by the State, and free for all citizens at all levels. So citizens do not pay to study, they are paid instead (Smith & Aboummoh 2013; Aleasa 2011).

With this in mind, the boom in expanding the higher education system has led to the construction of 20 new campuses for the 20 recently founded universities. The construction was undertaken in phases. Phase one has been completed to a large extent, which includes the construction of community colleges, science colleges, medical colleges, engineering colleges, and some housing units for both students and academic staff. Phase two is in the process of construction, and will include the building of the rest of the colleges, administrative buildings, and other supporting facilities. Some of these buildings have been already completed and are in use now.

The new campuses are located in cities that have had no prior history of hosting such institutions. Thus, their impact can be clearly ascertained, to the extent that it is safe to conclude that their construction has added value to these cities and even to the wider province. The added value of each university is that it has had a positive impact on knowledge and an equally positive impact culturally, socially, economically, and developmentally.

The facts and figures of newly established university campuses in Saudi Arabia indicate that there is a huge investment in the infrastructure and facilities of higher education. The new universities are believed to be costing more than 80 billion Saudi Arabian Riyals (18 billion Euros). The capacity of new campuses of public universities ranges from 10,000 to 90,000 students each (Ministry of Education 2012, 3). According to the Ministry of Education (2017), the enrolled students in public universities in 2015-2016 were 1,400,297 students; 1,342,286 Saudis (96%) and only 58,011 non-Saudis (4%). The enrolment in 2015-2016 consisted of 729,882 female students (52%) and 670,415 male students (48%). Over 300,000 new students (freshmen) are expected to be enrolled in public universities each year. The total capacity of the 20 new campuses will be decidedly more than one million students (Ministry of Education 2012). The enrolled students in the eight old universities in the academic year of 2002-2003 were 484,286 students. The well-established institutions have also expanded physically by building new college buildings and other supporting facilities. This means that the capacity of all public university campuses might be more than 1.5 million students once the new campuses are fully operational. This is a very conservative estimate, given that there is no data available on such an important figure. The total area of all land of the 20 new campuses is more than 11.8 thousand hectares (Ibid). On average, about six hectares of land were allocated to each university campus. The majority of the 20 new universities have a male campus and a female campus within the university campus boundaries. These campuses also include Medical City, Research City (Science Park), Sport City, Staff Housing, Students Dormitories, Endowment Lands (Investment Areas), and future expansion zones and other areas for services. This massive city-like area would give more flexibility and allow for possible future expansions. Such figures send a clear message that these mega-projects should be handled with extreme caution for the sake of a sustainable future. The sustainable development was defined as a development that ‘meets the needs of the present without compromising the ability of future generations to meet their own needs’ (United Nations 1987).

Figure 1.1 shows the main historical developments of recently established public universities in the Kingdom. It illustrates, in a chronological order, the most noticeable developments of Saudi Arabian public universities that have occurred in the last couple of decades. It shows a brief history of expansion: the Ministry of Education’s role in centralising the management of constructing the new campuses for recently founded universities, the construction phases, the handover process, and some other turning point events such as the launched strategic plan for the higher education system (The Horizon 2030), the merging of the Ministry of Education and the Ministry of Higher Education, the national vision (Saudi Vision 2030), and finally, the high and low oil prices, given that exporting oil, gas, and minerals are the backbone of the Saudi Arabian economy.

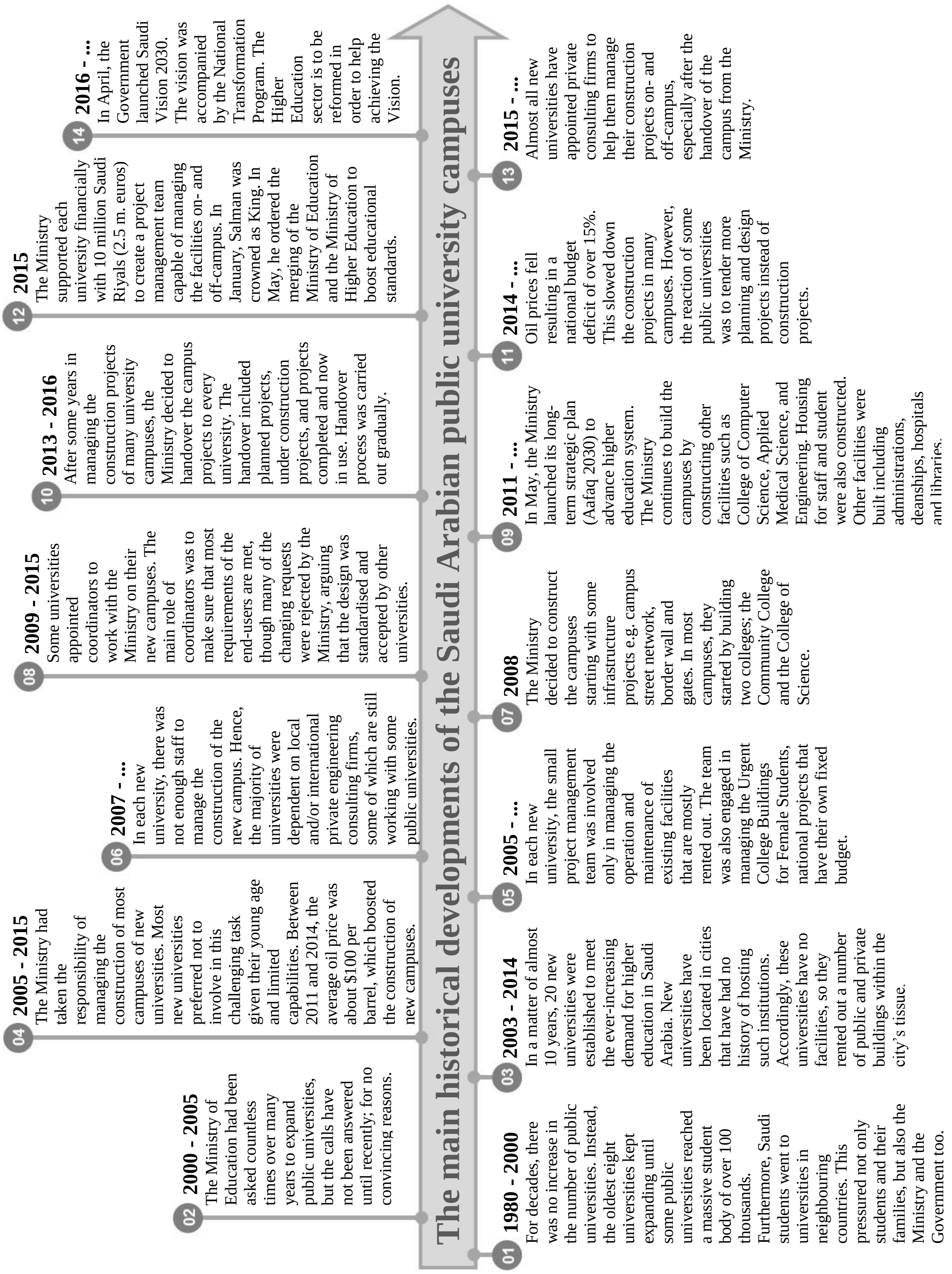


Figure 1.1: The main historical developments of public universities in Saudi Arabia

1.2 Problem statement

1.2.1 Overview

Between 2003 and 2014, 20 new universities were established. The Ministry of Education (formally known as the Ministry of Higher Education) has taken the responsibility of managing the planning, design, and construction of the main campuses and satellite campuses of these recently established universities. The task was described by many as enormous, by any standard. That is because most campuses were designed as a city-like development, in which each includes a hospital, a science park, sport facilities, staff housing, student dormitories, and other supporting facilities.

In order to accomplish the gigantic task of constructing these public institutions, campuses have been built in phases. This research assessed some planning, designing, and behavioural issues in some of the new university campuses, which were constructed in the first phase. This research has found that there are five sustainability aspects to evaluate in university campuses: management, engagement, environment, academia, and innovation. Each aspect can be assessed through a number of key performance indicators. The sustainability aspects evaluated in this research include the management aspects (such as vision, policy, planning, and commitments), the engagement aspects (such as attitude, knowledge, awareness and willingness to change), and the environment aspects (such as location, physical accessibility, climate considerations, flexibility, and space utilisation). The reasons for selecting these three aspects and their ten indicators were because they are of interest to the research, given their urgency and importance to the Saudi situation.

Preliminary explorations of this research have suggested that the majority of Saudi Arabian university campuses are failing to maintain the pace and progress made in many of the sustainability aspects compared to their counterparts in Europe and North America. The following points briefly summarise the main problems derived from an initial review of some public university campuses, in which a broad examination of university campuses documents (e.g. strategic plan) and architectural drawings (e.g. master plan) was conducted:

Management aspects (vision, policy, planning, and commitments)
Early assessment of this research has shown that the vast majority of Saudi public universities have neither a sustainability aim nor a plan for their campuses. In spite of the fact that these universities present a common vision to create a learning environment that is appealing, smart, and sustainable, they seem to lack defined policies to achieve such vision.

Initial investigation of this research has indicated that most universities have no documented sustainability commitments for their campuses. It looks as if public universities in the Kingdom have neither developed tools to measure their advancement in sustainability nor adopted existing tools.

In general, most university projects appear to lack enough stress on sustainability in the project brief. Additionally, the time spent on developing the brief might not be enough and that seems to affect the consideration to incorporate some of basic passive environmental sustainability techniques such as orientation and building placement, compactness, building size...etc.

At the national level, it seems that there is a lack of strategic planning for higher education facilities in terms of supply and demand. It is anticipated that a feasibility study has not been undertaken for these massive developments (the 20 new large-sized campuses). This is accompanied by the absence of a long-term study that evaluates youth population in Saudi Arabia. The United Nations projection of the demographic profile of the Kingdom suggests a serious fluctuation. It indicates that in the short- and medium-term, there will be an increase of the youth population aged between 14 and 24. It is expected that this particular segment of Saudi society will continue to increase and reach its peak between 2030 and 2035. In the long-term, however, a sharp continuous decline of the youth population can be clearly noticed, as can be seen in figure 1.2 (see also Note 1). This again raises the question of the feasibility of such large campuses. What makes it even troubling is the result of the status of admission in public universities in Saudi Arabia. According to the figures released by the Agency of Planning and Information at the Ministry of Education, there were more than 31,500 seats yet available in the academic year 2015-2016. This number counts for almost 12% vacant places, which is a figure to take into account (see Note 2).

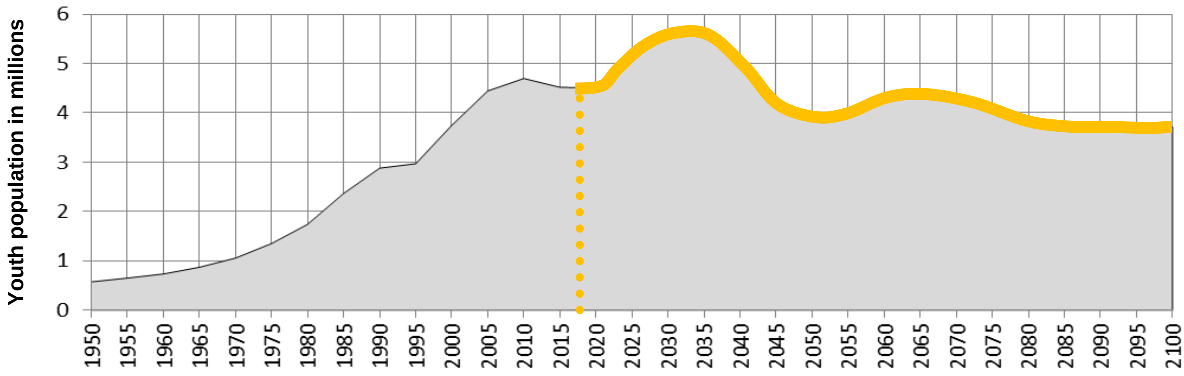


Figure 1.2: Saudi Arabian youth population projection in millions (United Nations 2012)

Initial examination of this research has also shown that the planning of new campuses rarely deviates from a particular standardised design. In other words, the Ministry and the designing team used only a few concepts or prototypes. The design and planning standards at one institution can be clearly found in another institution. Although standardising both the college buildings and the landscaping objects has helped the Ministry of Education, who managed the planning and construction of new university campuses, to speed up the process of constructing the new campuses, standardisation did not consider key aspects for each institution. It did not take into account the differences in a) size of student body, b) education programs, c) attitudes to campus housing, d) the importance of having a unique image and identity, e) climate (air temperature, humidity, wind, dust storm, rain...etc.), f) landscaping, and g) building materials' specifications, to name but a few. Consequently, this lack of innovation in planning and designing the university facilities might negatively impact the institution not only in attracting the top-class students, academics, and researchers, but also as 'a marketing lever' (CABE 2005, 22). This could be a result of the fact that these new campuses were designed by only one consultant in a very short span of time. It has to be highlighted that although standardisation, in general, might be seen as a sustainable practice. However, it may not be always the case considering the abovementioned reasons.

Engagement aspects (attitude, knowledge, awareness and willingness to change)

Early evaluation of this research indicates that there is a lack of assessment for student's knowledge and awareness of sustainability in the majority of public universities in Saudi

Arabia that is undertaken on a regular basis. Therefore, it is assumed that students have little knowledge about the concept of sustainable development, which is one of the most important and hot topics worldwide.

On one hand, it is anticipated that students might lack interest and willingness to participate in some of the on-campus sustainable initiatives. On the other hand, Saudi policy- and decision-makers might suffer from inadequate knowledge and awareness about the recent sustainability developments in university campuses.

Environment aspects (location, physical accessibility, climate considerations, flexibility, and space utilisation)
The recently founded universities have been located in provinces that have had no history of hosting such institutions. Besides, statistics show that there are large numbers of enrolled students in the 20 recently founded universities. But as these universities were, and still are, being constructed (phase two), the questions were: where do students in these universities actually learn, study, and live? Research has indicated that these new universities decided to rent out specific buildings in different parts of their cities to serve the university functions: administration, education, research, and housing. These buildings tend to be large in size and vary in functions. Although these buildings were not purpose–built, they have been adapted to suit the university functions. Existing secondary education school buildings, government agency buildings, office buildings, public theatres, and sometimes wedding halls are all cases in point. This can be seen as a sustainable practice, given that these premises are physically accessible, since they are within the city tissue. They can also be used for such purposes providing there is demand. However, if there is no need, they can just serve their original purpose or some other need.

Initial investigations of this research illustrate an issue with the location of and the physical accessibility to public university campuses, especially the recently founded institutions. The remote locations, the absence of public transportation, incompleted on-campus infrastructure projects, and the challenging topography of some sites are some cases in point. A large number of Saudi university campuses, especially new ones, seem to be located far away from their own cities. Consequently, many of these campuses are not located near existing infrastructure (such as power lines, water supplies, telecommunication lines, and sewage systems). The chosen locations may even encourage developments to continue outside the urban boundaries, triggering suburban sprawl. Additionally, it is expected that the vast majority of people use their own cars to come to the university campus. That is obvious given that a) the Kingdom is a car-oriented country and b) the absence of public transportation systems in the majority of Saudi Arabian cities.

As for the climate considerations, initial analyses suggests that the masterplans of new campuses, as well as the college buildings, show that little consideration have been given to the harsh and hostile climate of Saudi Arabia. Compactness, for example, has a number of advantages especially for the Saudi Arabian context, given the extreme climate. The idea to occupy as little space as possible was not realised. Overall building size is excessive, contradicting the very basic principle of sustainability which says ‘smaller is better’; it is imperative to optimise use of interior space through careful design so that the overall building size and resources used in construction, operation, and maintenance are kept to a minimum (building life cycle). This negatively impacts the density, outdoor walking distance, and the amount of exterior envelope exposed to the sun, among others. There are other issues with the environmental quality including the orientation of buildings, shading and day-lighting, passive ventilation strategies, and other clean energy facilities (e.g. solar panels and wind turbines).

Regarding physical flexibility, early observation has indicated that the materials used in dividing the layout of college buildings in campuses of recently founded universities are an issue. This is because brick walls, along with the span (distance) between columns, limit the prospect for adjustment in college buildings now and in the future.

In terms of space unitisation of facilities in campuses, it is assumed that there is no space management assessment that looks at space supply and demand at the national level. On the other hand, it is also anticipated that there are no space utilisation studies. Therefore, it is expected that there might be a low rate of space unitisation in college buildings in public universities. It is noticeable that almost all public sectors in the Kingdom, including higher education, are not familiar with space utilisation studies. The lack of expertise and knowledge are just two reasons for not undertaking such study.

The main reasons behind such problems are as follows:

i) **Delay in reaction**. The government's desire to make up for lost time, since there was a dramatic increase in the youth population, accompanied by a growing desire of students to pursue higher education with no serious action taken by the government to address these issues for almost two decades (between 1980 and 2000).
ii) **Too much too soon**. The high oil price between 2011 and 2014, where the average price was about US$ 100 per barrel, had been a great help for the government to speed up the process of constructing the main and satellite campuses for newly founded universities. The rapid growth in investing in the physical expansion of the higher education facilities was carried out in a very short span of time to compensate for the lost time.
iii) **Feasibility study**. The need to expand higher education institutions in the Kingdom is not questionable. However, the need for such size of physical expansion is debatable. This might be because of a misinterpretation of Saudi Arabia's Higher Education Strategic Plan (The Horizon 2030), which indicates a need for physical expansion. Although the plan was introduced after the initial phase of planning and constructing the first phase of building these new universities, work is continuing. The issue was and still is the fact that the square meter per user ratio appears to be not meticulously thought about, given the circumstances of the serious projected fluctuation in the youth population in the country.
iv) **Central management**. The Ministry of Education has taken the responsibility of managing the task of planning, designing, and constructing the new campuses of recently established universities. This is because of two main reasons: a) to speed up the process of execution and b) new universities had (some still have) no capacity to undertake such a mission themselves, given their young age and having no campus management team.
v) **One architectural firm**. The Ministry of Education appointed only one local architecture, engineering, and planning firm to carry out this gigantic task (20 new city-like campuses in different parts of the Kingdom).

Scientifically, although there are a number of assessment tools to evaluate sustainability in university campuses, much less is known about the indicators through which sustainability in universities can be assessed through. Besides, existing assessment tools are not easily comprehended. This, therefore, does not help higher education institutions to assess their sustainability advancement.

1.2.2 Prioritising the research problems

Given the fact that every problem in this research has its own causes, characteristics, and dimensions, prioritising them is of the utmost importance for addressing them in a way in which they can be solved systematically. What makes the research problems complex and complicated is their diversity. Some problems are design problems (e.g. climate considerations and standardisation). Other problems, however, are management and planning problems (e.g. vision, policies, commitment, demographic changes, location, and physical accessibility, flexibility, space provision and utilisation). This, therefore, requires rather different strategies in trying to make these campuses more sustainable. But, where to start, why, and how are three important questions that need to be addressed.

Looking back at the research problems, it can be seen clearly that some issues should take priority over others. There are problems that cannot be easily solved. Others, nonetheless, can be looked at, controlled, and hence developed to be potentially sustainable solutions. The order of priority has been carried out based on factors such as importance (problems of great significance and value), urgency (requiring swift action given the insistence and risk involves), consequence (the result and effect of the problems), and ability to influence (how easily the outcome of this research can impact and control these problems).

The prioritisation of the research problems was based on the possibility of controlling these problems and hence turning them into possible sustainable solutions. Looking at the hierarchy of sustainability, then management and planning problems (e.g. vision, policies, commitment, demographic changes, location, and physical accessibility, flexibility, space provision and utilisation) should be at the top of the agenda when addressing sustainability in Saudi Arabian university campuses. This is because of the fact that the consequences of these problems are considerably massive, expensive, and risky. Policy- and decision-makers are advised to deal with the management and planning problems, given that they have a profound impact on resources now and in the future.

The bottom line is that planning, designing, and constructing sustainable buildings exclusively in terms of energy efficiency are simply not enough if we were to weigh it with other issues. For example, campuses might be considered unsustainable, even if they consume far less resources such as water and energy, when looking at issues such as location and physical accessibility. Locating a university campus far from its city cannot be considered sustainable. Another key point to highlight is the projected demographic change in youth population. Declining scenario might have a huge impact on these large campuses that are, to a large extent, located far from their cities and towns. Not much is known about what the future holds for university facilities. Buildings might have another type of use in the future. Therefore, the main principle here is to look at the ‘big picture’ and be careful not to be ‘penny-wise’ and ‘pound-foolish’.

1.3 Research focus

This research has found that to address sustainability in higher education institutions, there are five aspects to evaluate and advance: management, academia, engagement, environment, and innovation. The five aspects were a result of a systematic review of 12 well-known assessment tools, frameworks, and systems, evaluating sustainability in university campuses (Alghamdi et al. 2017). Each aspect has many performance indicators to assess how sustainable the institution is.

With this in mind, the emphasis in this study concentrates on addressing issues that were characterised as hierarchically important. That is because these aspects, among others, are essential and they are where the emphasis in Saudi campuses should be placed. Particular attention has been given to certain issues within three sustainability aspects in university campuses, because of their importance and urgency. Therefore, the examined three aspects and ten indicators were as follows:

- **Management aspects**
  (Vision, policy, planning, and commitments)
- **Engagement aspects**
  (Attitude, knowledge, and awareness of sustainability and willingness to change)
- **Environment aspects**
  (Location, physical accessibility, flexibility, climate considerations, and space utilisation)

In Saudi Arabia, there are now 28 public universities; 8 are well-established, whereas 20 are recently founded universities. In this research, more attention has been given to the recently established universities, since they are still under construction and hence improvement in phase two can be appropriate, affordable, and feasible.

1.4 Research purpose

1.4.1 Aim and objectives

The ultimate aim of this research is to holistically improve sustainability aspects in university campuses in Saudi Arabia. The other objectives of this study are:

- Document the developments in higher education sector in the Kingdom,
- Demonstrate how sustainable Saudi Arabian public universities are, and
- Present what potential solutions can be offered to advance sustainability practices and operations in campuses in Saudi Arabia and elsewhere. That is by proposing planning guidelines and a sustainable approach for public universities in Saudi Arabia and elsewhere.

1.4.2 Societal and scientific relevance

Saudi Arabia is experiencing rapid and major developments in its higher education sector with 70% of its universities currently being designed and built. The need for this research is based on both significant values:

- **Societal relevance**: This research is to focus on solutions or, put differently, implementations of sustainability aspects. This research offers planning guidelines, implementation steps, and an approach to sustainable university campuses. Such an approach has been especially designed to serve colleges and universities that are still at early stage of sustainability implementation. However, other advanced universities can be also aided by utilising the proposed approach. Therefore, not only do the empirical outputs of this research benefit Saudi Arabia, but also other countries with similar conditions (e.g. climate, transportation modes, and campus planning and design).
- **Scientific relevance**: This study makes two scientific contributions to research on sustainability in universities. First, there is considerable research on sustainability tools that measure and report the advancement of sustainability in universities such as

Shriberg (2002), Cole (2003), Alshuwaikhat and Abubakar (2008), Leal Filho et al. (2009), Disterheft et al. (2012), Lozano et al. (2013), Kamal and Asmuss (2013), and Gómez et al. (2014). Such studies have reviewed a number of tools giving background information and show the strengths and weaknesses of each tool. However, very little is known about the indicators through which sustainability in universities can be assessed. Consequently, this research bridges this scientific gap in operationalising sustainability tools for universities; ensuring that these tools are more intelligible, primarily through highlighting indicators, so that they clearly communicate the essential information. In doing so, this research identifies five criteria that can be grouped into a holistic framework, comprising aspects of management, academia, environment, engagement, and innovation. Therefore, the research contribution to the body of knowledge is by simplifying and detailing the structure and contents of existing sustainability tools, which enables universities to recognise key issues and ultimately improve their sustainability policies. In this way, universities, in Saudi Arabia and elsewhere, are helped through utilising the existing assessment tools or maybe developing new tailored tools. The latter is because universities face a variety of challenges and they might lack the ability to measure their sustainability policies and practices. Second, despite the importance of sustainability in university campuses, very little attention has been given to such a topic in Saudi Arabia. A number of studies were carried out on specific areas of sustainability in some Saudi Arabian public and private universities such as Alhefnawy (2014), Abanomi (2014), Alshuwaikhat et al. (2016), Almufadi & Irfan (2016), Abubakar et al. (2016), Adenle & Alshuwaikhat (2017), and Alshuwaikhat et al. (2017). However, the vast majority of these studies do not address sustainability inclusively. In fact, much of the previous research indicates a need for a comprehensive investigation of sustainability in public universities. Therefore, this research fills in this vacuum and provides an extensive study using scholarly literature and a best practices review combined with a field work including 38 expert interviews, 1,901 questionnaires, and 12-site observations. This study provides the body of knowledge with information, tools, and an approach through which sustainability aspects can be evaluated and advanced.

1.5 Research questions

The main and sub-research questions, therefore, deal with how to make the existing campuses more sustainable and also how to prevent ‘mistakes’ from happening again in new colleges or campuses in Saudi Arabia. Scientifically, the research questions address information, tools, and approaches which can help advance sustainability in university campuses in Saudi Arabia and elsewhere.

The main research question is:

> What information, tools, and approaches will allow existing and new college buildings and campuses in Saudi Arabia to become more sustainable?

The sub-research questions are:

1. How can sustainable campuses be defined and assessed?
2. Why is sustainability important in university campuses? And why is it particularly important to Saudi Arabia?
3. What are the main issues of sustainability in university campuses in Saudi Arabia?
4. What lessons can the Kingdom learn about sustainable campuses in different parts of the world?

5. What approach can university campuses in Saudi Arabia adopt to become more sustainable?

1.6 Research literature

In order to help answering the above mentioned research questions, a review of relevant scholarly literature was carried out. This was not only to highlight what is known already in the field of university campuses from different perspectives, but also to outline important concepts, models, and theories that relate to this study. Figure 1.3 shows that there are four literature domains which this research focuses more on. These domains are as follows:

- **Campus planning and design**. Main theories of planning and best practices in designing a sustainable campus were reviewed, so as to find out the most recent and advanced planning and design principles of university campuses (including but not limited to Dober 1963, 1992, & 2000; Turner 1984; Kenney et al. 2005; Sinclair 2008; DBPA 2010 & 2013; Haar 2011; Temple 2014; and Haggans 2016).
- **University campus management**. Main theories of managing the university campus were explored to learn more about improving campus management through crucial information and tools benefiting policy makers from operational to strategic level for making effective decisions adding value to the campus and beyond (including but not limited to De Jonge 1994 & 1997; NAO 1996; SMG 2006; De Jonge et al. 2009; Den Heijer 2011; and Den Heijer & De Jonge 2012).
- **Sustainable campus (Living laboratory)**. Main theories and principles of ‘sustainable development’ in general and ‘sustainable campus’ in particular were explored to define and outline the evolving concept of ‘sustainability’ in the built environment so as to learn more about the conceptual approaches, information, and tools that help advance sustainability in university campuses (including but not limited to Shriberg 2002; Cole 2003; Lozano 2006; Martin & Samels 2012; König 2013; Bartlett & Chase 2004 & 2013; and Thomashow 2014).
- **Higher education in Saudi Arabia**. A detailed overview of Higher Education in Saudi Arabia was conducted to comprehend the system through acquiring more knowledge about its history and recent developments. This was in order to build a solid database upon which decisions related to the built environment can be made (including but not limited to Aafaq 2011; Smith & Aboummoh 2013; Pavan 2013; CDSI 2014; United Nations 2012; Ministry of Education 2017; and Alshuwaikhat et al. 2016).

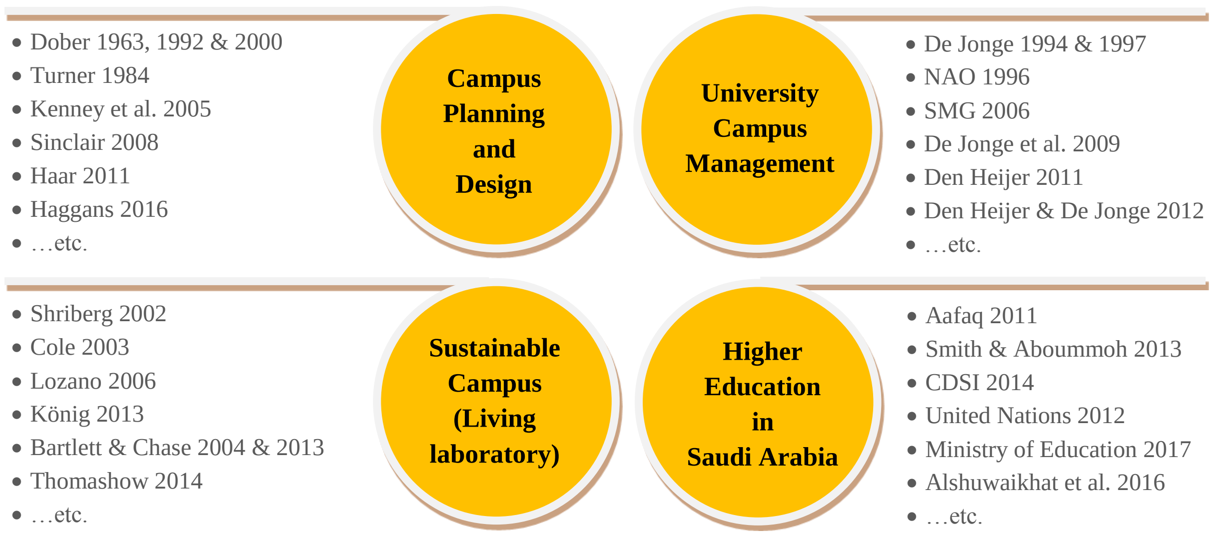


Figure 1.3: List of some materials consulted in relation to this research

1.7 Research methodology

The main research question and its sub-research questions cannot be answered without utilising a case studies approach. That is because case study – as 'a method of research' (Yin 2014, 03) or as 'a choice of what is to be studied' (Stake 2005, 443) – is for 'how' and 'why' type research questions. It is for research that does not require control of behavioural events and for studies focusing on contemporary events (Ibid). Therefore, the main form of inquiry in this research is case study. The research includes two multiple case studies. A) The main case studies were university campuses in Saudi Arabia. These cases can be defined by the subject of the research: sustainability. Sustainability implies a concern for economy, society, and environment. However, the focus of this research is on the environmental dimension and specifically the planning principles for sustainable campuses in Saudi Arabia. B) The other cases were from different parts of the world for the purpose of drawing lessons from best practices available that can be adopted to the Saudi case.

This research was undertaken in three main stages and a number of phases. Figure 1.4 shows that the three main stages were: exploration, explanation, and conclusion. Each stage has its own data-collection phases and techniques as follows:

- **Exploration Stage**: The first phase was to identify relevant sources and map the scholarly literature as well as other professional documents (e.g. architectural drawings of colleges and campuses including masterplans, sustainability reports, and strategic plans of universities). It includes developing a conceptual framework and an analytical tool. The second phase was a field trip to Saudi Arabia to visit eight selected cases and collect data through interviews, focus group, questionnaires, and observations. Phase three was to process the large data collected and analyse it. This phase explained many issues in the Saudi cases and hence the research problems were redefined, the focus was sharpened, and the research questions were reformulated.
- **Explanation Stage**: Phase three overlapped with the previous stage. This phase also included looking at some potential cases to be studied as best practices for sustainable campuses that are suitable for Saudi Arabia. Phase four was to select cases and make a visit to collect data. The selection was based on developed criteria. Two cases were

selected and they were both from the United States of America. This phase, however, did not go according to plan, because of an inability to acquire a visiting visa. Instead, only face-to-face interviews were conducted through some telecommunications application software (e.g. Skype and Facetime). Phase five was to process and analyse the data from the scholarly literature and from the interviews so that lessons could be drawn.

- **Conclusion**: In phase five, the preliminary planning guidelines to greening the Saudi Arabian university campuses were developed. Phase six was to review the proposed guidelines by conducting a field trip to Saudi Arabia so that interviews could be undertaken with experts (policy- and decision-makers) from some public universities and the Ministry of Education in order to evaluate the applicability and feasibility of the potential solutions proposed. However, due to time constraint, experts were interviewed through some telecommunications application software (e.g. Skype and Facetime). Sustainability experts from the United States were also consulted on the developed approach to advance sustainability in university campuses and insightful and credible feedback was obtained. The last phase, phase seven, was to further improve the guidelines and to finalise the research.

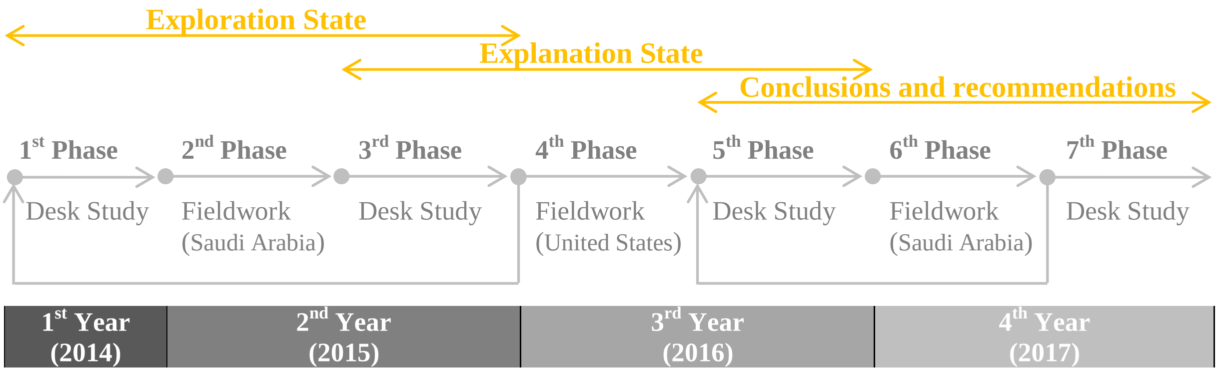


Figure 1.4: Research design

The explanatory nature of this research is a direct result of the little research that has been done on sustainable campuses in Saudi Arabia. Therefore, exploration is needed to understand this concept. Qualitative research is exploratory (Morse 1994), and such a method is needed as the topic is relatively new in Saudi Arabia and, as far as is known, has never been comprehensively addressed. On the other hand, the problems of the research are identifying factors (indicators/variables) with a numerical orientation. Thus, to understand the best predictors of outcomes, a quantitative approach was employed (Creswell 2003). This approach can be used to test and explain the research hypotheses at a later stage. Although this research is qualitatively driven, a quantitative approach supplements the qualitative study by providing deeper, broader, and fuller answers to the research questions (Johnson et al. 2007). Consequently, sequential mixed methods are utilised not only to capture the best of both quantitative and qualitative approaches (Creswell 2003), but also to illustrate the complementary relationship of these methods (Yin 2014). To sum up, the research has first the explored sustainable campuses concept to acquire more knowledge about it and then studied the variables using a statistical approach to obtain a more detailed explanation. In this case, the advantages of gathering both 'closed-ended quantitative data and open-ended qualitative data' prove advantageous to better comprehend the research problem (Creswell 2003, 24).

1.8 Research outline

The structure of this book takes the form of three parts, as shown in figure 1.5. Part I begin by laying out some key background information and introducing the research essentials. This part includes chapters one, two, and three. **Chapter two** introduces the theoretical dimensions of the research, how the conceptual framework was developed, and how the analytical tool used was formulated. In this chapter, the following sub-research questions were answered: *How can sustainable campuses be defined and measured?* And *Why is sustainability important in university campuses? And why is it particularly important to Saudi Arabia?* The **third chapter** presents the research design, strategy, methods, and data collection phases and techniques.

Part II of this book is about study of multiple cases and data analysis. It consists of two key chapters. **Chapter four** deals with the Saudi Arabian universities in which three sustainability aspects were evaluated through ten indicators as follows: Management aspects (vision, policy, planning, and commitments), engagement aspects (attitude, knowledge, and awareness of sustainability and willingness to change), and environment aspects (location, physical accessibility, flexibility, climate considerations, and space utilisation). This chapter looks at the Saudi Arabian campuses at two levels: macro (in which the planning of Saudi university campuses is assessed) and micro (in which the design of Saudi college building is evaluated). In chapter four, the following sub-research question was answered: *What are the main issues of sustainability in university campuses in Saudi Arabia?* **Chapter five** is concerned with learning from best practices available worldwide. Therefore, two benchmarking cases were chosen based on developed selection criteria. These cases are Arizona State University (Tempe Campus) and University of South Florida (Tampa Campus). Using the same three sustainability aspects and the ten indicators, this chapter draws lessons learnt from best practices available worldwide. This chapter answers the following sub-research question: *What lessons can the Kingdom learn about sustainable campuses in different parts of the world?*

Part III of this research presents the conclusions, recommendations, and reflections. It contains the last two chapters of this book. **Chapter six** outlines the practical outcome of this research which is the planning guidelines and the implementation plan (the six-step approach) to advance sustainability in universities. The guidelines propose potential solutions for not only improving the existing college buildings and university campuses, but also recommendations to prevent ‘mistakes’ from happening again in future developments. In this chapter, the following sub-research question was answered: *What approach can university campuses in Saudi Arabia adopt to become more environmentally sustainable?* **Chapter seven** provides theoretical output in which information, tools, and approaches to create more environmentally friendly university campuses are presented. In this chapter, the main research question was answered: *What information, tools, and approach will allow existing and new college buildings and campuses in Saudi Arabia to become more sustainable?*

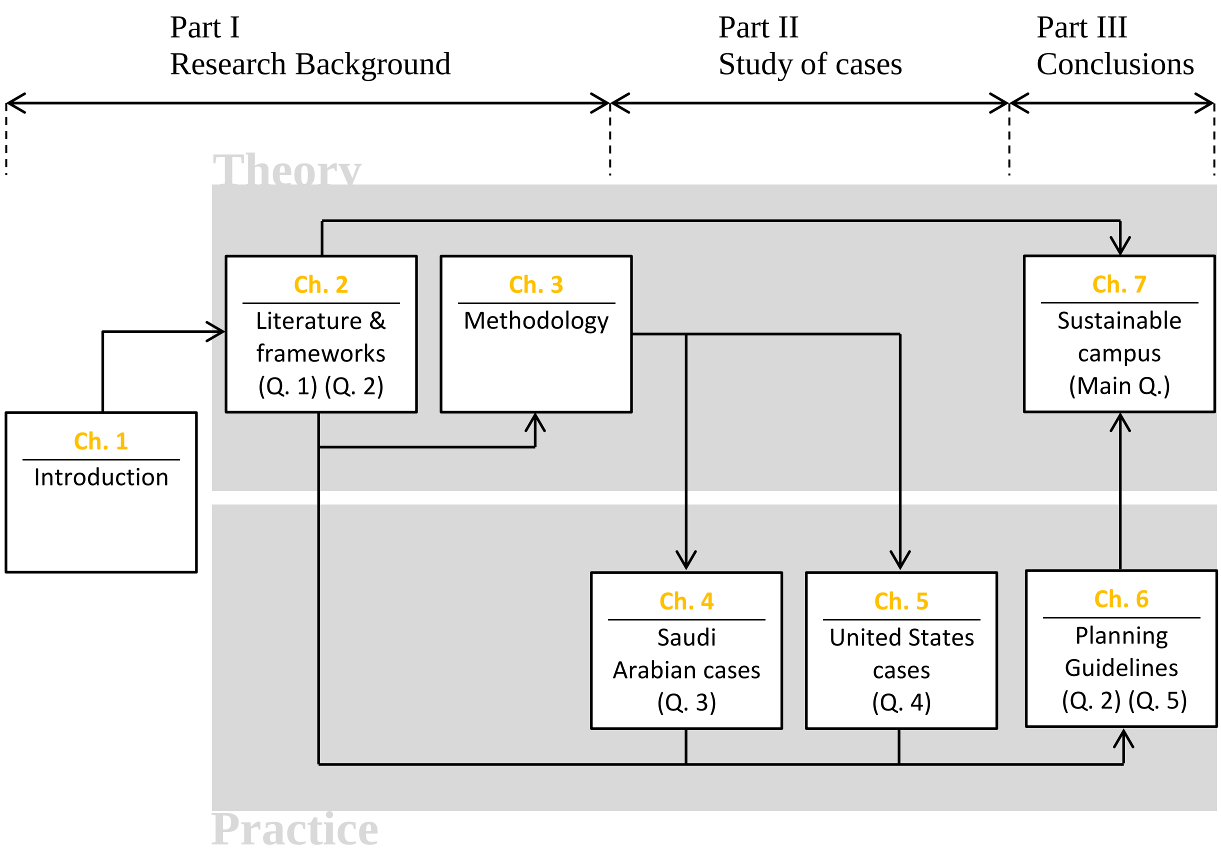


Figure 1.5: Research outline

1.9 Glossary of terms

This section presents the definition of some of the key terms used in this research. These definitions were either adopted from other scholarly sources or developed by this research, having undertaken extensive study.

Universities: This research adopts the definition of universities as ‘a place where people study for an undergraduate (= first) or postgraduate (= higher level) degree’ (Cambridge Dictionary 2017). It this research, higher education institutions, universities, colleges, and tertiary schools are used interchangeably. Haar (2011, 203) distinguishes between ‘college’ and ‘university’ as ‘colleges only award undergraduate (bachelor’s) degree, whereas universities are research oriented and award both undergraduate and graduate (master’s, professional, and Ph.D.) degrees’ and this is applicable in this research.

Campus: This research adopts the definition of campus as ‘the grounds and buildings of a university or college’ and its origin is from Latin campus ‘field’ (Oxford Dictionary 2017).

Sustainability: This research acknowledges that the most well-known definition of sustainability – or as many described as the root meaning of sustainability (Kirk 2003) –is stated in 1983 by Gro Harlem Brundtland, a Commissioner of the World Commission on Environment and Development, in which he succinctly says ‘Sustainability development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs’ (United Nations 1987). Therefore, sustainability is a powerful concept which is generally accessible and broadly agreed upon. Its foundations rest upon notions of *current* maintenance and preservation for *future* generations. What are built on top of these foundations are common ideas of care for one's environment, appreciating the value of society and acting responsibly and accountably (Alghamdi et al. 2017).

Sustainable university: This research concludes that 'when thinking about a 'sustainable university', its campus has to consider the implementation of sustainable practices (environmentally, economically, socially and educationally) through its campus life cycle (planning, constructing, operating, maintaining, and retrofitting) through all management directions (top-down as well as bottom-up approaches) on all levels of campus (from classrooms to laboratories, transportation, procurement, housing and other services) in many ways (e.g. energy saving, water conservation, air quality, social equity, waste reduction, walkability, well-being and health) or in many different shapes and forms (e.g. flexibility, multi-functionality, optimal space utilisation)' (Alghamdi 2018, 115).

Campus planning: This research adopts the definition of campus planning proposed by Dober (1963). He defines campus planning as 'the premediated guidance of the amount, quality, and location of facilities for higher education so as to achieve a predetermined objective. The objective is the plan. The plan may be illustrated as a physical form. Depending on the type of the plan the form may range from a portion of a building to the entire campus and its environs' (Ibid, 54). Campus plan, institutional plan, Master plan, Development plan, and physical plan are used in this research interchangeably. Four factors distinguish between different types of campus plans: time (the span of time reflected in the plan), size (the physical area encompassed by the plan), program (the precision of the program), and style (the characteristics of the design) (Ibid, 46).

Campus management: This research adopts the definition of campus management as 'the collection of strategic management tasks to match the university campus with the changing context and various stakeholders' demands, adding value to the university's performance' (Den Heijer 2011, 53).

Qualities of space: This research adopts the definition of qualities of space as spaces that 'enhance learning, encourage or facilitate social interchange and experiential learning, accommodate multiple pedagogies, promote collaboration and interaction, and address creature comforts' (Chiang et al. 2008, 5).

Flexibility: This research explores some of the properties of flexibility. That is only in terms of building elements, furniture, and time. This research adopted the following definitions: 'flexibility refers to the ability of built space to accommodate for unforeseeable changes such as demographic shifts, community needs, or policy mandates' (Moore and Lackney 1994). And 'physical flexibility refers to the adjustability of a space to the practices of individuals, such as meeting the special sensory and/or mobility needs of students. Movable furniture and walls, or re-configurable buildings, rooms, and passageways all represent this type of physical flexibility' (Monahan 2002). As for the flexible time, it refers to strategies that can be employed by universities such as online education (offering distance education or distance learning to both undergraduates and postgraduates), flexible work schedules (allowing for flexible work schedules for faculty and staff members and introducing a condensed work week option for employees), and remote work (exploring other alternatives to conventional arraignment of working options, known as tele-work, tele-commute, or work-from-home).

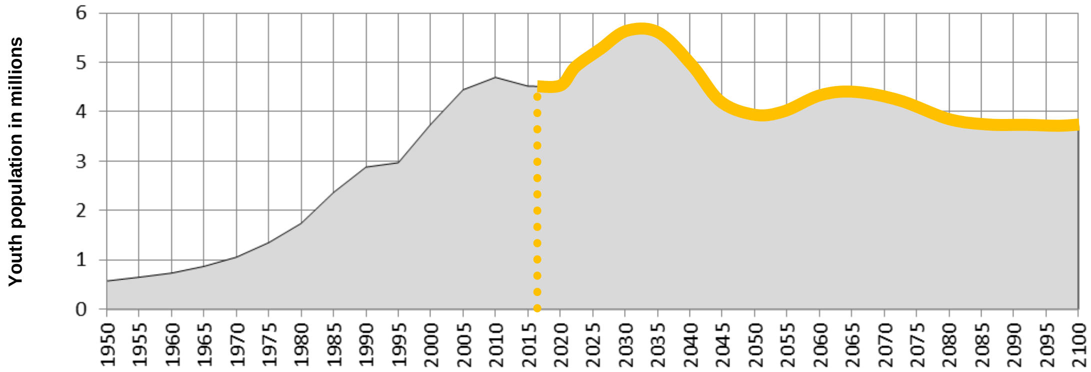
Space utilisation: This research adopts the definition of space utilisation from the Space Management Group in the United Kingdom. In one of their early reports (SMG 2006, 03), they concisely defined space utilisation key terms as following: Space utilisation is 'a measure of whether and how space is being used'. Space utilisation rate is 'a function of a frequency rate and an occupancy rate'. Frequency rate 'measures the proportion of time that space is used compared to its availability', while the occupancy rate 'measures how full the space is compared to its capacity'.

Notes

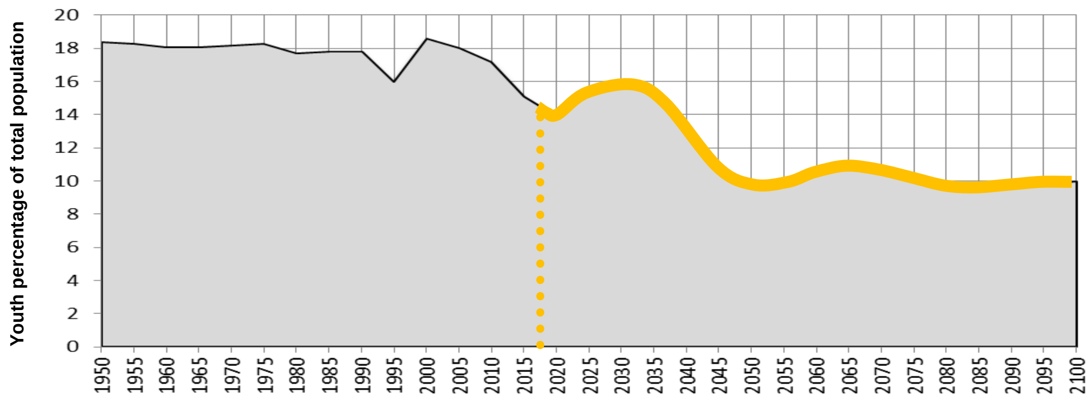
Note 1

United Nations projection of Saudi Arabian youth population

The United Nations (UN) projection of Saudi Arabian youth population indicates an increase in the next two decades and then a dramatic decline of the youth population. The drop is expected to continue for many decades. This issue can also be seen in Note 1.1, which illustrates the UN forecast about the percentage of the youth population compared with the rest of the segments of Saudi society. The youth segment percentage will continue to shrink. These figures must be taken into account when planning for any development, such as university campuses in Saudi Arabia and elsewhere. Note 1.2 shows the percentage of youth aged between 14 and 24 among other segments of the Saudi society. It mirrors the trend shown in Note 1.1, which illustrates an increase (in the short- and medium-terms) followed by a continuous decline in the youth population (in the long-term).



Note 1.1: Saudi Arabia youth population in millions (United Nations 2012)



Note 1.2: Saudi Arabia youth percentage of total population (United Nations 2012)

Source:

- Central Department of Statistics and Information in Saudi Arabia - (CDSI 2014).
- United Nations - World Population Prospects of Saudi Arabia (United Nations 2012).

Note 2

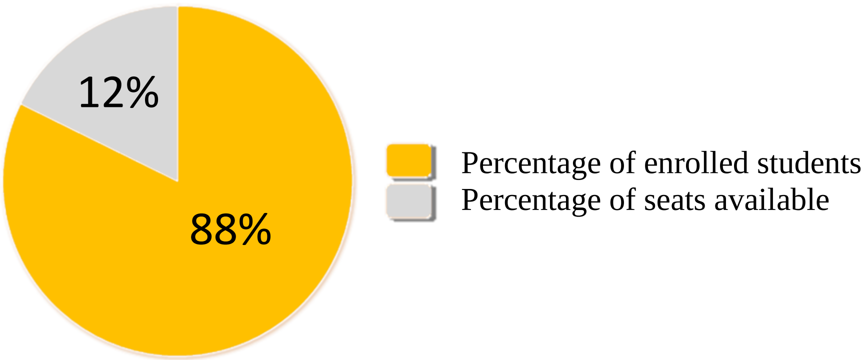
The status of admission in Saudi Arabian public universities

Notes 1.3 and 1.4 present the status of admission in Saudi Arabian public universities in 2015-2016 for Full-time equivalent (FTE) according to statistics released by the Center for Education Statistics (CES), Agency of Planning and Information (API), at the Ministry of Education:

Note 1.3: Status of admission in public universities 2015-2016 (Ministry of Education 2015)

Total seats in all public universities		Total number of enrolled students so far		Total seats available (vacant places)	
249,086 (100%)		218,253* (88%)		31,525 (12%)	
Male	Female	Male	Female	Male	Female
118,700 (48%)	130,386 (52%)	99,538 (46%)	118,715 (54%)	18,956 (60%)	12,569 (40%)

* This figure is an increase of 0.3% (692 students) over the planned capacity figure of 249,086. This gap can be explained by the fact that while some departments exceeded their capacity limit, others admitted less than their capacity.



Note 1.4: Percentages of seats available in public universities 2015-2016 (Ministry of Education 2015)

Other issues to consider as reasons that may, to a large extent, play an important role in the figure of total seats yet available were:

- **Internal scholarships:** A report released in December 2014 from the Ministry of Education (formerly known as Ministry of Higher Education) indicated that there are 32,000 internal scholarships for foreigners studying in the public universities this year (SABG 2014). (This figure, 32,000, represents 14% of the total enrolment). These students usually come from 155 different countries with the majority of them from Yemen, Syria, Egypt, Sudan, Jordan, Libya, Tunisia, Algeria, Morocco, Mauritania, Pakistan, and Indonesia.
- **External scholarships' program:** In May 2015, the Ministry of Education (formerly known as Ministry of Higher Education) announced the results of the King Scholarship Program 10th Stage for Saudi students (MHE 2015). There were 10,491 candidates to be sent abroad next year (medical subjects 40%, engineering and computer 20%, economic and finance 17%, and 23% for other subjects). (This figure, 10,491, represents almost 5% of the total enrolment).

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Chapter 2

Literature and Frameworks

"Sustainability is needed and it is not just 'nice' to have"
Katherine Richardson
Chair of the Scientific Steering Committee at University of Copenhagen

2. 1 Introduction

In the previous chapter the focus was on introducing this research project. The chapter principally established the context and the background. It briefly showed the research problems, stated the purpose and research questions, highlighted the limitations, provided the research outline, and defined key terms used throughout this study.

The aim of this chapter is to present the theoretical dimensions of the research. It highlights and analyses the existing knowledge. It maps ideas, perspectives, and arguments (Hart 1998). The further aim of this chapter is to establish how the conceptual framework was developed as well as how the analytical tool was formulated. The former helps to describe what is going to be studied, whereas the latter is used to evaluate what is going to be studied. The other objectives of this chapter are defining important terms, identifying key models, and reviewing past and recent related studies.

Along with highlighting the conceptual framework and the analytical tool, the two sub-research questions to be answered in this chapter are '*How can a sustainable campus be defined and assessed?'* And '*Why is sustainability important in university campuses? And why is it particularly important to Saudi Arabia?'*

In order to achieve the aim of this chapter as well as to answer the above mentioned questions, a systematic review of relevant scholarly literature and professional documents were carried out. This was not only to underline what is known already in the field of university campuses from different perspectives, but also to outline important concepts, models, and theories that relate to this research.

This chapter takes the form of four sections. The second section begins with analysing the main four bodies of knowledge that this research focuses on. These four literature domains are: (1) campus planning and design, (2) campus management, (3) sustainability and university campuses, and (4) higher education in Saudi Arabia. The third section shows the conceptual framework as well as the analytical framework. The last section summarises the review of previous literature and answers the raised sub-research questions.

2. 2 The four knowledge domains

The title of this research – *University campuses in Saudi Arabia: Sustainability challenges and potential solutions* – along with the main research question – *What information, tools, and approaches will allow existing and new college buildings and campuses in Saudi Arabia to become more sustainable?* – indicate a need to review relevant bodies of knowledge. The research is based on four domains of literature: campus planning and design, university campus management, sustainability, and higher education in Saudi Arabia. In order to understand every domain and its relationship to the current research, key ideas and theories from each domain are systematically outlined, evaluated, and critically analysed. Figure 2.1 shows the four literature domains:

- **Campus planning and design**. Main theories of planning and best practices in designing a sustainable campus were reviewed, so as to find out the most recent and advanced planning and design principles of university campuses (including but not limited to Dober 1963, 1992, & 2000; Turner 1984; Kenney et al. 2005; Sinclair 2008; Haar 2011; Haggans 2016).

- **University campus management**. Main theories of managing the university campus were explored to learn more about improving campus management through crucial information and tools benefiting policy makers from operational to strategic level for making effective decisions adding value to the campus and beyond (including but not limited to De Jonge 1994 & 1997; NAO 1996; SMG 2006; De Jonge et al. 2009; Den Heijer 2011; and Den Heijer & De Jonge 2012).
- **Sustainable campus (Living laboratory)**. Main theories and principles of 'sustainable development' in general and 'sustainable campus' in particular were explored to define and outline the evolving concept of 'sustainability' in the built environment so as to learn more about the conceptual approaches, information, and tools that help advancing sustainability in university campuses (including but not limited to Shriberg 2002; Cole 2003; Lozano 2006a; König 2013; Bartlett & Chase 2004 & 2013; and Thomashow 2014).
- **Higher education in Saudi Arabia**. A detailed overview of higher education in Saudi Arabia was conducted to comprehend the system through acquiring more knowledge about its history and recent developments. This was to build a solid database upon which decisions related to the built environment can be made (including but not limited to Aafaq 2011; Smith & Aboummoh 2013; CDSI 2014; United Nations 2012; Ministry of Education 2017; and Alshuwaikhat et al. 2016).

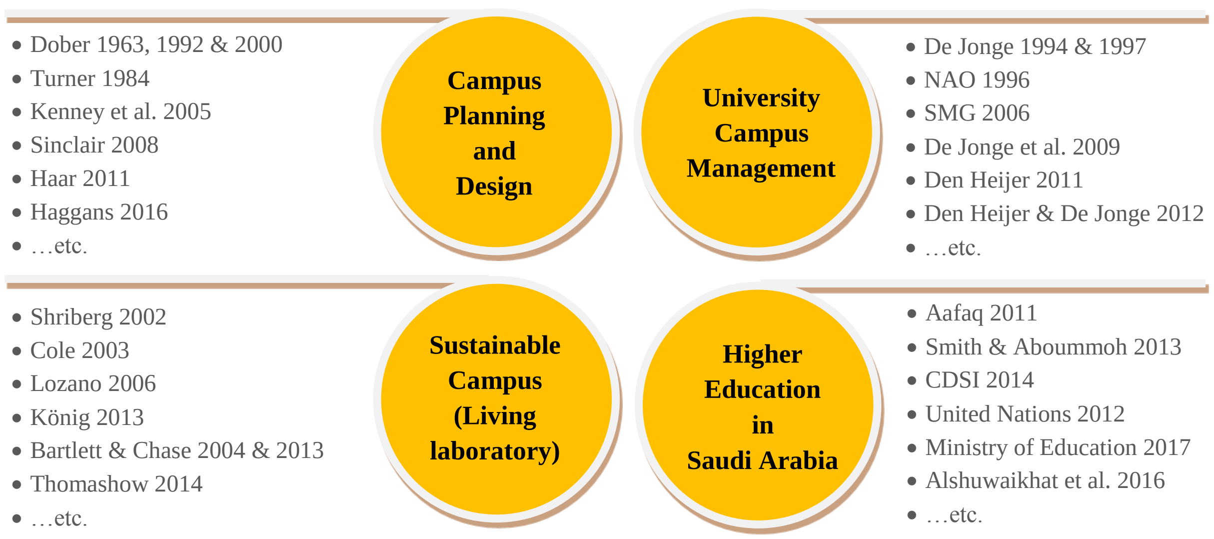


Figure 2.1: List of some materials consulted in relation to this research.

2.2.1 Campus planning and design

The research literature four domains

One of the first authors, if not the first, to address the university campus planning, design, and landscapes is Richard Dober (1963) (1992) (2000), respectively. Although these books were released decades ago, they can be considered, to a large extent, as practical reference books for any university planner. Tertiary education is considered as a 'big business' and 'its continuing growth is a national asset' (Dober 1963, 11). Campus planning as defined by Dober (Ibid, 54) is 'the premediated guidance of the amount, quality, and location of facilities for higher education so as to achieve a predetermined objective. The objective is the plan. The plan may be illustrated as a physical form. Depending on the type of the plan the form may range from a portion of a building to the entire campus and its environs'. Campus plan, institutional plan, master plan, development plan, and physical plan are all used in this research interchangeably. Four factors distinguish between different types of campus plans: time (the span of time reflected in the plan), size (the physical area encompassed by the plan), program (the precision of the program), and style (the characteristics of the design) (Ibid, 46). Dober's publications are important, since there are many similarities in the Saudi Arabian model of planning public universities with that of the American.

Campus planners deal with a number of important issues. These issues include higher education and future trends, enrolment projections, programming, architectural style, facilities and their condition, location, physical accessibility, circulation and parking, housing, sports and recreation, and services and utilities. On the other hand, the plan itself can be about a design of a new campus, an expansion of existing facilities, or maybe just a renovation of a college building.

● Youth population projections and the enrolment forecasts

Planning for higher education facilities is of great importance especially at the national level. This is to understand what needs to be accomplished in the short-, medium-, and long-terms. Enrolment estimations are hugely influenced by the youth population projections aged between 18 and 21, among other factors. Dober (1963, 5) believes that campus planning can be described in three ways: 'examining enrolment projections, evaluating what these mean as to physical plant, and making a common sense judgment as to what conditions or events will affect these prognostications.' Among other segments of any society, the youth population projections are important to estimate, to a large degree, the expected number of enrolment in higher education institutions. The youth population projections can be obtained from the national census data. Specialists can estimate the enrolment rates in the short-term and medium-term in public colleges and universities. However, Dober (Ibid, 8) argues that 'what is true for the nation does not necessarily hold for all institutions, particularly private schools which have the alternative of controlling their size and growth, and public institutions located in regions where there are strong migrations in and out of the state.' Therefore, enrolment projections in certain types of universities can be impacted in different magnitudes.

● Scenario planning

Projections and estimations can be greatly helped by scenario planning. The latter has been well-defined and explored by many scholars. Porter (1985, 63) defines scenario planning as 'an internally consistent view of what the future might turn out to be – not a forecast, but one possible future outcome'. Schwartz (1991, 45) defines it as 'a tool for ordering one's perceptions about alternative future environments in which one's decisions might be played out.' Ringland (2006, 4) defines it as 'that part of strategic planning that relates to the tools and technologies for managing the uncertainties of the future.' There are many planning tools and approaches that exist and used by governments, companies, and other organisations including universities. Examples of these planning tools include experts' scenarios, morphological approaches, cross-impact approaches (Ibid, 21). Ringland (Ibid, 27) believes that:

> *'trend-impact analysis, which is concerned with the effects of trends, for instance... populations, over a period of time. The work done to isolate the important trends... looking for the unexpected; that is, what could upset the trends'.*

Ringland (Ibid, 33) indicates that in a comparison of scenarios and forecasting, the latter can be of great assistance in reliably predicting issues such as 'demographics or technology'. This can be carried out by the widely used method of Delphi. Delphi panels are used to 'establish and verify critical variables and indicators, which both trend-impact analysis and cross-impact analysis would then help to assess the implications of the interactions among critical variables and indicators' (Ibid, 18). The reasons for favouring such an approach is because it 'involves reaching a consensus view among experts through iteration... which allows envisioning several years ahead' (Ibid, 34). Consequently, such an approach can be used to help mitigate the uncertainty in forecasting the youth population and hence improving the estimation for future enrolment in higher education institutions.

● Rate of admission in universities

Another key factor that plays an important role in the population of universities is the rate of admission, especially in public higher education institutions. Ministries of education, or related government organisations, have the control over the percentage of high school graduates to be admitted to public colleges and universities. Depending on the interest of the nation, the admission standards and rates can be either raised or lowered. The needs and the ever increasing desires to go to university play an additional role. Such 'needs and desires may be outpaced planning' and similarly 'construction' (Dober 1963, 8). As a result, planning for higher education facilities should be approached proactively and not reactively, given the time needed to plan and build the desirable facilities.

There are other important factors that play essential parts in the planning for higher education facilities. These factors include capital investments, science, and technology (such as online learning and education). On one hand, how to finance planning, constructing, operating, maintaining, and modernising university campuses have all become very challenging tasks. Resources have become limited and both public and private institutions are experiencing such capital shortages. On the other hand, science and technology are also impacting the growth of universities. Dober (1963, 9) believes that 'where the wealth of a nation was once measured by capital and population, a true scale of progress today lies in its capacity to promote research in science and its application to technology.' He adds that 'in significant ways, observable if not measurable, colleges and universities will thus expand for important reasons other than increasing numbers' (Ibid, 10). However, distance education has made some impact on the physical plant of universities. In the United States, it is reported that around one in ten undergraduate students enrol exclusively online (Jaggars et al. 2013; U.S. Department of Education 2013). Hillman and Weichman (2016, 2) argue that 'research has yet to show that distance learning provides quality equal to or greater than place-based learning'. This does not mean that the physical plant of the university has not been impacted. Haggans (2016, 5) indicates that 'most campuses already have either too much capacity or few students'. This shows, yet again, that planning for higher education facilities are vitally significant particularly at the national level.

● Campus location

Another aspect of campus planning is the geographical location of the higher education institutions. The location of colleges and universities is of strategic importance. This is because it has many profound positive aspects to every region, city, or towns economically and socially. Economically, locating a college building or a university campus in any community adds many economic values such as increasing value of land and real estate. Having a college can be considered as very much a community asset. Dober (1963, 24) states that ‘Intense competition even led to bidding among towns for a college to be located within its boundaries.’ He adds that ‘the usefulness of the campus to promote local real estate development was not limited to one period of history or to one region.’

Traditionally, many university campuses were intentionally located in remote sites ‘to avoid the conflict and distractions presented by cities’ (Haar 2011, xx). Historically, and especially in the United States of America, a number of campuses located in the countryside believing that ‘the academic ideal has been profoundly suburbanised, where a rural setting is part of the definition of academic excellence’ (Bender 1988, v). Turner (1984, 4) confirms this saying that:

> *‘... the placing of colleges in the countryside or even in the wilderness, an unprecedented break with the European tradition. The romantic notion of a college in nature, removed from the corrupting force of the city, became an American ideal. But in the process, the college has to become even more fully a kind of miniature city. And its design became an experiment in urbanism.’*

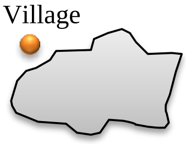
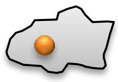
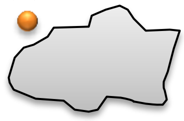
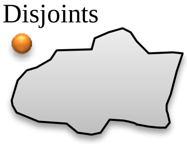
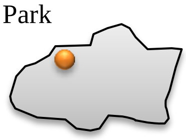
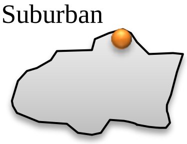
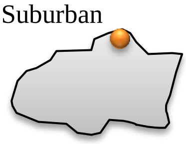
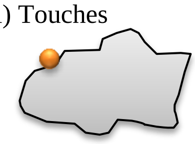
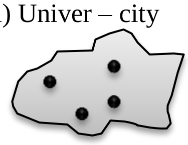
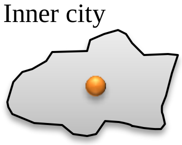
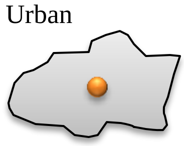
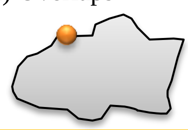
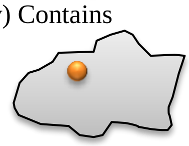
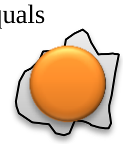
One might ask about the relationship between the location of the college or university and the students’ preference in selecting the institution. Based on research undertaken by Eagan et al. (2014), Hillman and Weichman (2016, 2) state that in America, ‘place still matters, in fact, the majority – 57.4 percent – of incoming freshmen attending public four-year colleges enrol within 50 miles [80 kilometres] from their permanent home’. This highlights the fact that the location is still important even in the 21st century.

Scholars have classified the locations of campuses into a number of categories. Table 2.1 shows a summary of the main typologies of locations of campuses (Den Heijer 2011; König 2013; Thomashow 2014; Curvelo Magdaniel 2016). It presents the physical connection between the university campus and the city or town. The ‘town-gown relationship’ between the university and the city brings benefits for both parties (Kenney et al. 2005, 62). In general, classification of the locations can be grouped in three main categories, regardless of the terminology used to describe the location label. These three categories were captured by Thomashow (2014) and are adopted by this research:

- **Rural**: The location of the campus is remote and it is far away from the city. The campus can be regarded as a city in itself. The campus, therefore, shares almost nothing with the cities around it. Terms in this category maybe include village, college town, and disjoint.
- **Suburban**: The location of the campus tends to be at the edge of the urban area. The campus can be described as a suburban if it is located at the urban fringe of its city. Being almost at the border of the city means there are some opportunities to share some facilities and functions with the city. Terms in this category maybe include park, overlap, and touch.

- **Urban**: The location of the campus is within the city boundaries. The campus is part of the city and has the prospects of taking advantages of whatever the city can offer (facilities, utilities, and services). The higher education institution may have one campus/building or many satellite campuses/buildings within the city. Terms in this category maybe include Univer – city, inner city, and contain.

Table 2.1: The main typologies of locations of campuses

Scholar	Den Heijer (2011, 182)	König (2013, 52)	Thomashow (2014, 30)	Curvelo Magdaniel (2016, 114)
Classification of campus locations	i) Village 	i) College town 	i) Rural 	i) Disjoints 
	ii) Park 	ii) Suburban 	ii) Suburban 	ii) Touches 
	iii) Univer – city 	iii) Inner city 	iii) Urban 	iii) Overlaps 
				iv) Contains 
Legend: Buildings, Campus, City				v) Equals 

The advantages of good location for the university campus can be used as an attractive factor. Research shows that 'where universities possessed a particularly distinctive campus (and/or location), the survey results clearly indicated that this was a marketing lever' (CABE 2005, 22). This indicates the importance of locations of higher education institutions which can be employed as advertising tool for the sake of the university.

The locations of the university campuses can also promote innovation locally and regionally. Curvelo Magdaniel (2016, 18) points out that 'Location decisions and area development facilitate the long-term concentration of innovative organisations in cities and regions.' This means that the decision to locate the university campus has a consequence not only on the short-term, but also on the long-term too. Choosing a location is of vital importance not only to the university, but also its community. This emphasises the strategic choice to be taken when locating the higher education facilities.

This leads us to think about how to select a location for the university campus. In the Green Building and LEED Core Concepts Guide (USGBC 2010, 52), there are six strategies to be used when selecting a more sustainable site:

- 'Choose redevelopment and infill development. Build on previously developed land and brownfield sites.
- Locate near existing infrastructure. Avoid triggering suburban sprawl and unnecessary materials use by consolidating development along existing roads, power lines, and water supplies.
- Protect habitat. Give preference to locations that do not include sensitive site elements and land types.
- Increase density. Create a smaller footprint and maximize the floor-area ratio or square footage per acre.
- Increase diversity. Provide the services that are most needed within communities and support a balance of jobs and housing.
- Encourage multiple modes of transportation. Enable occupants to walk, bicycle, and use public transit.'

● Campus planning and design

The task of planning and designing facilities for a higher education institution is immense, involves many stakeholders, and takes years or decades. Turner (1984, 4) states that planning 'can mean many different things, ranging from the design of a single building to the creation of a master plan involving many structures, their surrounding environment, and the gradual execution if the plan over a period of time.' This shows the perspectives to bear in mind when planning and designing a university campus.

There are many issues to address when planning and designing the university campuses. Dober (1992, 233) presents a list of factors to consider when planning and designing a university campus, as shown below:

- Transportation (Airports, Highways, Transit, and Traffic capacity),
- Demographics (Adequate population, and employment opportunities),
- Housing (Owned-occupied housing and rent, and rental units and land),
- Geotechnical (Exclusionary conditions, foundation conditions, hydrology, seismology, and typology),
- Site appeal (Visual resources, land use control, adjacent land use, cultural amenities, recreation, commercial land, education, health care, emergency services),
- Public support (Public expressions, and growth policy),
- Environmental (Environmental site assessment such as hazardous materials/waste, cultural resources, noise or odour, climate, biological resources, water supply and quality, and air quality),
- Site availability (Easements, ownership and use, assembly, relocation, public access, and size and configuration), and
- Utilities (Utility available).

There are other design principles that planners and architects deal with in planning higher education facilities. Kenney et al. (2005) proposed some of these principles including:

- Meaningful places (Enhancing 'a student's experience from every day experiences to once-in-a-lifetime events' (Ibid, 74), increasing the competitive advantages through 'creating a good first impression' (Ibid, 76), symbolising the institution's identity, increasing 'density or compactness of uses and spaces for interaction' (Ibid, 80), providing synergism 'by intermixing various campus uses' (Ibid, 81), designing and implementing 'campus landscape establishes the campus's overall character and beauty' (Ibid), 'mastering the need for automotive access on campus' given that 'on some campuses, roadway and parking consume up to 40 percent of the developed campus land' (Ibid), maintaining the buildings of the campus because 'they contribute to the overall life and vitality of the campus' (Ibid), providing cutting-edge technology such as wireless internet to the campus –wide community improve the experience).

- Comprehensive campus plan (such plan can 'express the idea or vision of the institution, guide growth and change, [and] reinforce the strategic plan' (Ibid, 88)).
- Density (The idea of a dense or compact campus is 'a close adjacency of buildings and functions' (Ibid, 105). The advantage is that 'this physical compactness allows students and faculty to walk more easily from one place to another, encouraging interaction and community, and reinforcing a sense of place and institutional identity' (Ibid). Promoting interaction and encountering may lead to stimulate innovation. Den Heijer (2011, 98) states that 'innovation in primary processes can be achieved by stimulating planned and unplanned encounters between uses adding to serendipity, unintentionally making discoveries or finding new solutions by the interference of others').
- A mixture of campus uses (The campus serves many functions or uses including academic, research, offices, residential, sports, recreation, parking, and other supporting services. Mixing these functions means physically mingling them 'within a single building or in a group of buildings arranged in such a way that they utilise common spaces collectively over an extended period of time' (Ibid, 121). The academic, social, and fiscal advantages of a mixture of campus uses are 'increased collegiality and community, enhanced learning, safety, competitive admissions, [and] flexibility for growth' (Ibid, 132)).
- Landscape (Landscaping is used by many universities as a tool to distinguish themselves through 'the development of a coherent and consistent landscape' (Ibid, 137). Landscaping the campus can be regarded as an added value and hence acting as an attractive element for the institution. It enhances the experience of users, visitors, and surrounding communities. 'The sensory richness of colour, texture, and scale in the landscape contribute to its beauty, and is also a deeply satisfying experience in itself... The campus landscape can provide a laboratory for classes in biology, ecology, and related work' (Kenney et al. 2005, 145). On the other hand, 'trees are valuable assets on campus' (Ibid, 146). Trees on campus provide both environmental and economic benefits. For example, in summers, trees can provide much needed shade for buildings and hence decrease the heating load. In winters, however, trees can be used as windbreaks, which then cut the heating bills (Ibid)).
- Green campus (Any campus that is well planned and designed and that can provide 'memorable places' and that can 'promote community, collegiality, vitality, and a learning environment is, in many ways, a green campus' (Ibid, 156). The campus plan and layout is the single most significant impact on 'achieving a sustainable campus', which is the 'overall organisation of the campus and its facilities' (Ibid, 157). Some of the main issues to be considered are: the solar orientation of buildings, optimising utilisation, minimising impact by reusing the sites and buildings in all possible ways, reducing dependence on the automobile, spacing and massing the buildings can help 'cutting operating costs by up to 60%' (Ibid, 162), 'build for the long term while maximising building flexibility for reuse, reduce maintenance requirements, strive to minimise the full life-cycle costs of the materials used, [and] use materials with low environmental impact' (Ibid, 163)).

Campuses in Arabic countries particularly in the Gulf region (Saudi Arabia, United Arab Emirates, Bahrain, Kuwait, Oman, and Qatar) have their own planning and design characteristics. Such physical characteristics have given an attention to the region's climate through borrowing a number of traditional strategies. Planners and architects employ both passive and active design strategies. The former (passive strategies) can tremendously help the latter (active strategies) by making climate considerations much easier. Examples of sustainable campuses, seen in figure 2.2, which were designed using passive as well as active measurements in the Gulf region, include the following:

- King Abdullah University for Science and Technology (KAUST) in Thuwal, Saudi Arabia
- Masdar Institute (MI) in Abu Dhabi, United Arab Emirates
- Qatar University (QU) in Doha, State of Qatar.

They all share the same principle of compacted pattern. For example, to show the importance of passive solutions, the architect HOK, who designed KAUST campus, has borrowed five design strategies from local culture and traditions to address the environmental concerns. These five strategies were summarised by the American Institute of Architects (2017) as follows:

1. *'Structured like traditional Arabic cities, the campus is compressed as much as possible to minimize the amount of exterior envelope exposed to the sun and reduce outdoor walking distances.*
2. *As found in a traditional souk, or Arabic market, shaded and passively cooled circulation thoroughfares are characterized by dramatic light and social spaces.*
3. *The Arabic Bedouin tent inspired designers to create a monumental roof system that spans across building masses to block sun on building facades and into the pedestrian spine, to facilitate natural ventilation and to filter light. Solar panels covering the surface capture the sun's energy.*
4. *Passive ventilation strategies of the traditional Arabic house influenced the design of iconic, solar-powered wind towers that harness energy from the sun and wind to passively create airflow in pedestrian walkways.*
5. *Similar to Arabic screening called 'mashrabiya,' the campus shades windows and skylights with an integral shading system that reduces heat loads while creating dramatic dappled light.'*

Another example of employing a range of passive along with active solutions can be found in Masdar Institute (MI). The Institute, which forms part of Masdar City known as the most sustainable city in the world, designed by Foster and Partners who emulate many of the local elements. According to Mitchell (2015, 41):

> *'Buildings are arranged to create a series of narrow alleys and open plazas, one of which contains a large-scale wind tower with integrated mist generators to direct breezes down into open court... Masdar Institute buildings employ a number of passive measures, such as louvers and glass-reinforces concrete (GRC) screens to block direct solar radiation and allow airflow. Buildings rely on natural ventilation during cooler months – air enters into the ground floor and, as it is heated, rises and escapes through openings on the upper floor.'*

As a result, MI campus is believed to have sustainable facilities that show green practices and operations. The MI (2017) indicates that:

> *'The Masdar Institute campus has clean technology at its core. It has been built to consume 75 percent less in cooling demand than a conventional building of its size, as well as 70 percent less in potable water, 95 percent less in domestic hot water energy and 70 percent less in electricity. The campus offers students a unique opportunity to experience what cutting-edge technology can do for the environment.'*

Qatar University (QU) campus was designed by an Egyptian architect Kamal El Kafrawi and opened its door in 1985. The campus consists of systematic octagonal modules roofed by wind towers which facilitate the flow of air and permit the natural light to flood inside. Mitchell (2015, 41) describes the design of QU campus as:

> *'a significant example of an early attempt to develop a contextual approach to campus planning. Except for buildings housing the administration, student activities and ancillary services, the initial phase of the campus was developed according to a series of octagonal modules arranged according to an 8.40-by-8.40-metre grid interspersed with 3.48-by-3.48-metre modules. Academic buildings do not exceed two floors, while the library is three storeys in height to indicate its primary role as the symbolic 'centre' of the campus. The octagonal modules used for the library and the academic buildings are capped with a square wind tower-like element that mediates light and facilitates airflow in the open spaces; when the modules are combined to create larger open spaces, precast roof trusses or cast-in-place folded plates are used. In addition to region-specific visual references such as the wind tower, grilles throughout the project recall mashrabiya (interlaced screens used to control light, reduce glare, facilitate airflow and maintain privacy).'*

Qatar University is believed to be the first university in the Gulf region to measure its campus carbon footprint (QU 2017). This is part of the institution's sustainability initiative, which is a pledge to environmental sustainability through research, teaching, and operational practices in QU campus and beyond. The university used the well-known Campus Carbon Calculator, developed by the Sustainability Institute at the University of New Hampshire. The calculator has now been changed into Sustainability Indicator Management and Analysis Platform (SIMAP 2017), a carbon and nitrogen-accounting platform which can track, analyse, and improve campus-wide sustainability.

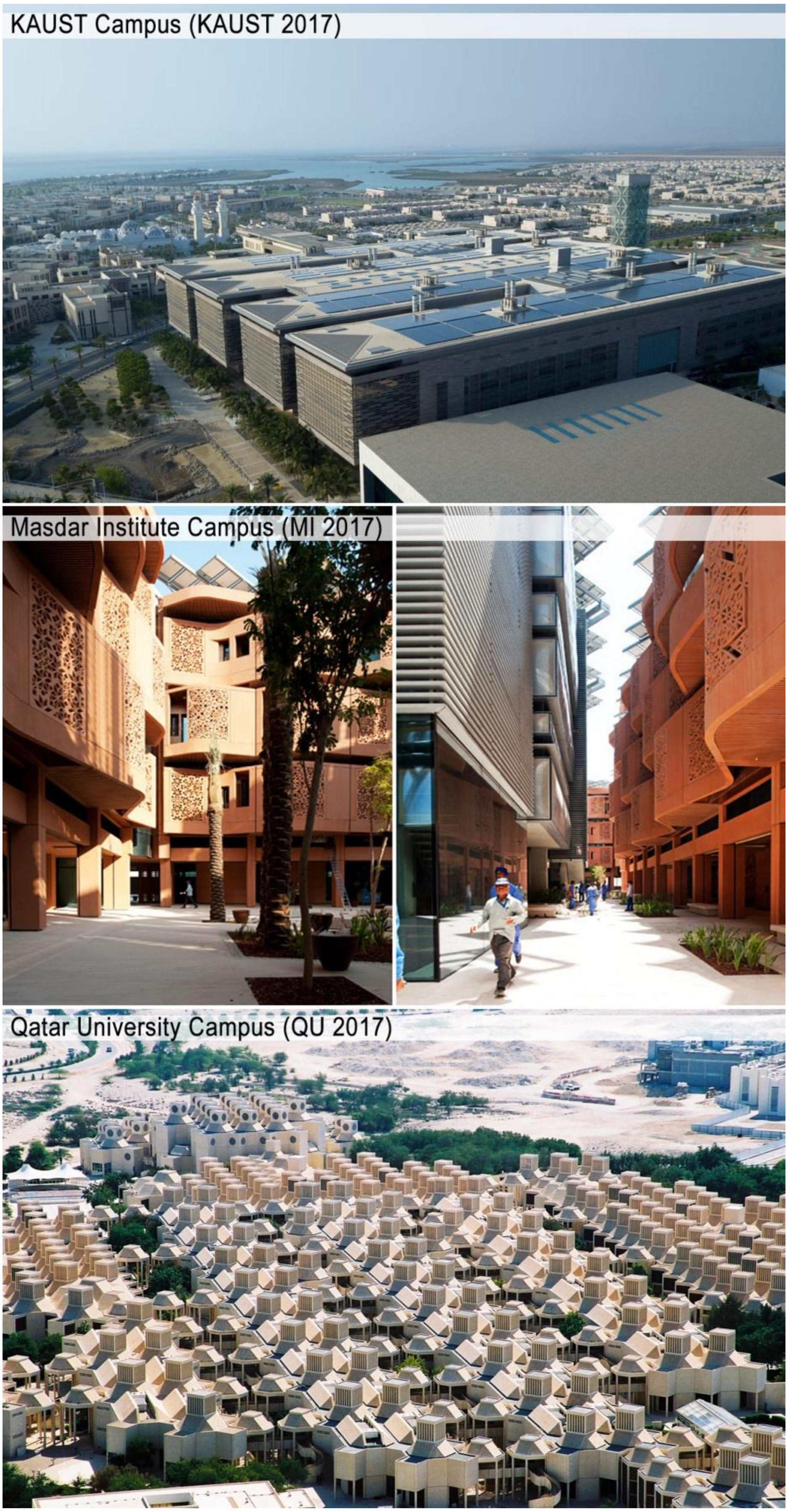


Figure 2.2: Environmental solutions in campuses of KAUST, Masdar Institute, and Qatar University

● Physical accessibility

The physical accessibility is an issue to be addressed especially in countries that can be characterised as car-oriented societies. Transportation is one of the problems that has no simple, quick, or cheap fix. 'Tackling the issues of the automobile's impact on campus is not easy, but it can have great rewards' (Kenney et al. 2005, 187). Transportation might be addressed through both management strategies and campus planning and design strategies. It has to be noted that there are some strategies that can be implemented immediately whilst others, however, cannot unless some alternatives are in place and ready for use. The following schemes are suggested by many scholars:

- Highlighting the impact of automobile. The aim is to underline the importance of the negative impacts of automobile. This can help in implementing more environmentally friendly initiatives to overcome the issue of transportation and improving safety on campus. Poor air quality, traffic congestion, lack of land for parking, cost of constructing parking garages, impact on surrounding neighbourhoods are all cases in point (Poinsatte and Toor 2001).
- Addressing the transportation behaviour. This can be crucial given its influence on not only the current campus community (students, faculty, and staff), but also on the future generations though affecting their transportation habits. The long-term impact is that today's students are the potential agent of change as Tolley (1996, 214) puts it 'they will progress to occupy influential roles in government, companies, or other organisations'.
- Reviewing the automobile policies. The goal of such policy is to 'provide more movement options (move people not cars)' and 'enable the highest and best uses of resources (land and capital)' (Kenney et al. 2005, 186). Universities could offer 'subsidies and incentives for other means of transportation that can lower single-occupancy automobile use, including walking, bicycling, use of remote lots, carpooling, vanpooling, mass transit, and other kinds of shared transportation' (Ibid).
- Promoting more sustainable means of transportation. Putting into place incentives that encourage using other modes of transportation. This cannot be undertaken unless there is an investment in the campus facilities, infrastructure and landscape. In order to promote walking or biking, which are the most sustainable modes of transportation, universities need to provide adequate facilities ranging 'from protection from the weather and good illumination, to visual appearance and amenities (litter containers, benches, etc.)' (Balsas 2003, 38). According to Kenney et al. (2005, 187), 'people will be happily walk fifteen to twenty minutes if the experience is pleasant'. They indicate that 'a pedestrian-oriented campus provides an efficient and safe network of pedestrian pathways. Landscaping, shade trees, arcades, and good lighting after dark can all enhance the quality of the pedestrian experience, as well a chance to see and be seen by others.' The design of the campus core is expected to be designated to pedestrians only. For biking, on the other hand, facilities that encourage riding a bicycle include 'bicycle paths and lanes, intersection treatments, signage, and parking' (Balsas 2003, 38).
- Managing the parking lots/structures/garages. Many rural university campuses around the world especially in car-oriented societies face a daunting challenge in managing their university parking lots and parking garages/structures. Introducing (or increasing) parking fees has been implemented in many campuses. Yet, this cannot be introduced unless there are other attractive and economical alternatives including availability of other modes of transportation. Additionally, some facility managers in universities do undertake utilisation studies on parking lots and structures to examine the actual provision of space as well as its utilisation. For example, University of South Florida (USF) found that the utilisation rates of car parking range between 57% on Fridays and

81% on Tuesdays (USF Tampa Campus Master Plan 2015, 94). The University aims to elevate the utilisation rate to 88% (Ibid).

- Introducing other soft solutions. Many universities across the world use other soft approaches such as telecommuting (staff working from home for a day or so), flex-time (flexible working schedule), compressed work week / condensed work week (e.g. Four-day/40-hour work week) and distance learning (on-line education offering classes to student at home).
- Transportation demand management (TDM). The concept of TDM includes a wide-range of solutions such as ‘market prices for parking, expanding transit access, park and ride lots complemented by bus shuttles, rideshare programs, bicycle and pedestrian facilities, and traffic-calming schemes’ (Balsas 2003, 35).
- Exploring alternative fuels to the university fleets. Many universities are replacing the conventional fuels for their cars and buses with greener alternatives such as compressed natural gas or electricity (Keniry 1995). Universities work with partners to provide electric bicycle (e-bikes), electric cars (e-cars), and recharging stations on-campus.
- Offering incentives to promote living nearby. Some universities use this incentive to encourage students and staff to live in close proximity with the campus.
- Mass transit (Pass Programs). Universities are recommended to work hand-in-hand with other partners such as transport agencies to provide reduced (or free of charge) price transit passes to students, faculty, and staff to access local modes of transportation. This can be funded entirely by student fees or partially by involving other partnerships such as local municipalities. This is known as ‘Unlimited Access’ (Brown et al. 2001) or ‘U-Pass’.
- University Shuttle. Another option to ease the accessibility to university campuses is by using the university’s fleets which connect the campus with the surrounding neighbourhoods or between satellite campuses.

Forward thinking, the future transport revolution might bring something different. The new generation of modes of transportation is believed to be smart, flexible, reliable, punctual, driverless, and sustainable (zero emissions). Masdar City, Abu Dhabi, United Arab Emirates has shown leadership in many aspects of sustainability as it aims to be the world’s first zero emission city. ‘Since November 2010, Masdar City has been operating a personal rapid transit (PRT) system, which has now carried more than 2 million passengers between its two stations without a single accident or injury. System availability and vehicle reliability consistently exceed 99.6% and 99.9% respectively. The PRT system is operational 18 hours a day, from 06.00 hr until midnight, every day’ (Masdar City 2017). Universities are advised to explore these cutting-edge technologies and be the frontrunners in developing and implementing such technologies.

● Flexibility in higher education facilities

Scholars have looked at flexibility from different angles. Dober (1963, 40) states that ‘the first requirement for an adequate campus design is a general design form which can adapt itself to future change, and at the same time maintain its integrity as a design.’ Upton (1994, 72) defines flexibility as ‘the ability to change or react with little penalty time, effort, cost or performance’. Naim et al. (2006) and Gosling et al. (2008, 3) see flexibility as ‘a proactive attribute designed into a system, rather than a reactive behaviour that may in fact result in a detriment to time, effort, cost and performance.’ Moore and Lackney (1994) refer to flexibility abstractly as the capacity of space to house unforeseeable changes for instance demographic changes, community requirements, or policy mandates. Monahan (2002, 1) defines physical flexibility as ‘the adjustability of a space to the practices of individuals, such as meeting the special sensory and/or mobility needs of students. Movable furniture and walls, or re-configurable buildings, rooms, and passageways all represent this type of physical flexibility.' These definitions indicate that flexibility in the built environment of educational facilities means the capability of adapting and accommodating future needs in little or maybe no impact on time, effort, cost, or performance.

Given the changing trends in higher education, university facilities are required to be flexible to respond to such shifts. For example, the teaching and learning methods have changed. Oblinger (2006) and Luz (2008, 2) indicate that:

> *'...spaces designed in the 1950s are not likely to fit the 21st century learning approaches and learners' experience. Active, participatory, social, experiential, networked, connected, and flexible learning styles do not necessarily match with the traditional educational models of the past'*

The question is why flexibility is important in the educational and research facilities. Kuuskorpi and González (2011, 1) believe that tomorrow's physical learning environments are 'flexible, modifiable, and sustainable while supporting the teaching and learning processes'. Fisher (2016, 10) confirms this indicating that 'innovation and creativity so prized in the 21st-century economy thrives not in isolated, specialized spaces, but in open, flexible environments.' The advantage of flexible environment is it facilitates 'interdisciplinary exchange and collaborative opportunities', which 'requires flexible teaching, learning, and student life spaces' (Pieprz and Sheth 2017, 5). Moore and Lackney (1994, 53) argues that 'flexible learning may lead to higher attendance and more participation in schools'. This can be achieved through many ways. One of which is by providing rooms with different sizes to house classes not only smaller discussion groups and larger ones, but also to accommodate some community events (Genevro 1980). Therefore, the higher education facilities need to be 'adaptable to be able to adjust to changing enrolment patters, educational philosophies, and community needs over time' (Moore and Lackney 1994, 53). Chiang et al. (2008, 44) summarise the pros and cons of flexibility in the higher education facilities. On one hand, they (Ibid) believe that the advantages of being flexible are:

- 'Multiple configurations in the space
- Multiple teaching pedagogies in the space
- Adapts to changing technology
- Cuts down on renovations
- Respond quickly to needs of faculty and students
- Better use of resources (Increase utilization - More uses for less space)'

On the other hand, they (Ibid) indicate that the potential drawbacks of flexibility are:

- 'Possibility of space doing nothing well
- Higher square footage per station
- Higher initial construction costs
- Expectation that space will constantly be reconfigured'

Flexibility has many properties or aspects. Monahan (2002, 2) divided flexibility into five properties of space: 'Fluidity (represents the design of space for flows of individuals, sight, sound, and air); Versatility (indicates the property of space that allows for multiple uses); Convertibility (designates the ease of adapting educational space for new uses); Scaleability (describes a property of space for expansion or contraction); and Modifiability (the spatial property which invites active manipulation and appropriation).' De Jonge and Den Heijer (2004) categorised flexibility in four groups: Physical flexibility (providing the ability to change the layout and design of the building); Technical flexibility (a range of mechanisms offered in the building's systems); Functional Flexibility (a variety of activities that the building can facilitate); and Juridical-financial flexibility (addressing the legal structure of contracts – thinking about the contract type, ownership, and the contract duration – and the consequences of the legal structure – thinking about the financers, balancing the budget, and the liability). Geraedts (2008, 18) suggests four key performance indicators to measure flexibility: 'Partitionable (Collective/individual, Central/decentral, Disconnectible, Zonable, Modular); Adaptable (Dismantable, Rearangeable, Adjustable, Exchangeable, Alterable, Mobile, Shapable); Extendible (Over-Capacity, Over-Dimensions, Ductless); and Multifunctional (Intelligent, Automated, Universal, Integrated)'. These categorisations indicate that flexibility takes many shapes and forms.

To sum up, flexibility in educational facilities means the ability to adapt and accommodate future needs in little or maybe no effect on time, effort, cost, or performance. It can take many shapes and forms. Allowing reconfiguration, supporting future needs for space, permitting a range of activities and functions, and meeting the possible future changes are some cases in point.

Overall, there are many factors that can influence the planning for higher education facilities. Youth population projection, enrolment admission rate, needs and desire, resources and capital investment, science and technology are all cases in point. The location of the university campus is still important even in the 21st century. Flexibility in educational facilities means the ability to adapt and accommodate future needs in little or maybe no effect on time, effort, cost, or performance. Factors to address when planning and designing the campus should include time, size, program, and style.

2.2.2 University campus management

The research literature four domains

The built environment has become more complex to manage. It deals with different stakeholders, scales, and systems. The real estate consists of land, buildings, and infrastructure. It is essential for the economy of each country, given that the real estate is 'a country's most expensive capital good' (De Jonge et al. 2009, 9). The industry involves 'initiating, developing, financing, building, managing, operating, and redeveloping real estate' (Ibid, 9). Previous research has established that real estate management matches between the business (supply side) and the real estate (demand side) at two levels: strategic and operational (De Jonge 1994). Figure 2.3 shows the four real estate management (REM) domains: Asset management, portfolio management, project management, and property management. The figure also shows the focus of each domain and its management level. These domains can be represented in four different aspects. In this way, every organisation has to address four different standpoints: strategic, financial, technical, and functional. Den Heijer and De Vries (2004) show that the main stakeholders involved in managing real estate are: controllers, financiers, managers, and users. De Vries (2007) argue that human resources, information communication, real estate, capital, and technology are interdependent resources. Hence, real estate is 'closely related to the process, the people, the organisation's culture and the organisational objectives' (De Jonge et al. 2009, 21). This shows the importance of real estate management to the institution's success. De Jonge (1997) and De Vries (2007) provides ten ways that real estate can contribute to achieving the organisation's objectives: Increasing productivity, supporting image, enhancing flexibility, improving culture, stimulating innovation, increasing satisfaction, enhancing synergy, reducing costs, controlling risks, and expanding funding possibilities.

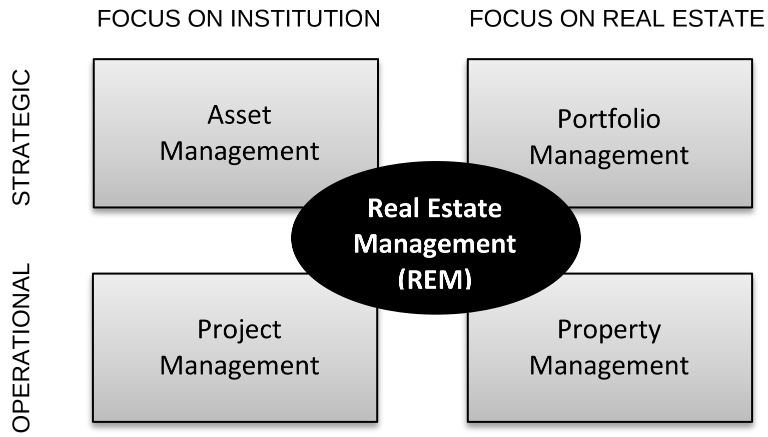


Figure 2.3: Real estate management domains (Adapted from De Jonge 1997)

● Matching supply and demand of space, now and in the future

Having established the importance of real estate management, the question now is how to practically manage it. Managing the real estate is 'a continuous process with implicit or explicit considerations about the match between supply and demand' (Den Heijer and De Jonge 2012, 180). This is known as Corporate Real Estate Management (CREM) theory (De Jonge et al. 2009). It aims to prevent a mismatch between the supply and the demand. Its objective is to secure sufficient accommodation at the required location, time, quality, and cost; meeting the basic as well as higher needs to satisfy the users through the physical environment (Van der Voordt and Van Wegen 2005).

Figure 2.4 shows the supply and demand framework, which illustrates 'an iterative process with four key steering events' (De Jonge et al. 2009, 35), which aiming at 'finding the match that has the highest added value' (Den Heijer and De Jonge 2012, 181). The frame helps decision makers in 'designing an accommodation strategy' for their organisation, refers to as DAS Frame. The framework has four management tasks or steps for decision-making process. These tasks are as follows:

- Task 1: Assessing the current campus to determine the current match
- Task 2: Exploring changing demand and hence determining the future match.
- Task 3: Generating future models for the campus to match the future demand and supply
- Task 3: Defining projects to transform the campus to a more modern campus.

This framework can be employed to i) help decision makers making choices for all types of real estate (including university campuses), ii) allow participation from stakeholders, iii) force decision makers to consider both objectives (demand) and resources (supply) (De Jonge et al. 2009, 35). Such framework, which assesses the current and future supply and demand, can be of great assistance in planning the facilities of universities.

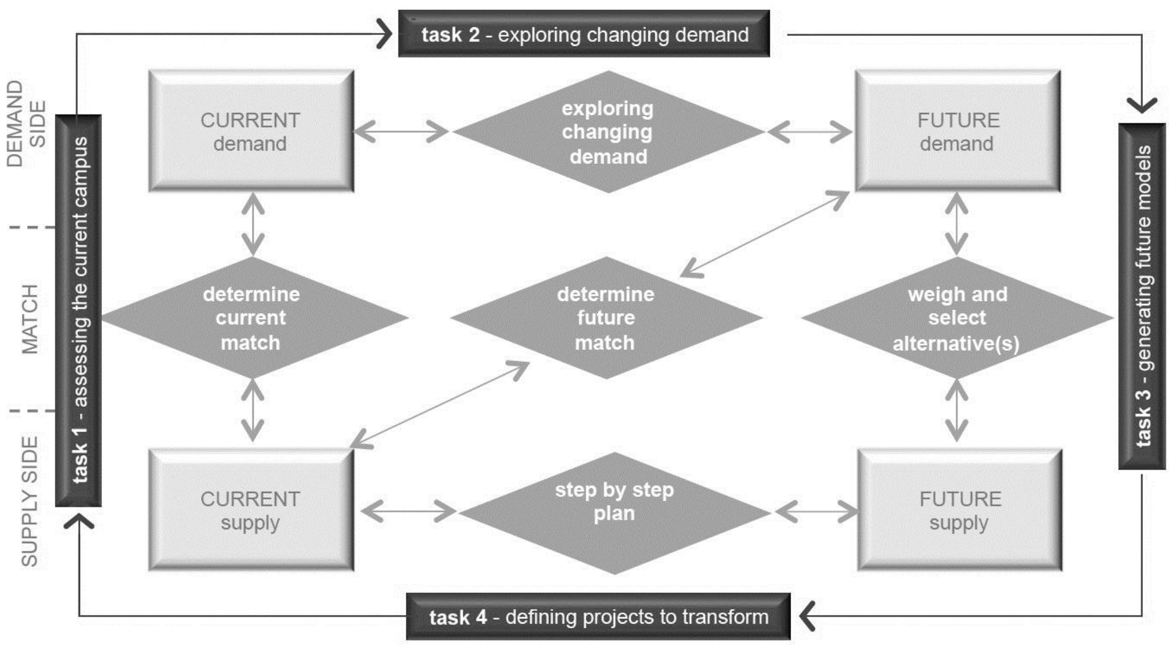


Figure 2.4: DAS Frame, managing real estate in four steps (De Jonge 2009, 36)

● Managing higher education facilities

In order to manage higher education facilities, there is a need for information that supports decision makers to make strategic choices. Den Heijer (2011) offers a conceptual and informative model to improve campus management. Figure 2.5 provides crucial information and tools from operational to strategic level, which enables decision makers to make effective decisions in the management of campuses. It is an integrated approach to managing the campus, which takes into account all stakeholders, weighing benefits and costs, covering strategic goals, user demands, and the physical aspects of the campus. The model, which was derived from De Jonge's (1997), shows that there are four stakeholders' perspectives (and their corresponding variables) in managing university campuses:

- Strategic: The performance criterion is competitive advantage (goals). The stakeholders are policy makers.
- Financial: The performance criterion is profitability (euros). The stakeholders are controllers.
- Functional: The performance criterion is productivity (number of users). The stakeholders are users including students and faculty and staff members.
- Physical: The performance criterion is sustainable development (m2). The stakeholders are technical managers.

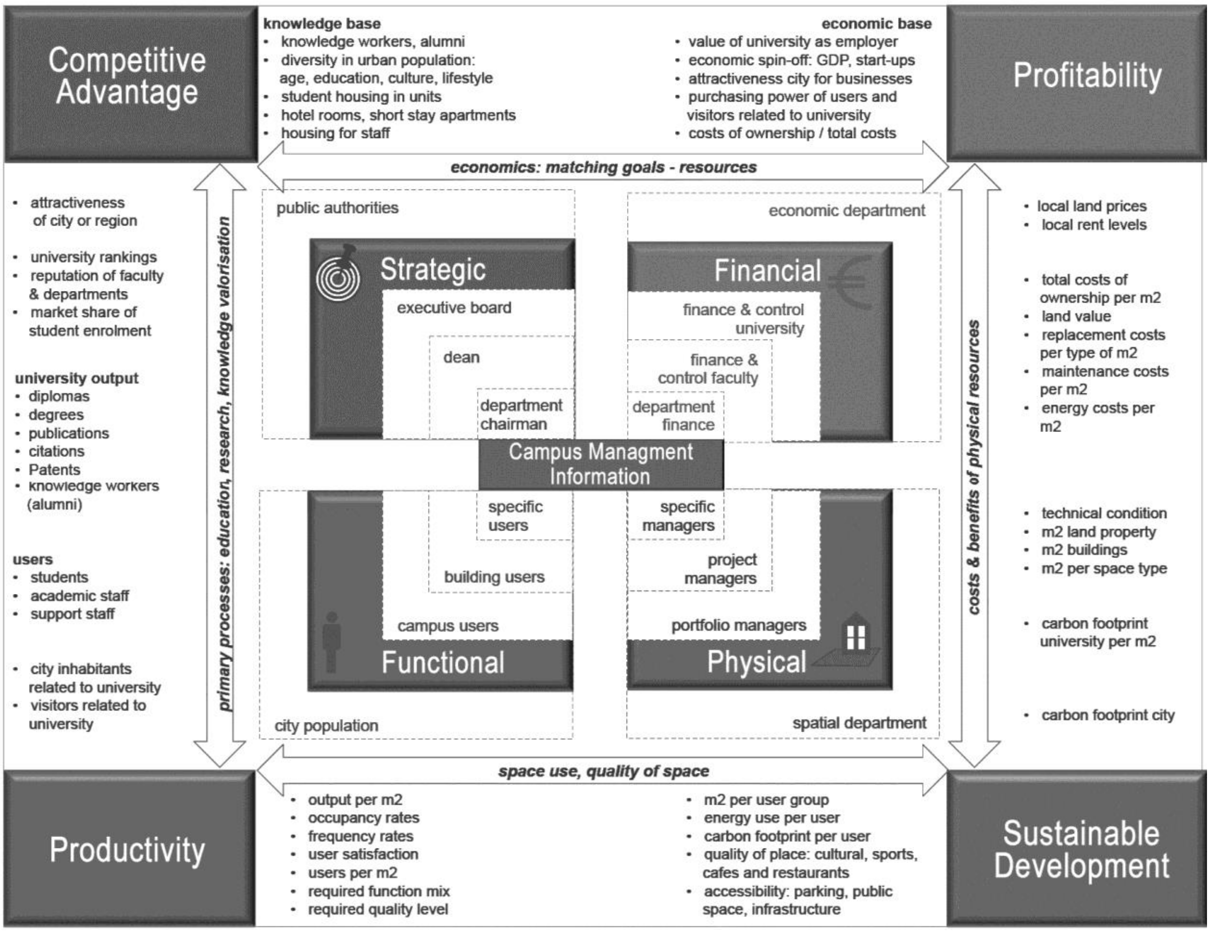


Figure 2.5: Campus management information (Den Heijer 2011, 250)

Higher education institutions occupy a vital component in any city, since it is a key partner in the knowledge economy – as a producer of knowledge and knowledge workers (Wiewel and Perry 2008). Currently, higher education institutions face many challenges including decreasing public funding, significant carbon footprints, low occupancy rates, investment issues, and uncertainty of student enrolment. Much concern has been given to the last challenge, primarily because the size of the campus has often followed trends in student enrolment. This underlines the importance of the campus to the university's productivity, profitability, competitive advantages and sustainable development (De Vries 2007).

In a time where managing a campus has become even more complex, forward planning is not as straightforward as it once was. Den Heijer (2011) believes that the changing functional needs requires a more flexible and adaptable campus. That is, for example, by considering partnership (for sharing use, ownership or management of the campus as a whole or just specific parts). This can include academic functions (research laboratories), residential functions (student housing), related business functions (incubators), retail and leisure functions (restaurant and sport facilities) and finally the infrastructure functions (accessibility and parking).

Den Heijer (2011) sums up 12 added values of managing the university campus, most of which were already introduced in De Jonge (1997) and De Vries (2007). These lists of values are goals either focusing on effectiveness or on efficiency. The list of goals is as follows:

controlling risks, increasing real estate value, reducing the footprint, decreasing costs, increasing flexibility, increasing user satisfaction, supporting user activities, improving quality of space, supporting image, supporting culture, stimulating collaboration, and stimulating innovation. This means that 'reducing footprint', for example, is just one of the goals that need to be considering in combination with the rest of the others.

Managing the university campus has become even more complex, given that there are many conflicting issues. Den Heijer and De Jonge (2012, 186) state that some of the above 12 goals:

> *'...illustrate the complexity of campus management, because these goals can be conflicting. Again, this pleads for managing the university campus by connecting different stakeholders' perspectives that confront user needs with costs and organisational goals with the physical consequence.'*

This indicates that managing the university campus is a daunting challenge. To help addressing this, all these aspects have to be taken into account when a decision is to be made. On the other hand, all stakeholders have to be involved in order to limit conflict of interest. All parties have to be willing to compromise and strive for balance so that the institution's main objectives can be achieved.

● Space utilisation of higher education facilities

This section aims to systematically review the concept of space utilisation by providing some key definitions as well as outlining some theories and practices in order to understand the idea behind space utilisation.

Key definitions

In one of its early reports, Space Management Group in the United Kingdom (SMG 2006, 03) has concisely defined space utilisation key terms as:

- Space utilisation is 'a measure of whether and how space is being used'.
- Frequency rate 'measures the proportion of time that space is used compared to its availability'.
- Occupancy rate 'measures how full the space is compared to its capacity'.
- Space utilisation rate is 'a function of a frequency rate and an occupancy rate'.

The importance of space utilisation studies

The SMG (2006, 11) emphasises that the survey of UK Higher Education Space Management Project 'found that utilisation rates were the most frequently cited indicator' for measuring the performance of managing space.

Additionally, there are a number of benefits resulting from conducting space utilisation studies. Russell and Doi (1957, 02) pointed out that there are two compelling reasons why universities should make space utilisation studies:

- Knowledge of the degree and kind of use made of the physical plant is a condition of good management. The physical plant of a typical college or university represents a large investment of financial resources. It is costly to build, costly to maintain in good repair, and costly to heat, light, clean, and attend to. Thus, any addition to the physical plant should be made only after careful study.
- A second compelling reason for plant utilisation studies is the prospect of large enrolment increases, dramatized by the now familiar phrase "the impending tidal wave of students." The plant facilities hosting greater student numbers will have to provide more efficient utilisation of space.

The strategic role of space utilisation studies was highlighted by the SMG (2006, 03) indicating that these studies assist universities to ‘assess what size of estate is affordable’ by providing ‘information on how space is being used and help to inform decisions about the type and scale of facilities needed.’ Such information can be directly used to reduce the energy consumption of building systems such as lighting, HVAC, IT, and other plugged-in devices including computers, printers, desk lamps, coffee makers...etc. (Garg and Bansal 2000). For example, good occupancy detection and control for lighting systems and for HVAC result in energy savings of 50% (Harle and Hopper 2008) and 20% (Erickson and Cerpa 2010), respectively.

The technical role of such studies was summarised by the National Audit Office in the United Kingdom (NAO 1996, 01) as:

- Measure how intensively accommodation is being used, both in terms of levels of occupancy and frequency of use.
- Reveal whether scheduled activities are actually taking place.
- Track changes in demand over a period of years.
- Identify surplus and shortfalls and areas of poor performance, which could be remodelled or disposed of.
- Provide data for reviewing space management policies.

Historical development of space utilisation studies

Historically, the first work on space utilisation in higher education institutions was initiated in the United States by the University of Iowa in 1916 (Sharma 1991). In 1957, Russell and Doi published a comprehensive document titled ‘Manual for studies of space utilization in colleges and universities’, which was seen by many as the first extensive research on how space in universities can be measured (Tjomsland 1959).

Kenny (1977) believes that space utilisation studies began to gain momentum in the United Kingdom in the late 1960's, when higher education institutions came under huge pressure to take in more students. The National Audit Office (NAO) was established in 1996 to manage the space provision and utilisation in British colleges and universities.

In Australia, Sharma (1982) is believed to be the first to undertake a space utilisation survey in the Australian higher education institutions. Since 1978, the then Tertiary Education Commission began a yearly gathering of space utilisation data from the Australian Colleges (Sharma 1991). Another early attempt to advance space utilisation studies in Australia was carried out by Lagunzad (1990) in which it was indicated that a great effort is needed to institutionalise such studies in higher education institutions.

Scanning the literature of space utilisation shows that there are a number of publications coming from Malaysia. Authors such as Abdullah et al. (2012), Kasim, Md Nor, and Masirin (2012), and Abdullah, Ali, and Sipan (2012), have all provided some insightful practice and performance of space utilisation in Malaysia.

The challenges in optimising space utilisation

There are a number of factors influencing the optimal use of space. The SMG (2006, 13) sums them up in eight factors:

- Poor condition and functional suitability.
- Poor environmental quality.

- Split sites.
- Specialist spaces and equipment that have a limited range of uses.
- Accessibility and health and safety restrictions on space.
- Availability of audio-visual equipment and the layout of rooms.
- The difference between predicted and surveyed rates of utilisation.
- Other factors include teaching and learning trends, whether or not detailed information is available on what space is needed, and the nature of the estate in terms of its fitness for purpose and versatility.

How to measure space utilisation level
There are a number of aspects to bear in mind when conducting data collection for space utilisation rate. There are two methods of calculating the utilisation rate:
- First is by calculating the planned utilisation which is based on the assumption of how the space will be used. For example, using data from the timetables in existing buildings or the projected level of use in new buildings.
- Second is by calculating how the space is actually being used. For instance, using data based on observation (manually counting).

Some colleges and universities collect data using both methods: planned and actual use of space. There is, however, a difference between predicted and surveyed rates. The predicted or timetabled rates tend to be higher than the actual use of space with about 15% (SMG 2006, 10).

Furthermore, some institutions have used other ways to collect space utilisation data. Swipe card and webcams are cases in point. Yet, these tools have pros and cons. The main advantage is that it reduces the time required to collect data. However, the swipe card does not provide reliable data about how many people are actually using the space. In both cases (Swipe card and webcams) 'data obtained would still need to be entered into the analysis software' (SMG 2006, 23). More advanced technologies are being used to monitor the utilisation of space in university campuses worldwide. Examples of such as technologies include Bluetooth, Wi-Fi, Passive Infrared and Ultrasonic Motion Sensors, and PC Login (Von Neida et al. 2001; Dodier et al. 2006; Melfi et al. 2011; Christensen et al. 2014). Valks et al. (2016) have investigated using such technologies in 14 Dutch public universities and concluded that using Wi-Fi to measure utilisation in university campuses is the most suitable tool, given that it uses already existing IT infrastructure and hence is cheaper compared with other technologies. It is also flexible and therefore easy to change, plus it is applicable for many users on campus.

Higher education institutions focus more on the teaching rooms, given that ‘the general purpose teaching space is the most common type of space to be surveyed’ (SMG 2006, 07). Other rooms that are less surveyed include science and technology laboratories, libraries, offices for both academic and staff, meeting rooms, exhibition areas, conference rooms, theatres/auditoriums, staff rooms, and leisure rooms.

According to the SMG (2006, 07), comparing results of utilisation between institutions is difficult. This is because there are many issues to take into account including ‘the types of rooms surveyed, the hours covered, the basis on which capacities are calculated, and whether reports are provided on the basis of a planned use of space or observations of how space is being used.’

The NAO (1996, 20) indicates that '[the] survey represents a snap shot view of the use of the estate at a particular time. The standard calculation of utilisation is

$$\frac{\underline{\%\ \text{frequency} \ \times \ \%\ \text{occupancy}}}{100} = \text{space utilisation rate}$$

● Frequency is the number of hours a room is in use as a proportion of total availability (the timetabled week).

● Occupancy is the average group size as a proportion of total capacity for the hours the room is in use.

It is important to highlight that some higher education institutions do not collect data on occupancy rates; instead they focus on merely the frequency levels. The SMG (2006, 08) shows that this is 'often on the grounds that they have much greater control over the frequency with which rooms are used, whereas occupancy rates are highly dependent on whether students and other users choose to attend.'

Timing is crucial when collecting data for the utilisation study. The utilisation rate will be greatly influenced by the chosen timeslots. 'Results will differ if average utilisation levels are calculated over a 9.00 am to 5.00 pm period or between 8.00 am to 8.00 pm' (NAO 1996, 21). Undertaking the survey over a period of time may result in a better overview of the utilisation level. 'One Welsh institution carried out a survey over five weeks taking a different day each week in order to minimise the possibility that staff would argue that the selected week was not typical' (Ibid). The main objective should be to:

- assess the space at 'a time of peak load',
- assess 'four to six weeks' after the semester starts, and
- 'avoid seasonal factors such as reading weeks, examination weeks, or field trips' (Ibid).

The targeted rate of space utilisation

The Polytechnics and Colleges Funding Council (PCFC) in the UK suggests a figure of 64 per cent (80 per cent frequency and 80 per cent occupancy), which many argue to be significantly higher than any figure in practice (NAO 1996, 21). They added that '[even] 50 per cent (70 per cent frequency and 70 per cent occupancy) may prove very challenging. The Higher Education Funding Council for England (HEFCE 2000, 37) grades space utilisation levels as follows:

- 'Good is equal to or greater than 35 per cent utilisation rate
- Fair is 25 to 35 per cent utilisation rate
- Poor is equal to or less than 25 per cent utilisation rate.'

Regardless, all higher education institutions 'must set their own target rate in relation to their individual problems of bad fit. The target rate should improve each year' (NAO 1996, 21).

Overall, managing the real estate is a continuous process with implicit or explicit considerations about the match between supply and demand, aiming at sourcing sufficient accommodation at the required location, time, quality, and cost. The values of managing the university campus were controlling risks, increasing real estate value, reducing the footprint, decreasing costs, increasing flexibility, increasing user satisfaction, supporting user activities, improving quality of space, supporting image, supporting culture, stimulating collaboration, and stimulating innovation.

2.2.3 Sustainable university (living laboratory)

The research literature four domains

Sustainability requires reinventing every dimension of the place we live in: place as physical, informative, normative, and institutional space (König 2013). Since sustainable innovations must address these multiple dimensions issues, they are ultimately developed in a 'living laboratory' for sustainable change. At the campus setting level, the 'living laboratory' concept means not only research and education should emphasise sustainability topics, but also daily lives in laboratories, lecture halls, and dormitories should embody sustainable principles. At the city level, the concept was best defined by the EU Living Labs Network as 'A Living Lab includes interactive testing, but is managed as an innovation environment well beyond the testbed functions. As a city-based innovation resource, the Living Lab can take advantage of the pools of creative talent, the affluence of socio-cultural diversity, and the unpredictability of inventiveness and imagination in the urban setting' (Living Lab Europe 2007, 02). This indicates the multiple dimensions of sustainability and that campuses can be utilised as 'living laboratory' for sustainable revolution.

Sinclair (2008) presents how sustainability can be achieved through the planning and design of university campus. He and his colleagues believe that the earlier in the planning process that sustainability planning begins the better. This shows that effective sustainability planning should begin with a campus master plan. A good campus plan provides a framework for further development with more detailed sustainability planning and implementation. The master plan provides what the more specific projects do not: the big picture. Therefore, the bigger the picture is the broader the effect.

Thomashow (2014) proposes nine elements believing that they would make universities more sustainable and that these elements can be 'suitable for adaptation to a wide variety of campus challenges'. These elements are energy, food, materials, government, investment, wellness, curriculum, interpretation, and aesthetics. Although Thomashow (Ibid) does not cover sustainability initiatives in depth or assess their effectiveness, his book points out some of them in order to highlight the many paths institutions can follow as well as to show how some of the projects mentioned are connected and hence how universities can learn from one another, even though every campus is different. He argues that the campus is the perfect place for developing ideas and action, engaging diverse communities and teaching the next generation of citizens. He (Ibid, 18) states that:

> *'A college or a university is an ideal venue for addressing the global climate crisis. What better place is there to conduct environmental research, to develop curricular approaches, to construct policy mechanisms, to convene multi-sector collaborations, and to implement sustainable solutions?'*

Thomashow (2014) shows the link between some of the sustainability initiatives on campus and the influence it makes on people and beyond. For example, renewable-energy installations can change how a campus community perceives energy. First, they establish the campus as an active producer of renewable energy, reducing climate emissions, and gaining more control of its energy future. Second, constructing such facilities on a campus builds energy production and consumption into daily behaviours of students, employees, and faculty members. Third, it develops energy partnerships and networks with other institutions and organisations, so that the campus becomes a decentralised regional hub. Fourth, it establishes the campus as an energy leader in the community. Fifth, the visibility of these efforts evokes an inquiry, emulation, and eventually a response. He argues that energy consumption can be reduced most effectively when human behaviour changes. He believes that people, not buildings or cars, are the ultimate users of energy. The full measure of our use is reflected in our consumption habits, he thinks. Yet energy-use behaviours are more likely to change when there are suitable infrastructures affecting and influencing behaviour.

Leadership is believed to be key ingredient in a successful planning and implementation of sustainability in the university campus. Martin and Samels (2012) argue that leadership plays a crucial role in the success of sustainability implementation and that sustainability has moved from purely operational advances to guidelines for much of the strategic thinking on campus. The (Ibid) add that sustainability professionals and faculty members can collaborate in preparing “sustainable citizens” on campus, who are committed to reshaping society’s goals through their careers and professional choices. Thomashow (2014, 3) points out that ‘university leadership is our last best hope for addressing the global climate challenge, and campus sustainability initiatives are the foundation of that leadership.’ Cortese (2003, 19) raises interesting question saying that ‘If higher education does not lead the sustainability effort in society, who will?’ Bartlett and Chase (2004) think that support from above is critical. Affirmation from the top is essential. Although bottom-up initiatives have proven to be of great value, being backed up and supported by actions as well as budget is far better, saving time, money, and effort. Top-down approach has a huge influence and it catalyses sustainability efforts across the campus.

Bartlett and Chase (2004) published a book on sustainability on campus. A number of lessons can be drawn from such research.

- First, success is not always related to numbers of people involved. At many institutions, one or two here and a handful there is all it takes to get sustainability efforts started.
- Second, trust, which emerges from strong relationships, drives the change (improvement) that is sought. The linking of arms to create systematic changes requires a slow building of trust. Although Bartlett and Chase emphasise the importance of trust, networks, and collaboration, competition among schools also plays a role in advancing sustainability efforts.
- Third, different paths to sustainability are not only fine, but are rather recommended. Bartlett and Chase see much variability in strategies and starting points. That is because of the fact that each of these paths begins from different origins. For example, recycling seems to be the first attempt to become sustainable. That is logical, although it requires logistics, staffing, and significant costs for storage and transportation. They believe that recycling is a behavioural change that requires long-term effort to sustain.
- Fourth, the last lesson is the issue of resources for sustainability efforts. This is a problem that the majority of universities, if not all, are concerned about. Would sustainability challenges be easier in universities that are prestigious, boast strong student bodies, and outstanding faculty? This question was answered by Bartlett and Chase (2004) who conclude saying that it is ‘not necessarily’ the case, citing Berkeley as a case in point. This is to show that when there is a will, there is a way.

A decade later, Bartlett and Chase (2013) edited another book about sustainability in higher education. The main lessons that can be learnt are as follows:

- First, among the challenges laying ahead of us is defining the next steps, maintaining momentum, and continuing to foster deep engagement.

- Second, we should be aware of the fact that it takes persistent energies and support to build new communities of trust to foster the breakthroughs we need to meet sustainability challenges.
- Third, there are many barriers to sustainability-related change in higher education – such as disciplinary boundaries, scale, multiple stakeholders, and financial pressers – all of which still exist. The most noticeable and pronounced issue today is financial pressures, they believe. However, there are huge developments in many institutions which should be mentioned and applauded. New sustainability positions, broadened mission statements, transformed curricula, new habits of building and purchasing, and new attention to endowments are all cases in point.
- Forth, sustainability in higher education is multi-layered, complex, and diffuse. There is a culture of sustainability which is still emerging in higher education, but no one exactly knows how it will evolve.

● Defining sustainability

There are numerous definitions of sustainability. Yet, ‘whether our definition of sustainability is anthropocentric, biocentric, egocentric, ecocentric, econocentric, sociocentric, worldcentric or perhaps simply personally eccentric, they are all valid’ (Emegnc 2003, 01). For many decades, the sustainability debate has brought to the forefront issues about our value systems, and more importantly, reflections on our own survival.

In order to show how ambiguous the concept is, Sinclair (2008, 5) explains that ‘sustainability is a much used, often misunderstood word these days. It seems to mean many things to many people, with some sharp differences in interpretation underscored by various agents, agendas and sectors on our society’. He adds that ‘Gaps, however, seem to be narrowing and the definitions converging, perhaps an outcome of more research, evidence and wisdom in the marketplace’. Simply put a ‘cross-fertilisation’ of ideas has strengthened insights, to the extent that some semblance of a unified definition is on the horizon. Following suit, the remainder of this essay pulls together a variety of ideas to create a rigorous and concrete definition of what it means to be ‘sustainable.’ This task was problematic due to the sheer amount of studies undertaken in this field. Failure to mention many of these works is not for the reason that they are any less essential, but because of constraints of time and space. The idea here is to shed more light on the concept of sustainability by highlighting the most commonly used definitions.

With the purpose of fully exploring key concepts of sustainability, we must first lay down its two foundations, the first of which is the notion of preservation for current use. For the first time in 1972, the dictionary defined ‘sustainability’ as an adjective which meant ‘capable of being maintained at a certain rate or level’ (Oxford English Dictionary 1993). Over the last 40 years, as the environmentalists, scientists, and decision-makers work jointly together on the ecological systems, ‘the word sustainability has gathered forces and turned into a movement’ (Kirk 2003, 10). That was because of the environmental degradation which was rapidly increasing throughout the world.

A second foundation of the term ‘sustainability’ is more forward looking; it is to do with the future use. This was proposed in 1983 by Gro Harlem Brundtland, a Commissioner of the World Commission on Environment and Development, in which he succinctly says ‘Sustainability development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs’ (United Nations 1987). This definition, known as Brundtland Commission, is described by many as the root meaning of sustainability (Kirk 2003). This definition has highlighted the 'time' as a dimension to consider.

Now fortified with these foundations, Bookhart (2012) enlightens the audience about two concepts 'triple bottom line' and the 'carbon footprint', which adds further layers to our construction. In regards to the former, this approach suggests that the 'bottom line' used to measure success by profitability is inadequate, because there are additional 'lines' to bear in mind. The 'triple bottom line' approach – which places an emphasis on people, planet, along with the profit – then comes to light, seen in figure 2.6. This creates a sense that business can be more successful when concentrated on these three pillars of performance rather than purely on the financial aspect. In relation to Bookhart's second concept, he explains that the term 'footprint' is widely used to measure the size of harm done to the earth, 'as if the institutions are literally stepping in, and blotting out, the ground under which we tread. We have carbon footprints, building and construction footprints, campus footprints, to name just a few' (Ibid, 90). The articulating idea here is the fact that 'footprints leave marks' and these marks are a sign of 'treading' on the environment and hence he calls for a sustainable approach to reduce the amount of effects of 'our collective feet.' Therefore, a balance between the human activities and the natural systems is what is urgently required.

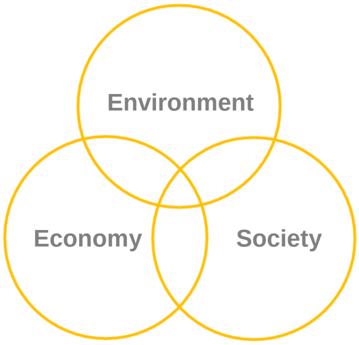


Figure 2.6: Sustainability aspects (Adapted from Flint 2010, 30)

Our construction so far is broad enough to incorporate different areas of sustainability. However, the environment, economic, and social aspects, mainly focused on in the literature, are also worthy of observation. Businesses, for instance, consider 'the triple bottom line' as planet, people, and profits. Meanwhile, the triple bottom line can be also expressed as natural capital, human capital, and financial capital. Similarly, educators in general see sustainability through the three E's: ecology, economy, and equity. The diagram on the right speaks of the diversity of this issue. Hence, sustainability cannot be balanced if one of these 'circles' is missing. Without these three symbolic circles, sustainability cannot function. This common demonstration depicts sustainability in the overlapped area of these circles. Meaning that to achieve sustainability, all the environmental, economic and social needs should be met.

Another illustration of sustainability, seen in figure 2.7, shows the concept in a rather concentric way. The diagram on the right displays all aspects of sustainability – social, environmental and economic – which are interdependence. This highlights the fact that all aspects depend on each other. This means that the economy exists within society and both the economy and society exists within the environment (AASHE 2006). Put differently, sustainability is characterised by the growth of economy which is based on social equity and efficiency in the use of natural resources (Lozano 2006b; OECD 2005).

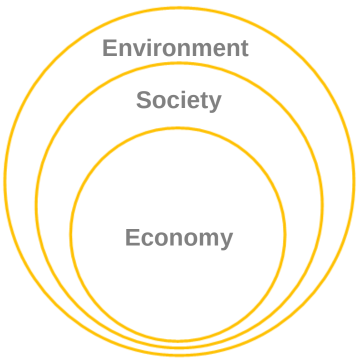


Figure 2.7: Inter-dependence aspects of sustainability (Adapted from Flint 2010, 34)

Further evidence of the diverse nature of sustainability was expounded by The Association for the Advancement of Sustainability in Higher Education (AASHE), the first professional higher education association for the campus sustainability community, 'defines sustainability in an inclusive way, encompassing human and ecological health, social justice, secure livelihoods, and a better world for all generations' (AASHE 2006). Similarly, Thomashow (2014, 7) sees sustainability as 'an approach to living and learning that links these qualities to ecological awareness.' He adds that the concept of sustainability is 'derived from a scientific interpretation of biosphere process – one that warns of an ecological crisis that may have a dramatic impact on humanity.'

The following 'words cloud' generated by Wordle (2013) emanate from an online software, which generates 'clouds' of words based on what is inputted, seen in figure 2.8. Wordle shows what appears quite often in the definitions of the concept of sustainability. It can be seen that there are key terms being highlighted. These terms can be then grouped in four categories. The first three are basically synonyms of the 'triple bottom lines' terms. The final category is closely connected to the concept of sustainability. The categories are:

- First category: environmental, ecological footprints and natural
- Second category: economic, financial and resources
- Third category: social, human, community
- Forth category: Brundtland, development, needs, equity and growth

Figure 2.8: Word clouds representing words often appear in the definitions of sustainability

In conclusion, sustainability can be defined as 'a powerful concept which is generally accessible and broadly agreed upon. Its foundations rest upon notions of current maintenance and preservation for future generations. What is built on top of these foundations are common ideas of care for one's environment, appreciating the value of society and acting responsibly and accountably' (Alghamdi et al. 2017, 84).

● Defining sustainable university campus

Sustainability on campus is vitally important because of a number of reasons, the first one being the university's role in producing policy makers, leaders, and future citizens. Cortese (2003) believes that because universities prepare most professionals who will play a critical role in the adaptation to a sustainable lifestyle, they have an ethical responsibility to promote and raise awareness, knowledge, skills, and values needed for sustainable future. Second, needless to say that the university uses a large amount of resources on its real estate to fulfil their traditional mission of research, teaching, and student services, among other functions (Kirk 2003). Third, the university campus serves higher education through offering inspiring, vibrant, and memorable spaces, which in turn influence the user's productivity, creativity, and innovation and hence adding value (Van der Voordt and Van Wegen 2005; Den Heijer 2011). Winston Churchill said that 'We shape our buildings; thereafter they shape us'.

These three reasons lead us to say that the battle for sustainable practices should be waged from and within higher education institutions. These institutions are far more than just a collection of college buildings. It enables development to be made and knowledge to be generated. In fact, university is the place where ideas can be examined in areas ranging from transport to housing to waste (Turner 1984). These ideas can then be scaled to other settings (White 2014).

Velazquez et al. (2006, 812) describe to us what type of 'sustainable campuses' would bring about this change? He and his colleagues believe that '[a] higher educational institution, as a whole or as a part, that addresses, involves and promotes, on a regional or a global level, the minimization of negative environmental, economic, societal, and health effects generated in the use of their resources in order to fulfil its functions of teaching, research, outreach and partnership, and stewardship in ways to help society make the transition to sustainable lifestyles.' Additionally, Alshuwaikhat and Abubakar (2008, 1778) point out that 'a sustainable university campus should be a healthy campus environment, with a prosperous economy through energy and resource conservation, waste reduction, and an efficient environmental management, and promotes equity and social justice in its affairs and export these values at community, national and global levels.' Other resources looked at the community of sustainable campus. Cole (2003, 4) defines the community as 'the one that acts upon its local and global responsibilities to protect and enhance the health and well-being of humans and ecosystems. It actively engages the knowledge of the university community to address the ecological and social challenges that we face now and in the future.' Newman (2006) provides a summary of the above conceptions of a sustainable campus saying that it implies a better balance between environmental, social and economic goals in policy making as well as a long-term view about the results of today's campus actions and activities.

However, Sinclair and Bookhart highlight two obstacles, which may prevent higher education from achieving Newman's summary. Sinclair (2008, 5) emphasises that 'Matters of sustainability cannot, and must not, be distilling down to lowest common denominators, cheapest solutions, most efficient answers and paths of least resistance. Emotions, feelings, and intuition all have legitimate roles to play in our quest for better planning, better designed, and more sustainable campuses'. He went a step further and stated that the 'triple-bottom line approach, that is attending to economic, social, and environmental aspects of our campuses, is absolutely essential. Yet, moving beyond the triple-bottom line is necessary – we must celebrate cultural, educational, political, and even spiritual dimensions of the campus ethos.' The second obstacle identified by Bookhart (2012, 84), the author of 'Sustainability: Shifting Definitions and Evolving Meanings', which stems from the higher education's point of view of sustainability. He argues that higher education 'often focuses on outcome, a more subtle yet vitally important element of sustainability is change. At its core, sustainability is about transformation, about going from what we have already to what we hope will be tomorrow.' He adds that sustainability is a process not an end. He posits that sustainable campuses cannot be 'a healthy natural environment without positive economic growth, which, in turn, is not possible without a vibrant and equitable community of citizens and workers' (Ibid, 88). Sustainability helps leaders to shape their visions for the future and hence 'it is the vision not the definition that is transforming higher education communities' (Ibid, 92).

To use the 'words cloud' method, generated by Wordle (2013), figure 2.9 represents the most mentioned words in the definitions of sustainable campus. There are a number of terms highlighted, which are similar to the ones underlined in the concept of sustainability. However, the distinction between both clouds is the words knowledge, research and education; and that is what adds value to the university and its campus.

Figure 2.9: Word clouds showing words that often appear in the definitions of sustainable campus

To conclude, this research defines a sustainable university as a university that considers the implementation of sustainable practices (environmentally, economically, socially and educationally) through its campus life cycle (planning, constructing, operating, maintaining, and retrofitting) through all management directions (top-down as well as bottom-up approaches) on all levels of campus (from classrooms to laboratories, transportation, procurement, housing and other services) in many ways (e.g. energy saving, water conservation, air quality, social equity, waste reduction, walkability, well-being and health) or in many different shapes and forms (e.g. flexibility, multi-functionality, optimal space utilisation) (Alghamdi 2018).

● **Assessing sustainability in universities**

'There is no equipment manufacturer that sells a sustainability meter'
Christopher Uhl
Professor of Biology, Pennsylvania State University

Having defined sustainable campus, this section shows how sustainability can be measured in higher education institutions. Scholars have recognised that there are many developments that have helped to manage sustainability in universities. For example, declarations for sustainability in universities have been reported in a number of publications (Calder and Clugston 2003; Wright 2004; Lozano et al. 2013; Disterheft et al. 2013). Meanwhile, other publications have reviewed the advancement of sustainability assessment tools in higher education institutions (Shriberg 2002; Cole 2003; Alshuwaikhat and Abubakar 2008; Kamal and Asmuss 2013; Gómez et al. 2014). Additional publications such as Ramos et al. (2004), Lozano (2006a), Velazquez et al. (2005), Caeiro et al. (2013), Boer (2013), Roorda (2013) and Amaral et al. (2015) have also given us insightful commentaries on ways to develop a new framework for assessing sustainability efforts in universities to review existing frameworks and to report the development of best practices in university campuses around the world.

However, assessing sustainability remains a complex and challenging process for higher education institutions, especially institutions that are at the early stage of their sustainable development programmes (Gómez et al. 2014). A Look back at some of these published works – which reviewed a myriad of assessment tools each such as Shriberg (2002) reviewed 11 tools, Cole (2003) reviewed 12 tools, Alshuwaikhat and Abubakar (2008) reviewed 3 tools, Kamal and Asmuss (2013) reviewed 4 tools and Gómez et al. (2014) reviewed 8 tools – enhances our knowledge of how to measure sustainable university in a variety of ways.

For measuring and analysing sustainability in general, three main approaches were developed: accounts assessment, narrative assessment and indicator-based assessment. Accounts are constructions of raw data, converted to a common unit (such as money, area or energy). Most cover highly important but limited aspects of sustainability. Additionally, accounts do not clearly reveal the main constituents of a sustainable institution. Therefore, this limits the usefulness of accounts for strategy development (Dalal-Clayton and Bass 2002, 133). Narrative assessments, on the other hand, combine text, maps, graphics and tabular data. They may use indicators, but are not built around them. Their strength is their familiarity and flexibility. However, this flexibility has pitfalls. Unsystematic choice of topics coupled with uneven treatment can mask gaps in coverage and obscure priorities. Limited transparency and consistency reduce the usefulness of these assessments for decision-making, particularly for strategy development and monitoring. To facilitate the measurement of sustainability in universities, many assessment tools are indicator-based. Like narrative assessments, indicator-based assessments may include text, maps, graphical and tabular data, but unlike them, they are organised around indicators (Dalal-Clayton and Bass, 2002, 135). Indicator-based assessments are thought to be one of the most used approaches in measuring sustainability. Ramos (2009, 1101) believes that 'Despite the diversity of methods and tools for measuring sustainability, indicators almost always play a fundamental role'. The indicator-based assessment approach, compared to accounts assessment approach and narrative assessment approach, is comprehensive and representative (Dalal-Clayton & Bass 2002). It is easily measurable and comparable (Lozano 2006b). The indicator-based assessment approach can 'convey value added messages in a simplified and useful manner to different types of target audiences, including policy and decision-makers and general public' (Ramos & Pires 2013, 82). A brief comparison between the three main approaches for measuring and analysing sustainability in universities is shown below in table 2.2.

Table 2.2: Main approaches to measuring sustainability (Dalal-Clayton & Bass (2002, 134)

Approaches	**Accounts**	**Narrative assessments**	**Indicator-based assessments**
Potential for transparency	Low	Medium	High
Potential for consistency	High	Low	High
Potential for participation	Low	High	Medium
Usefulness for decision-making	Medium	Medium	High

The old proverb that says 'What gets measured, gets managed' can, generally speaking, be very much applicable in the case of assessing sustainability. In our case, universities need suitable ways or methods for not only guiding or assessing but also comparing and reporting and hence making sure that higher education institutions are heading in the right direction.

With this in mind, assessment tools are significantly important to manage sustainability in universities. Monteith and Sabbatini (1997, 56) find out that ‘people were supportive of the sustainability mantra, but when the implications become more clearly defined, disparities in approach and implementation become apparent’. This explicitly indicates that there is a need for additional guidance, which should accompany existing methods to operationalise sustainability in universities.

There were two main important steps taken to help operationalise the concept of sustainability in higher education institutions (Shriberg 2002). The steps that will be explored in the following sections are: first, a series of initiatives such as charters, declarations and other policy statements about sustainability in universities are introduced as a means of understanding sustainability. Second, an overview of frameworks, tools and systems that were designed to assess sustainability in universities are presented.

Declarations for sustainability in higher education

The main aim of these declarations, charters and partnerships was to inculcate environmental, social, economic and educational sustainability in colleges and universities. Disterheft et al. (2013, 13) believe that ‘these declarations can be seen as landmarks, and if properly implemented they can contribute to facilitating change and integrating sustainable development into the universities’ landscape. Declarations seem to be principally founded upon a moral obligation towards promoting and contributing to sustainability within higher education institutions (Wright 2002). Table 2.3, which was updated to the present by conducting further research, represents major declarations in the higher education field. These declarations were designed to encourage and support sustainable development in higher education institutions (Lozano et al. 2013). Therefore, a large number of universities across the world have signed these declarations, showing how important the latter have become.

Yet, the number of universities that signed these declarations is ‘small compared to the total number of universities in the world’, says Lozano et al. (2013, 11). Reasons tend to be because of the lack of awareness, over-crowded curricula, lack of support, lack of accountability, resistance to change and lack of resources (Davis et al. 2003; Velazquez et al. 2006; Chau 2007; Bekessy et al. 2007), to name but a few. Roorda (2002, 6) claims that:

> *‘...although these documents contain important guidelines for education, none of them offers concrete prescriptions on an operational level for what higher education should do exactly in order to contribute maximally to sustainable development.’*

It was because of this reason, among others, that the movement of sustainability in universities went a step further to operationalise the concept of sustainability. The development of assessment tools, which was the second important step, made a noticeable contribution into operationalising sustainability in higher education institutions. This will be discussed in detail in the following section.

Table 2.3: Declarations in H.E. (Adapted and expanded from Lozano et al. (2013) & Disterheft et al. (2013)

Event/Declaration	Year
The Stockholm Declaration On The Human Environment	1972
Tbilisi Declaration	1977
The Magna Charta of European Universities	1988
University Presidents for a Sustainable Future: The Talloires Declaration	1990
Halifax Declaration, Conference on University Action for Sustainable Development, Canada	1991
Agenda 21 Report of the United Nations Conference on Environment and Development	1992
Ninth International Association of Universities Round Table: The Kyoto Declaration	1993
Swansea Declaration, Association of Commonwealth Universities' Fifteenth Quinquennial Conference, Wales	1993
COPERNICUS University Charter, Conference of European Rectors (CRE)	1993
Ball State University Greening of the Campus conferences were in 1997, 1999, 2001, 2003, 2005, 2007, and 2009	1996
International Conference on Environment and Society—Education and Public Awareness for Sustainability: Declaration of Thessaloniki	1997
World Declaration on Higher Education for the twenty-first century: Vision and Action	1998
Earth Charter (directed to all education areas, not higher education-specific)	2000
Global Higher Education for Sustainability Partnership (GHESP)	2000
Lüneburg Declaration on Higher Education for Sustainable Development, Germany	2001
Ubuntu Declaration	2002
Declaration of Barcelona	2004
The UN Decade Education for Sustainable Development 2005-2014	2005
Graz Declaration on Committing Universities to Sustainable Development	2005
Declaration on the Responsibility of Higher Education for a Democratic Culture—Citizenship, Human Rights and Sustainability	2006
G8 University Summit Sapporo Sustainability Declaration	2008
Abuja Declaration on Sustainable Development in Africa: The role of higher education in SD, Nigeria	2009
Tokyo Declaration of HOPE (directed to all education areas, not higher education specific)	2009
Torino (Turin) Declaration on Education and Research for Sustainable and Responsible Development, Italy	2009
World Conference on Higher Education	2009
The ISCN-GULF Sustainable Campus Charter developed by the International Sustainable Campus Network and GULF Schools, Global University Leaders Forum convened by the World Economic Forum (WEF) in Davos, Switzerland	2010
G8 University Summit: Statement of Action	2010
Copernicus Charta 2.0.	2011
People's Sustainability Treaty on Higher Education	2012
UN Higher Education Sustainability Initiative within Rio + 20	2012

Assessment tools for sustainability in universities

Declarations, charters, and partnerships were helpful as a first step, but have not been useful enough to operationalise sustainability in universities. Therefore, there was a need for another step; a step that pushes the boundaries by clarifying a way in which sustainability can be measured, evaluated, and thus controlled. Assessment tools then were regarded to be the second, and perhaps most important, development in operationalising sustainability in universities. Shriberg (2002, 255) points out that "Assessment tools can help through identification of best practices and focusing campus efforts on continual improvement". He adds that:

> *'These tools also facilitate communication of progress within and across institutions, which is key to mutual success in moving toward the ambitious and amorphous target of sustainability in higher education.'*

This illustrates the importance of assessment tools for universities in their efforts towards a sustainable future.

A multitude of assessment tools have been developing for almost two decades now. There are a relatively large number of tools available to help universities to measure their sustainability. Yet, many are still being improved, and this is evidenced by a recent release of some of these tools. But what determines the quality of these assessment tools? This question was addressed through five attributes by Shriberg (2002, 256), who believes that, in general, ideal cross-institutional sustainability assessments:

- ‘identify important issues;
- are calculable and comparable;
- move beyond eco-efficiency;
- measure process and motivations; and
- stress on comprehensibility.’

It seems very challenging to create an assessment tool that matches all five attributes aforementioned. Ultimately, therefore, ‘no tool – and certainly no individual indicator – will capture all these attributes’ (Shriberg 2002, 257).

Another angle to look at the assessment tools is their approach. Lozano (2006b) has categorised the assessment tools based on their approaches into three parts:

- accounts assessment;
- narrative assessment; and
- indicator-based assessment.

Each and every approach has its own strengths and weaknesses. Lozano (Ibid, 964) states clearly that:

> *‘...indicator-based assessments have an overall higher performance and are more easily measurable and comparable then the other two approaches because they [the accounts and narrative assessments] tend to be more objective.’*

He adds that “indicator-based assessments offer higher levels of transparency, consistency and usefulness for decision-making” (Ibid, 971). Dalal-Clayton and Bass (2002, 135) point that:

> *‘Indicators enable assessments to be comprehensive yet selective: because they can be selective, they are better equipped than accounts to cover the wide array of issues necessary for an adequate portrayal of human and environmental conditions.’*

They (Ibid, 159) add that ‘an indicator is fully representative if:

- ‘it covers the most important parts of the component concerned; and
- it shows trends over time and differences between places and groups of people’

Furthermore, for an indicator to be reliable, Dalal-Clayton and Bass (Ibid) stipulate that it has to be accurate, measured in a standardised way with sound and consistent sampling procedures, well-founded, and directly reflects the objective of the element or sub-element concerned. These advantages of indicator-based assessments make it clear what option to go with in this study and what assessment approach should be selected.

It is essential to highlight also the reasons behind the evolution of the newly proposed assessment tools. Authors who reviewed a number of assessment tools have concluded saying that these tools vary in ‘purpose, scope, function and state of development’ (Shriberg 2002, 266). Assessment tools vary also in ‘Impact of weighing methods, flexibility and access to information’ (Gómez 2013, 14). Additionally, assessment tools vary in focus of ‘the realms of campus life – education, research, operations, governance and community engagement’ (Kamal and Asmuss 2013, 460).

To do so, an overview of some of the well-known assessment tools is required. Therefore, a literature review has been carried out. As mentioned earlier, there are many tools to assess sustainability in higher education institutions and yet more to come. However, the main reasons or criteria for selecting and reviewing the 12 frameworks are:

- These tools have been mentioned quite often in the literature.
- They are still widely used for assessing, comparing and benchmarking, thus addressing most of the specific needs of universities, as these tools were developed to be used within universities.
- They are, to a larger extent, accessible, and much more information is available in English.
- They cover basic sustainability dimensions and equally emphasised them all.
- They are, to a large degree, indicator-based assessment tools, which mean that they are more easily measurable and comparable.

Any tool that does not meet these criteria has been excluded. In table 2.4, the reviewed 12 frameworks are represented in a chronological order. The order is based on the latest version released of the tools, given the fact that some tools have been updated recently.

Table 2.4: A summary of the 12 selected benchmarking tools

No.	Tool	Abbreviation	Year
01	Sustainability Assessment Questionnaire	SAQ	2001
02	Graphical Assessment of Sustainability in University	GASU	2006
03	Sustainable University Model	SUM	2006
04	University Environmental Management System	UEMS	2008
05	Assessment Instrument for Sustainability in Higher Education	AISHE	2009
06	Benchmarking Indicators Questions – Alternative University Appraisal	BIQ - AUA	2009
07	Unit-based Sustainability Assessment Tool	USAT	2009
08	The Green Plan	Green Plan	2012
09	Sustainable Campus Assessment System	SCAS	2014
10	Adaptable Model for Assessing Sustainability in Higher Education	AMAS	2014
11	Sustainability Tracking, Assessment and Rating System	STARS	2014
12	Green Matric – UI’s GreenMetric University Sustainability Ranking	GM	2014

To give a brief idea about these tools, every tool will be explained succinctly in terms of its background, purpose, criteria and indicators, design approach, potential use and the tool structure. Each tool will be represented in a simplified tree-like graph showing the levels of the hierarchy – main criteria, sub-criteria and indicators. In this paper, the terms tool, model, system, instrument and framework are used interchangeably. The same goes for the terms evaluation, assessment, appraisal and audit. Appendix A shows the 12 reviewed tools in a great detail.

The 12 tools reviewed show many similarities in their structure. Table 2.5 gives an illustration of the levels of hierarchy, numbers of main criteria, sub-criteria and indicators. It is apparent from this table that the majority shares the same numbers of hierarchy (between three and four) and numbers of main criteria (between three and seven). A considerable variation can be noticed in the numbers of sub-criteria (between 0 and 27) and numbers of indicators (between 23 and 75). Overall, it can be said that there is no clear correlation between the levels of hierarchy and the numbers of main criteria, sub-criteria and indicators, meaning that there is no significant relationship between the number of criteria or sub-criteria and the number of indicators.

Table 2.5: The 12 selected benchmarking tools, the levels of hierarchy, and the numbers of indicators

No.	Assessment tools	Levels of hierarchy	Number of main criteria	Number of sub-criteria	Number of indicators
01	SUM	3	4	0	23
02	AMAS	4	3	9	25
03	UEMS	4	3	8	27
04	AISHE	3	5	0	30
05	BIQ - AUA	4	4	13	30
06	GM	3	6	0	33
07	SAQ	3	7	0	35
08	Green Plan	4	5	8	44
09	SCAS	4	5	27	48*
10	GASU	4	4	8	59
11	STARS	4	5	18	74
12	USAT	4	4	9	75

* 48 categories with 174 questions

Nonetheless, when comparing the number and type of indicators in the tools reviewed, interesting results can be found, as in figure 2.10. First, the total number of indicators in these 12 tools is 503 indicators, distributed as follows: management 115 (23 per cent), academia 132 (25 per cent), environment (34 per cent), engagement (17 per cent) and innovation (1 per cent). It comes as no surprise that the numbers of environmental indicators are quite often the highest in most of the tools. This is followed by the academic and management indicators. Engagement indicators are occasionally mentioned in the 12 tools reviewed, whereas innovation indicators were not clearly indicated in the majority of them. Second, it can also be observed that the numbers of academic indicators correlate with either management or environmental indicators, which can be seen in a number of tools such as the GASU, USAT and STARS.

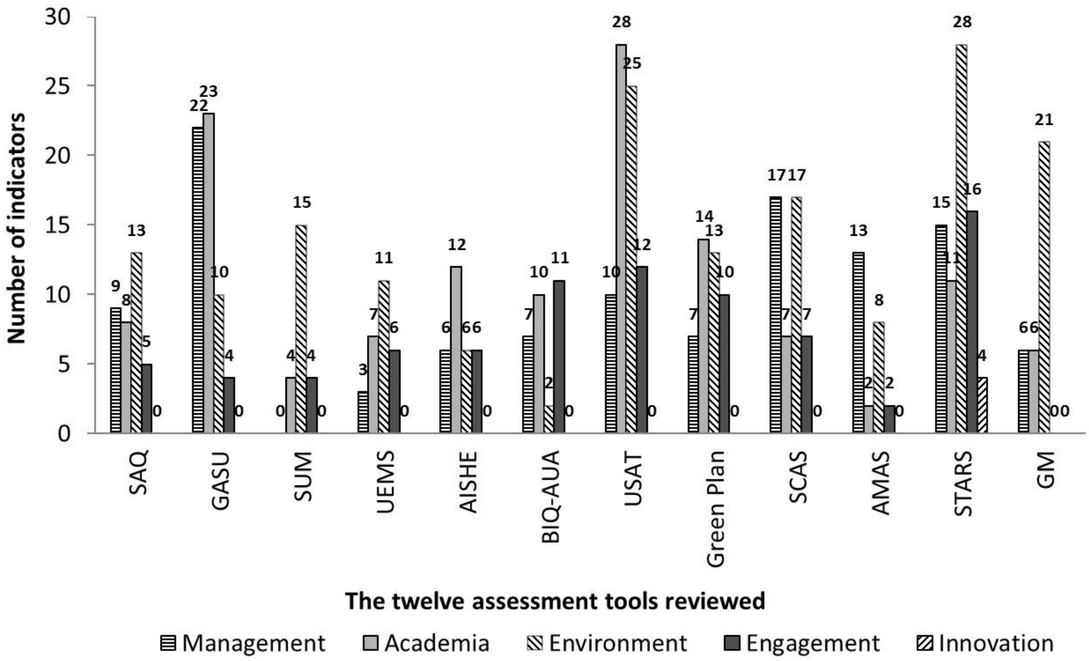


Figure 2.10: A comparison of the 12 assessment tools

The current tools show that although there is a slight variation in their content, they share many commonalities. Figure 2.11 illustrates the identified five areas (criteria) used in the 12 reviewed frameworks to improve sustainability performance in higher education institutions. The identified common denominators can be grouped in a holistic framework, including aspects of management; academia; environment; engagement; and innovation. For example, curriculum, research, training, conferences and so on were grouped under academia aspect. The same goes for infrastructure, transportation, energy, water, waste and so on which were grouped under the environment aspect. When assessing sustainability at universities, the terminology used will relate to these five areas of sustainability, in spite of differences.

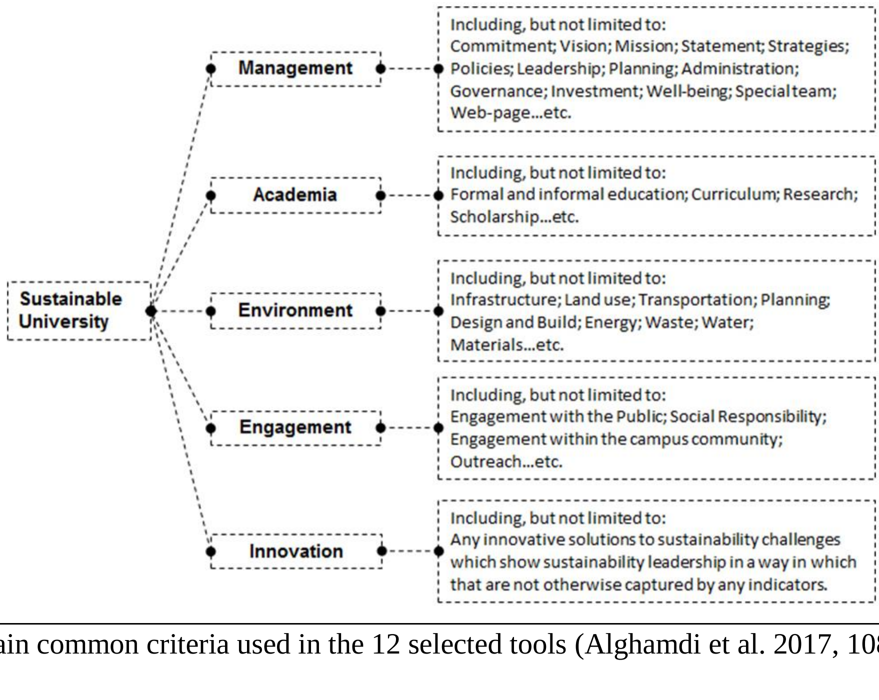


Figure 2.11: Main common criteria used in the 12 selected tools (Alghamdi et al. 2017, 108)

The proposed framework can also be regarded as a means for any higher education institution to develop its own instrument to advance its progress and to measure its efforts towards sustainability. As each university is faced with different challenges, universities can tailor their own tool based on the proposed framework. In this way, individual universities can be helped – contrary to the ‘one-size-fits-all’ approach of conventional mainstream assessment tools. This is not to disregard the existing tools, but to empower higher education institutions to decide for themselves the development of their own processes. Once this has been established, institutions should use assessment tools not only for guiding or assessing but also for comparing and reporting and hence making sure that universities are heading in the right direction.

The proposed framework appears to be comparable to STARS. This supports the conclusion reached by Kamal and Asmuss (2013) that STARS is one of the most comprehensive and advantageous assessment tools. The paper makes its conclusion by arguing that STARS meets the most important attributes of an ideal assessment tool suggested by Shriberg (2002). These attributes are: identifying important issues; emphasising comprehensibility; and easiness of comparability and calculability.

First, STARS, which was newly established and recently updated, captures to a large extent most of the criteria mentioned in the proposed framework. This means that all five aspects of sustainability in universities (management, academia, environment, engagement and innovation) are covered by STARS.

Second, STARS has 74 indicators that assess sustainability in sufficient detail. For example, under the criterion ‘Academics’, there is a sub-criterion ‘Curriculum’, which has the indicator ‘Campus as a Living Laboratory’. This can be defined as how ‘A university utilises its infrastructure and operations for multidisciplinary student learning, applied research and practical work that advances sustainability on campus’ (STARS 2014, 51). Such an indicator provides a variety of examples (17 in total), showing a diverse and rich content that is remarkably coherent. Another interesting example is the ‘Innovation’ criterion. Compared with the 12 tools reviewed, STARS explicitly offers such criterion with the aim of promoting ‘out-of-the-box thinking’ in approaching sustainability. This criterion with its innovative indicators is reserved for:

> *‘... new, extraordinary, unique, ground-breaking, or uncommon outcomes, policies, and practices that greatly exceed the highest criterion of an existing STARS credit or are not covered by an existing STARS credit’ (STARS 2014, 307).*

Third, STARS has the highest number of indicators in almost all five criteria. Furthermore, it has a large number of indicators in each criterion as in figure 2.9. Additionally, to make the comparison and calculation of credits much easier, STARS uses an online credit-based survey. STARS also accommodates the diversity of higher education institutions by making some of the credits have less detailed specifications, but are instead flexible or open. In other cases:

> *‘... credits include an applicability criterion, so that the credits only apply to certain types of institutions. By following this approach, institutions are not penalised when they do not earn credits that they could not possibly earn due to their circumstances’ (STARS 2014, 10).*

These tools also share essential strengths and weaknesses, as shown in table 2.6, which summarises pros and cons of the 12 selected benchmarking tools. However, the critical issue to highlight here is that with such comparison, the real issue is subjectivity. In other words, each author assesses strengths and weaknesses from a variety of conflicting perspectives. Such comparison would be meaningless if the scale of measuring strengths and weaknesses differ. Thus, the real question is does the assessment of tools suffer from subjectivity? Further research needs to address this issue.

Table 2.6: Pros and cons of the 12 selected benchmarking tools, chronologically ordered

No	Tool	Number of indicators	Main Strengths	Main Weaknesses
01	SAQ	35	● Emphasises on (cross-functional) sustainability as a process.[1] ● Useful as a conversational & teaching tool.[1] ● Probing questions that identify weaknesses & set goals.[1] ● Serves as a pilot & strategic planning tool.[2] ● Defines sustainability from various perspectives. [2]	● No mechanisms for comparisons or benchmarking.[1] ● Difficult for large universities to complete.[1]
02	GASU	59	● Covers all important issues.[3] ● Uses AMOEBA graph to facilitate understanding.[3]	● Requires large amounts of data.[3] ● Hard to apply in HEIs without GRI reports on sustainability.[3]
03	SUM	23	● Useful in achieving initial momentum to progress and advance sustainability on campus. ● Top-down approach as well as bottom-up. ● Validity & reliability of this model are proven by other references such as TSCE Report.[4]	● Takes long time to document the model's effectiveness and efficacy.
04	UEMS	27	● Proven to be useful to assess sustainability actions.[5] ● Developed by researchers from emerging countries (Saudi Arabia). ● Covers most aspects of sustainability.	● Indicators are not as detailed as other frameworks.
05	AISHE	30	● Flexible for institutional comparisons.[1] ● Process-orientation which helps prioritise & set goals through development stages. [1] ● Created through international consensus.[1]	● Difficult to comprehend.[1] ● Motivations are potentially excluded.[1] ● Narrative assessment.[3]
06	BIQ (AUA)	30	● Used alongside a qualitative assessment.[3] ● Supported by ProSPER members. [3]	● Does not cover social aspects of sustainability.[3] ● Environmental indicators are not as detailed as other frameworks.

(Continued)

No	Tool	Number of indicators	Main Strengths	Main Weaknesses
07	USAT	75	● Allows for self-assessment by individual units/departments, also capable of evaluation the whole institution. [3] ● Supported by UNEP and MESA. [3]	● Does not cover social responsibility issues.[3]
08	The Green Plan	44	● Covers all important aspects of sustainability. [3] ● Very detailed and well explained, defined & easy to implement.	● Requires large data as well as a lot of effort.
09	SCAS	174	● Covers most aspects of sustainability. ● Covers other unusual aspects such as disasters. ● Supported by Hokkaido University.	● Too long to complete. ● Social issues have not emphasised enough.
10	AMAS	25	● Covers most aspects of sustainability. ● Flexible and can be adapted to different contexts at different stages.	● Does not cover issues such as Procurement, Contracting and Food/Dining in university campus.
11	STARS 2.0	74	● Most comprehensive tool including important categories.[2] ● Detailed explanation. ● Technical Manual.[2] ● Active support from AASHE.[3]	● Complex assessment procedure.[2] ● Cost associated with registering & participating.[2] ● Functions in contexts in which SD is already advanced.[3]
12	GM	33	● World University Ranking based on sustainability. ● Active support from Universitas Indonesia.[3]	● Focuses more on the environmental aspects of sustainability & hence not covering issues such as Social Responsibility, Diversity & Equity.

Sources:
[1] Shriberg (2002)
[2] Kamal and Asmuss (2013)
[3] Gómez et al. (2014)
[4] United Nations Economic and Social Council (2001)
[5] Castro and Jabbour (2013)

There are several important areas to which this study makes contributions to. Scientifically, this research can be used to improve existing sustainability assessment tools. Additionally, it can help to develop new tailored tools, as each university is facing different challenges to advance its progress and measure its efforts towards sustainability. Socially, applying these assessment tools through not only education and research but also operation and engagement creates a culture of sustainability at universities.

The applicability of the tools reviewed, both scientifically and socially, can be summarised in the following points:

- The tools can be used to assess and report sustainability along with ranking universities based on their advancement in sustainability.
- The assessment tools can be used as both baseline and reference lists, as a broad guide and as a method to set and achieve sustainability objectives.

- They can offer a base for strategic planning by highlighting key dimensions of sustainability.
- These tools can be used to compare and contrast a university's efforts towards sustainability. Also, it can be used for internally comparing the university's colleges and departments and externally with other universities nationally and internationally.
- A number of tools concentrate merely on meeting the challenge of operational eco-efficiency, whereas theory and practice point to the necessity of an integrated approach to sustainability across functional areas.
- Assessment tools can help a university to reorient itself towards a sustainable future and assist the university to explicitly acknowledge areas to be recognised, addressed and hence improved.
- These tools can offer a platform through which universities across the world can share challenges and potential solutions.
- Some assessment tools can even aid improving other tools by following the same processes used, and hence make the criteria and sub-criteria much more tangible and understandable.
- Some of the sustainability criteria within these assessment tools can be carried out inside or outside the university campus (such as education, research, outreach, partnerships). Other criteria, however, can only be implemented on campus (mainly, the operational practices such as energy efficiency, water efficiency, waste management... etc.).
- Such tools would also impact the public directly and indirectly. Applying these assessment tools through not only education and research but also through operating the campus and engaging with the internal community (students, faculties and supporting employees) as well as with the external communities (different stakeholders), creates a culture of sustainability at universities and beyond benefiting societies and promoting living more sustainably.
- Although there are many assessment tools and hence there has been a noticeable progress, this progress is not clearly measurable.
- The next step should be moving from proposing more tools, criteria and sub-criteria to practically detailing and operationalising the core of these tools, which is indicators. Indicators should be given more attention. Tools ought to develop indicators in easily measurable ways, which are clearly defined and agreed upon.

Sustainable campus implies a better balance between environmental, social, and economic goals in policy making as well as a long-term view about the results of today's campus actions and activities. 'Living laboratory' concept means not only research and education should emphasise sustainability topics, but also daily lives in laboratories, lecture halls, and dormitories should embody sustainable principles.

2.2.4 Higher education in Saudi Arabia

The research literature four domains

The Kingdom of Saudi Arabia is the largest Arab state in Western Asia by land area. The total area is 2,149,690 km2, which is equivalent to half of Europe. The population is over 30 million and hence the density is very low (12.3/km2). The Gross Domestic Product (GDP) was worth 646.44 billion US dollars in 2016 (Trading Economics 2017). Saudi Arabia possesses 18% of the world's proven petroleum reserves and ranks as the largest exporter of petroleum. The oil and gas sector accounts for about 50% of gross domestic product, and about 85% of export earnings. Apart from petroleum, the Kingdom's other natural resources include natural gas, iron ore, gold, and copper. Saudi Arabia is home to the world's largest continuous sand desert, the Empty Quarter, which occupies the southeast of Saudi Arabia. Hence Saudi Arabia has a desert climate characterised by extreme heat during the day, and a sudden drop in temperature at night, and very low annual rainfall, with the exception of the province of Asir and Baha on the south western coast. There are 13 provinces and the capital city is Riyadh (6 million inhabitants). The main cities are Jeddah (4 million inhabitants), Makkah (2 million inhabitants), and Medina (1 million inhabitants). 95% of the Kingdom is desert. Figure 2.12 shows the geographical boundaries map of the 13 provinces of Saudi Arabia and the main cities at each province (CDSI 2014).

Figure 2.12: Saudi Arabia's provinces and main cities (Adapted from the CDSI 2014)

● Saudi Arabia and climate change

In general, the climate of the Kingdom of Saudi Arabia is described as a desert climate, with the exception of the areas in southwest, which features a semi-arid climate. It is characterised by extreme heat during the day and low temperatures at night, and very low annual rainfall (Weatherbase 2018). Figure 2.13 shows some climate data about the Kingdom. It indicates the average temperatures (which reaches 40 °C) and precipitation (which shows low rainfall).

	ANNUAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Average Temperature (C)	25.2	15.6	17.4	21	25.1	29.7	32.1	33.3	33	30.9	26.6	21.4	17.2
Average High Temperature (C)	30.4	20.7	22.5	25.9	30.1	34.6	37.4	38.1	37.9	36.4	32.1	26.5	22.4
Average Low Temperature (C)	18.6	10.2	11.6	15	18.6	22.4	24.6	25.7	25.7	23.5	19.4	15	11.4
Average Precipitation (mm)	124.1	14.6	10.3	24.2	19.5	10.2	1	2	3.4	1.1	4.1	13.2	13.9

Figure 2.13: Saudi Arabia's weather averages (Weatherbase 2018)

Saudi Arabia is particularly vulnerable to climate change (CAT 2016). The question is what makes the Kingdom seriously challenged by global warming. The top three causes, inter alia, are:

- First, much of the landscape of Saudi Arabia is typified by semi to hyper aridity climate with very low rainfall (FAOUN 2016). It has limited groundwater and about 2% of the country's land area is arable, challenging national food sources (Darfaoui and Al Assiri 2010, 01). Additionally, Saudi Arabia is classified by the United Nations as a water-scarce nation (UNDCWS 2016, 210).
- Second, the Kingdom has the world's largest oil reserves and it is the biggest oil exporter (WTEx 2016). Therefore, the backbone of Saudi economy is based mainly on exporting fossil fuels. The latter is considered to be one of the major causes of global warming (LSE 2016).
- Third, as a fast-growing economy, the Saudi Arabian government is in a race to meet the internal demand of energy and water, given the rapid growth in urbanisation in which some of its cities are characterised globally by being one of the 'fastest growing cities' (World Bank 2016).

The Kingdom's efforts towards climate change have been classified by Climate Action Tracker as 'Inadequate' (CAT 2016). This was because, in general, the country has not shown clear commitments, pledges, and targets. For example, in its plans and actions outlined in the Intended Nationally Determined Contribution (INDC) submitted to the UNFCCC Secretariat on November 10th 2015, Saudi Arabia did not provide quantified measures (e.g. its energy efficiency, renewable energy, carbon capture and storage) (Ibid).

Saudi Arabia is very sensitive to climate change. Yet, the Saudi efforts to deal with climate change are not satisfying enough. According to the Climate Action Tracker (CAT 2016):

> *'The Saudi climate plans are highly inconsistent with the projected climate impacts for the region, an area where average warming is higher than the global average. In a 3-4 °C world, three quarters of the country will suffer from excessive dryness by the end of the century... Yet the Saudi government still has no policies in place to begin – or encourage – this shift to renewable energy'.*

Against such challenges, Saudi Arabia has made significant moves to address climate change. According to the United Nations Development Programme, ‘Saudi Arabia is party to the following conventions: Climate Change, Climate Change-Kyoto Protocol, Desertification, Endangered Species, Hazardous Wastes, Law of the Sea, Marine Dumping, Ozone Layer Protection, [and] Ship Pollution’ (UNDP 2016, 01). Moreover, the government of Saudi Arabia has taken steps to address climate change issues through a number of sustainability programmes. The top ten actions and measures taken, among others, are:

- 2005 – Saudi Arabia became a member of the Carbon Sequestration Leadership Forum, Washington, DC, U.S.A. (CSLF 2016).
- 2008 – Saudi Arabia along with other oil exporting Kingdoms’ including Netherlands, Norway, and the United Kingdom established the ‘Four Kingdoms Initiative’ for Carbon Capture Utilisation and Storage (CCUS). The country plans to build the world’s largest carbon capture and use plant (PRC 2016).
- 2008 – Saudi Arabia launched a National Energy Efficiency Programme (NEEP) to initiate and promote energy efficiency measures (Alyousef and Varnham 2010).
- 2010 – Saudi Arabia created The Saudi Energy Efficiency Centre (SEEC) to develop a national program to rationalise and raise the efficiency of energy consumption through proposing plans and policies to achieve such aim (SEEC 2016).
- 2010 – Saudi Arabia established King Abdullah City for Atomic and Renewable Energy (KACARE). KACARE conducts research and sets and implements national atomic and renewable energy policies with an ultimate aim of building a sustainable future for Saudi Arabia by developing a substantial alternative energy capacity fully supported by world-class local industries (KACARE 2016).
- 2012 – Saudi Arabia started an internal engagement to further address climate change and sustainability issues with its national research centres (e.g. King Abdulaziz City for Science and Technology and King Abdullah Petroleum Studies and Research Centre), public universities (e.g. King Saud University, King Fahd University for Petroleum and Minerals, and King Abdulaziz University), and private universities (e.g. King Abdullah University for Science and Technology).
- 2014 – Saudi Arabia joined the ‘Global Methane Initiative’ (GMI) for the purpose of knowledge sharing in Methane gas capture and reuse in the areas of flare management and fugitive emissions control for oil and gas operations (GMI 2016).
- 2015 – Saudi Arabia launched its Vision 2030 aiming at a vibrant society, thriving economy away from depending merely on oil-exporting, and more sustainable developments. Among many targets, the vision states an initial target of 9.5 gigawatts of renewable energy by 2030 (CEDA 2016). Under the umbrella of King Salman Renewable Energy Initiative, the vision speaks of localising not only the manufacturing of renewable facilities, but also research and development in renewable energy. Research on renewable energy has been underway for a number of years now by King Abdulaziz City for Science and Technology (KACST) and King Abdullah University of Science and Technology (KAUST). One of the ultimate aims of this joint research program is for Saudi Arabia, the world’s top crude oil producer, to become a top solar energy exporter. It was reported that the former Saudi Arabian Oil Minister, who headed the country’s climate planning, said in a conference in Paris that ‘the government planned to be a global leader in solar and wind energy’ (King 2015).
- 2016 – Saudi Arabia signed the Paris Agreement indicating its willingness to be responsible and act accordingly (UNFCCC 2016).
- 2017 – Saudi Arabian giant oil company Saudi Aramco installed the country’s first wind turbine in Turaif in north-western Saudi Arabia. The project, developed in partnership with General Electric, marked a new milestone in Saudi Aramco’s plan

towards realising the 9.5-gigawatt national renewable energy target defined in Saudi Vision 2030 (Saudi Aramco 2017).

- 2017 - The Crown Prince Mohammad bin Salman announced the plan to build a smart city, known as Neom. The city is to be powered only by clean energy sources such as wind and solar (NEOM 2017).

However, despite the above initiatives, much more is needed from the Kingdom. The precariousness circumstances that Saudi Arabia finds itself in demands a more robust approach to sustainability. This has been confirmed by a number of analysts; one of which was a report to the Food and Agriculture Organization of the United Nations (FAO) and Regional Office for the Near East and North Africa (RNE), Darfaoui and Al Assiri (2010) concluded that:

> *'Saudi Arabia is particularly vulnerable to climate change as most of its ecosystems are sensitive, its renewable water resources are limited and its economy remains highly dependent on fossil fuel exports, while significant demographic pressures (2.3% increase), continue to affect the government's ability to provide for the needs of its population. The KSA Government is engaging in various mitigation and adaptation measures to cope with adverse impacts of climate change as well as with response measures especially by the Annex 1 parties of the UNFCCC, which are expected to have diverse economic and social impacts on the country. However, a great deal remains to be done to contribute in the mitigation programmes in order to face this global and national challenge.'*

● Higher education system in Saudi Arabia

The Kingdom of Saudi Arabia has adopted a long-term strategic plan for its higher education. The strategic plan, known as 'The Horizon' or 'Aafaq' in Arabic, aims to build a 'knowledge society' by investing in human resources through both secondary and higher education. The Horizon plan's strategic dimensions, through which higher education in the Kingdom can advance in achieving a knowledge society, are: expansion, quality, and diversity, as shown in figure 2.14. These three strategic dimensions are:

- **Expansion** – in terms of increasing accessibility to higher education to the maximum capacity by which 70% of high-achieving high school students directly enter universities, 25% go to technical and vocational education and training institutions, whereas only 5% look for a job. Expansion also includes expanding geographically by spreading out higher education institutions to include each and every province in the Kingdom in order to ease the accessibility to higher education.
- **Quality** – it can be achieved through the graduation of highly qualified professionals, the production of value-added research, provide services to the community to contribute effectively in advancing development and achieve a knowledge society.
- **Diversity** – in terms of a) the focus of each higher education institution (whether research focus or teaching focus or both), b) in terms of the subjects each university offers and their relevance to the country needs.

The plan identifies eight main areas on which to focus on, as seen in figure 2.15. One of these areas is developing the infrastructure of the university campuses. The infrastructure program focuses on enhancing the quality of facilities and infrastructure in universities raising their efficiency and ensuring compliance with specifications standards, taking into account the difference between well-established university campuses and recently founded university campuses. Smith and Aboummoh (2013, 4) indicate that 'success cannot be achieved unless the necessary human and physical resources, administrative infrastructure, technology systems and collaborative networks are in place'. This makes it clear that physical resources are key to a successful higher education system.

Infrastructure program

● ***Rationale*** – This includes increasing the number of universities, providing an inspiring environment for teaching, learning, and research, continuing to provide maintenance services for university facilities, and considering the disparity between universities in the quality of infrastructure and completion of facilities.

● ***Goals*** – The main goals are: planning for the expansion in buildings of higher education institutions, completing the construction and development of all university campuses including their services, ensuring providing of an infrastructure with a stimulating and inspiring environment for teaching, learning, and research, strengthening preventive and periodic maintenance and transformation of facilities, creating facilities that are accessible to people with special needs, providing infrastructure for information technology, optimising operation of buildings and efficiency, and developing specifications and standards for buildings and equipment.

● ***Main Tasks*** – The main tasks are finding the organisation and regulation to develop specifications and standards for university buildings and equipment through taking advantage of the local expertise, activating and developing the management of preventive maintenance and periodic departments in universities, investigating users' satisfaction with the services and infrastructure, and organising joint use (sharing) of some facilities and advanced laboratories.

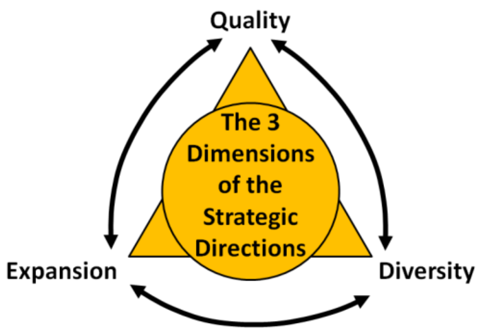


Figure 2.14: The 3 dimensions to achieve 'knowledge society' via H.E. (Adapted from Aafaq 2011)

Figure 2.15: Areas to focus on in the Horizon Plan (Adapted from Aafaq 2011)

To implement the abovementioned strategic plan, the government of Saudi Arabia is currently investing heavily in the education sector with a special focus on the higher education sector. In 2016, almost a quarter of the national budget was spent on education and training sector.

Furthermore, when comparing higher education in Saudi Arabia with other nations, the Kingdom's system is relatively young. Only four universities are over 50 years old. For almost four decades (1960 – 2000), the Kingdom was known to have just eight universities, established between 1957 and 1998. Today, however, it has 28 public universities, in which the majority of universities were established between 2003 and 2014, as seen table 2.7. The recently founded universities were in fact satellite or branch campuses of those eight well-established Saudi universities, which in recent years became independent universities. This in turn means that 70% of public universities have been established in the last decade. These 28 public universities are funded directly by the Saudi Ministry of Education. These public universities tend to be comprehensive; providing a wide range of disciplines. Furthermore, there are other higher education institutions that are managed and funded by other ministries and government agencies. These institutions focus on some technical, industrial, medical, and administrative aspects, offering higher education to 125,279 students in the country (Ministry of Education 2017).

Table 2.7: Public universities in Saudi Arabia, chronologically ordered

No	Name of the institution	Code	Location	Year of foundation
01	King Saud University	KSU	Riyadh	1957
02	Islamic University of Medina	IUM	Medina	1961
03	King Fahd University for Petroleum and Minerals	KFUPM	Dhahran	1963
04	King Faisal University	KFU	Alhasa	1964
05	King Abdulaziz University	KAU	Jeddah	1967
06	Imam Muhammad Ibn Saud Islamic University	IMSIU	Riyadh	1974
07	Umm Al Qura University	UQU	Makkah	1981
08	King Khalid University	KKU	Abha	1998
09	Qassim University	QU	Buraydah	2003
10	Taibah University	THU	Medina	2003
11	Taif University	TFU	Taif	2003
12	King Saud bin Abdulaziz University for Health Sciences	KSAUHS	Riyadh	2005
13	Jazan University	JNU	Jazan	2005
14	University of Hail	UH	Hail	2005
15	Al Jouf University	AJU	Skaka	2005
16	Al Baha University	ABU	Albaha	2006
17	Tabuk University	TKU	Tabuk	2006
18	Najran University	NU	Najran	2006
19	Northern Border University	NBU	Arar	2007
20	Princess Nora bint Abdulrahman University	PNU	Riyadh	2008
21	Shaqra University	SU	Shaqra	2009
22	Prince Sattam bin Abdulaziz University	PSAU	Alkharj	2009
23	University of Dammam (Imam Abdulrahman Al Faisal)	IAU	Dammam	2009
24	Majmaah University	MU	Majmaah	2009
25	Saudi Electronic University	SEU	Riyadh	2011
26	University of Hafr Al Batin	UHB	Hafr Albatin	2014
27	Bisha University	BU	Bishah	2014
28	University of Jeddah	UJ	Jeddah	2014

Moreover, private higher education in the Kingdom is expanding rapidly. Currently, the country has 11 private universities and 18 private colleges, covering a whole range of areas including medical, administrative, scientific, and technological subjects. There are over 78,798 students in private universities and colleges in Saudi Arabia (Ibid).

According to the Ministry's Statistic Centre, there were in total 1,527,769 students, 76,985 faculty members, and 77,130 administrative and technical staff in higher education institutions, both public and private (Ibid).

Other characteristics of the higher education system in the Kingdom are: a centralised system of control, gender segregation, funding provided by the state, free for all citizens at all levels. Citizens do not pay to study; they are paid instead (Smith & Aboummoh 2013). Aleasa (2011) emphasises that higher education system in the Kingdom will continue to face many challenges and difficulties in achieving its ultimate goal (a knowledge society), unless the government eases the control over the system. He highlights this matter showing that the main issues are 'autonomy and flexibility in decision-making'. This is because education is fully funded by the state, thus government influence remains an important factor.

● **University campuses in Saudi Arabia: A general overview**

The boom has led to the construction of 20 new campuses in different parts of the kingdom. Phase one – which includes constructing community colleges, science colleges, medical colleges, engineering colleges, and some housing units for both students and academic staff – is expected to be completed by 2017. These campuses are located in cities that have had no prior history of hosting such institutions. Thus, their impact can be clearly ascertained, to the extent that it is safe to conclude that their construction has added value to these cities and even to the wider province. The facts and figures of newly established university campuses in Saudi Arabia indicate that there is a huge investment in the infrastructure and facilities of higher education. The new universities are believed to be costing more than 80 billion Saudi Arabian Riyals (18 billion Euros). The capacity of new campuses of public universities ranges from 10,000 to 90,000 students each (Ministry of Education 2012, 3). According to the Ministry of Education (2017), the enrolled students in public universities in 2015-2016 were 1,400,297 students; 1,342,286 Saudis (96%) and only 58,011 non-Saudis (4%). The enrolment in 2015-2016 consisted of 729,882 female students (52%) and 670,415 male students (48%). Over 300,000 new students (freshmen) are expected to be enrolled in public universities each year. The total capacity of the 20 new campuses will be considerably more than one million students (Ministry of Education 2012). The enrolled students in the eight old universities in the academic year of 2002-2003 were 484,286 students. The well-established institutions have also expanded physically by building new college buildings and other supporting facilities. This means that the capacity of all public university campuses might be more than 1.5 million students once the new campuses are fully operational. This is a very conservative estimate, given that there is no data available on such important figure. The total area of lands of the 20 new campuses is more than 11.8 thousand hectares (Ibid). On average, about six hectares of land were allocated to each university campus. The majority of the 20 new universities have a male campus and a female campus within the university campus boundaries. These campuses also include Medical City, Research City (Science Park), Sport City, Staff Housing, Students Dormitories, Endowment Lands (Investment Areas), and future expansion zones and other areas for services. This massive city-like area would give more flexibility and allow for possible future expansions. Such figures send a clear message that these mega-projects should be handled with extreme caution for the sake of a sustainable future.

Figure 2.16 displays the geographical locations of the Kingdom's public universities. The eight old universities are located in the biggest seven cities in Saudi Arabia. They can be geographically described as on the east-west axis where the population density is high. They are categorised either as comprehensive with a research focus or as specialised universities (Ministry of Education 2012). The figure also shows the locations of the 20 new universities, which were established between 2003 and 2014. These universities are located in the provinces that have had no history of hosting such institutions.

The 20 new universities are spread geographically out all over the country. Such a distribution balance is healthy, because for decades the Kingdom was known to have just eight public universities located on the east-west axis. Now, however, all cities in Saudi Arabia are served with higher education institutions.

With that being said, there many advantages for having public institutions such as universities. It is one of the biggest, if not the biggest employers in the city. Hence, many aspects of life have flourished in such cities. Growth in the economy is noticed. For example, the value of lands in close proximity with the university increased dramatically. Demand for rental accommodations has risen remarkably. Perhaps one of the most important positive points to mention is the fact that students do not have to migrate anymore from their small cities to bigger cities to enter university. This may trigger a 'reverse migration', in which many people may consider moving out of big overcrowded cities to these small and quiet cities.

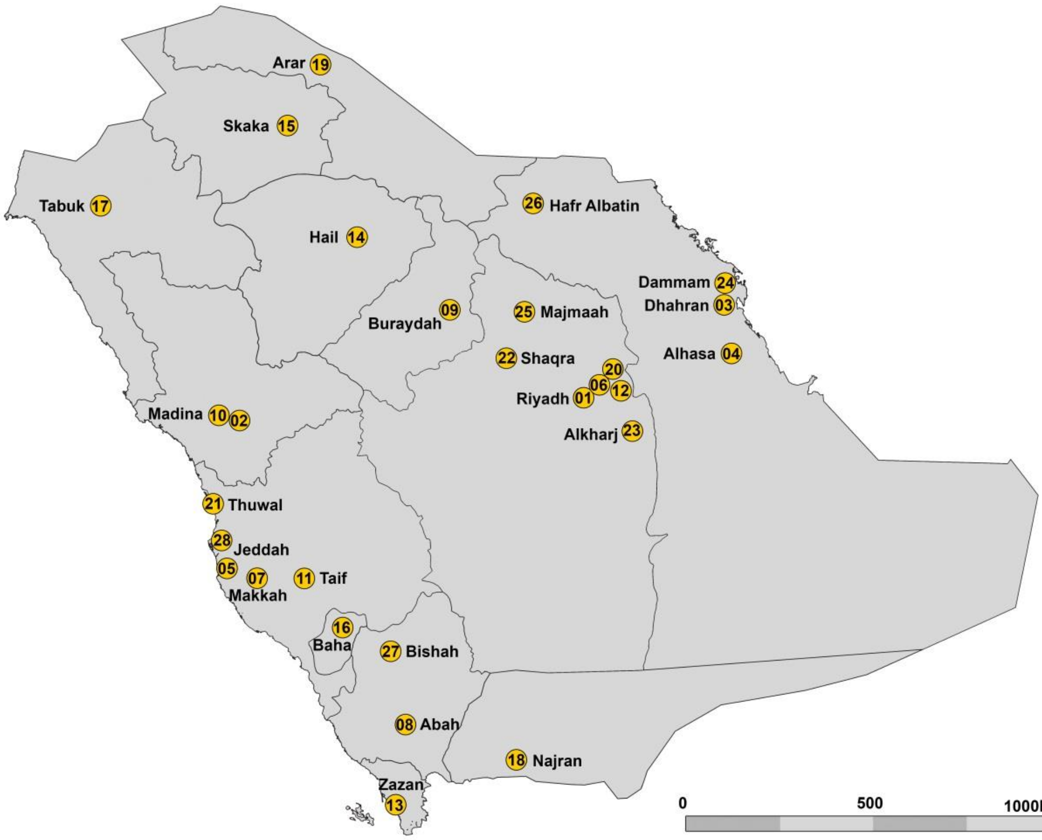


Figure 2.16: The geographical locations of Saudi Arabian public universities

Public universities in Saudi Arabia are predominately for male and female students. The only exceptional cases are Princess Nora University (PNU), King Fahd University of Petroleum and Minerals (KFUPM), and King Abdullah University for Science and Technology (KAUST).

- The Princess Nora University (PNU) is the largest female only university in the world with a capacity of over 60,000 female students. The eight million m2 campus was constructed in a record time of two years, supported by 75,000 construction workers and the latest building machinery and methodologies. It has 14 colleges and several departments. The campus has 600 high-tech and smart buildings, large-capacity student dormitories, various models of faculty residence units, and three spacious, state-of-the-art recreation centres. The campus has an 11.5 km automated metro system with 4 lines and 14 stations. It has its own 300-bed teaching hospital. The PNU is an environmentally friendly campus with water recycling plant, solar thermal plant (which provides 16% of heating and 18% of air-conditioning needs). 38 of the university's buildings, totalling a million square meters, have been submitted for a Leadership in Energy and Environmental Design (LEED) green building rating. The library has applied for the second highest LEED "Gold" rating (PNU 2014).
- King Fahd University of Petroleum and Minerals (KFUPM) was established in 1963. It is one of the most highly ranked public universities in the Middle East and it is only for male students. It is located in the eastern part of the country where the most-valuable natural resources (oil and gas) in Saudi Arabia are found.
- King Abdullah University for Science and Technology (KAUST) is the only mixed university in the Kingdom where male and female students can study together.

The sheer majority of the 20 new universities can be categorised as teaching institution. This comes as no surprise since they are recently founded universities, many of which have no capacity yet to be focusing more on research besides which they are still under construction. Figure 2.17 shows the categorisation of the 28 public universities in Saudi Arabia which can be grouped in 6 sets (Adapted from Smith & Aboummoh 2013):

- **Comprehensive university with a research focus (R)** is a well-established university with a focus on research along with teaching. These universities tend to be in major cities and have a large body of students and academics accompanied by researchers. The research universities are Saudi Arabia's link to the global knowledge economy.
- **Comprehensive university (C)** is a relatively newly established university that can offer a wide range of academic programmes. They share some of the characteristics of Group (R) and hence have large faculty members, students and employees. These universities are also located in big cities.
- **Highly specialised university (H)** is a unique university with different goals and missions from any other public university in the Kingdom. Established in 2009, to create a world-class institution in the country, the King Abdullah University for Science and Technology (KAUST) is the only university in the Kingdom with these characteristics. It is an international graduate-level research university offering only (Masters and PhD degrees) located in Thuwal, North West of the Kingdom. It has a very limited number of students, around only 1,200, and a state-of-the-art sustainable campus of 3,600 hectares with cutting-edge facilities. It also has the sixth largest endowment of any university in the world, around 20 billion US Dollars. It has its own identity and a total independence from the Ministry of Higher Education unlike the rest of public universities in the Kingdom (KAUST 2017).
- **Specialised university with a research focus (F)** is a university with a research emphasis on a particular area of speciality, such as King Fahd University for Petroleum

and Minerals (KFUPM), which is one of the oldest and much respected universities. It has all the expertise that supports the county's petroleum and minerals industries.

- **Specialised university (S)** is universities with a focus on teaching particular subjects, such as medical subjects or Islamic subjects.
- **Teaching university (T)** is universities that have been recently established and are located away from the metropolitan centres, many of which are still under construction. These universities can be partially attributed to the formation of branch campuses from well-established Saudi universities that in recent years eventually became independent universities.

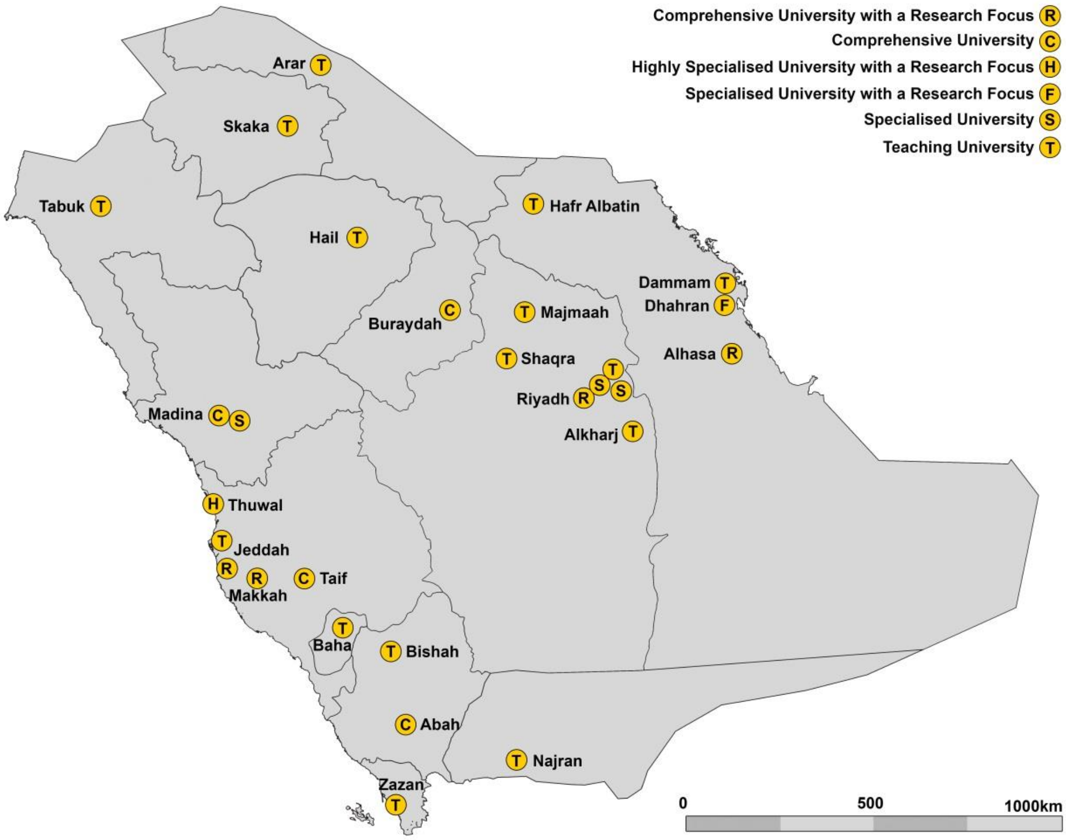


Figure 2.17: The categories of Saudi Arabian public universities

● Saudi Arabia's youth population

Figure 2.18 shows that the projections of the youth population in Saudi Arabia aged between 15 and 24. The data is based on the United Nations (2012) projections of the Saudi youth population. It should be highlighted that the important segment for this study is the group aged between 19 and 24, where youth are expected to be at the university having completed their high school. The graph displays that in the short-term; there will be an increase of the youth population. It is also projected that this particular segment of the Saudi society will continue to increase and reach its peak in 2035. In the long-term, however, a sharp continuous declining of the youth population can be clearly noticed. This raises a concern about the long-term planning for space management and the feasibility of such large university campuses.

Looking closely at this graph, especially at the statistics of the year 2015, it can be said that of the 4.5 million youth population, 1.5 million were studying in higher education institutions in Saudi Arabia. This means that around one-third of the youth population was enrolled in the

Kingdom's colleges and universities. Moving forward, it can be seen that there will be a sharp increase until the year 2035 with the peak reaching about 5.7 million. If one-third attends universities, then the expected number would be around 1.9 million students in the years 2030-2035. This should not automatically mean an increase in the space provision at university campuses. That is because there will be a huge drop in the youth population from its peak of 5.7 million to 5 and then 4 million in 2040 and 2045, respectively. The projection indicates that the youth population might remain flat at around 4 million, which means about 1.3 million students in higher education system if the admission's level stays as it is now. This data should be taken into account when planning for physical space in university campuses. In order to avoid over-provision of space, there is a need to audit space at the national level, given that the latter does not exist yet in the Kingdom of Saudi Arabia. The drop in the number of students is a major issue facing many countries around the world, including Japan (TJTN 2016), Russia (UWN 2015), and the United States of America (IHED 2015). The only reservation about the United Nations (2012) projections for the Saudi youth population is that it is merely a prediction. With this in mind, planners should put forward prospective scenarios in which the youth population might be far less or maybe far more than projected and build upon these scenarios by taking into consideration other alternatives.

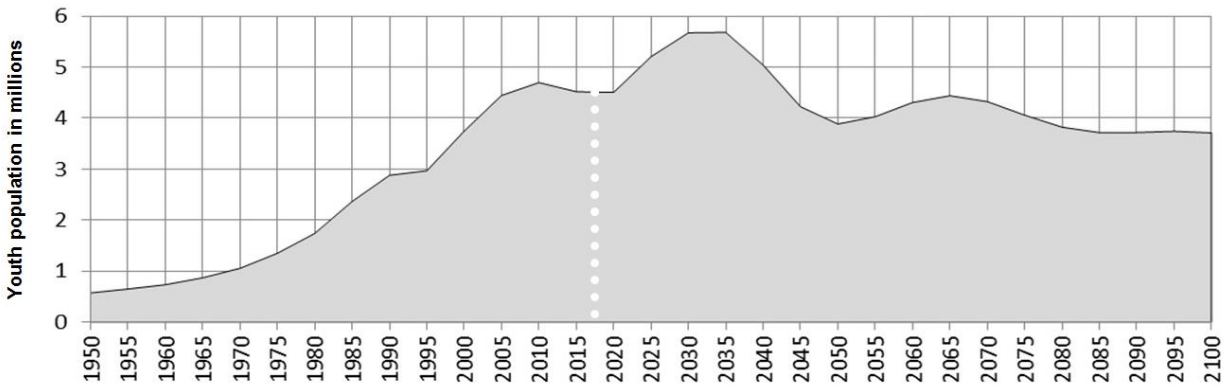


Figure 2.18: Saudi Arabia's youth population in millions (Adapted from the United Nations 2012)

2.3. Conceptual and analytical frameworks

This research has mapped the literature of sustainable campuses. This research has found that in order to operationalise the notion of sustainability in university campuses there is a need to express such concept in such context in five aspects. These five aspects are management, academia, engagement, environment, and innovation. Each aspect is represented by many distinct variables. Figure 2.19 is a representation of mapping sustainable campus, where visual illustration displays the five aspects and some of their indicators which can be used to measure performance.

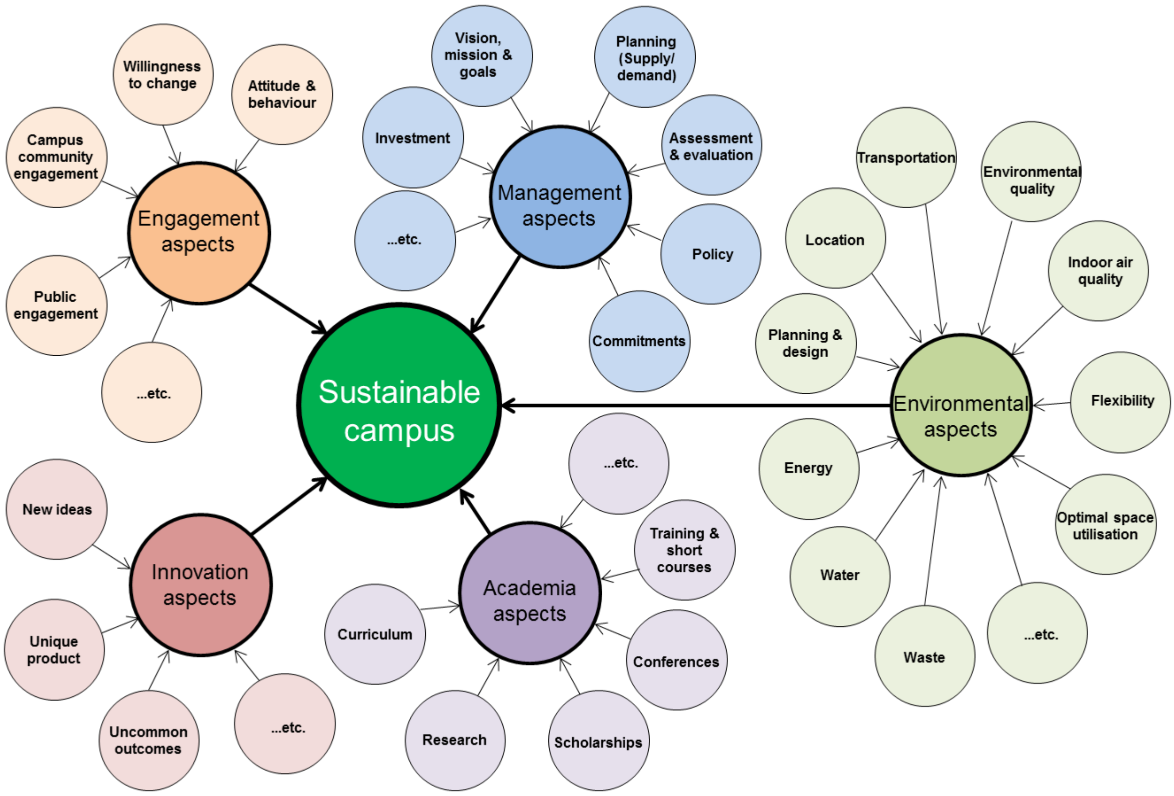


Figure 2.19: Mapping the field of sustainable campus

● **Conceptual framework**

Figure 2.20 illustrates the theoretical framework of this research, in which it shows a map of the territory being studied (Miles et al. 2014). The conceptual framework was built upon the other conceptual models. The starting point was mapping the literature of sustainability in university campuses. In doing so, 12 well-known sustainability assessment frameworks, tools, and systems were reviewed. Five aspects were identified: management, academia, engagement, environment, and innovation. Within the Saudi Arabian context, the Horizon Plan was adopted to achieve a 'knowledge society' or 'knowledge economy' (Aafaq 2011).The plan identifies eight areas to advance higher education in Saudi Arabia. However, given of the focus of this research, the area of infrastructure was selected. Infrastructure includes both existing and new university buildings and grounds. Other areas such as governance and users of university campuses (faculty, staff, and students) are of interest to this research, because of the close relation to the research problem. To assess the advancement of sustainability, performance indicators were selected. This research concentrates on three aspects of sustainability and their related indicators in university campuses, given their importance to the problem facing most Saudi higher education institutions. These aspects were management, engagement, and environment. Figure 2.20 shows the 10 indicators that have been used to assess the status of sustainability in Saudi universities. To check how sustainable the campus is, Den Heijer's model (2011) was employed with its four overall assessment criteria: competitive advantage, profitability, productivity, and sustainable development. The latter means climate-neutral campus which is defined as 'a campus [that] has no net climate impact resulting from carbon or other greenhouse gases' (NREL 2017).

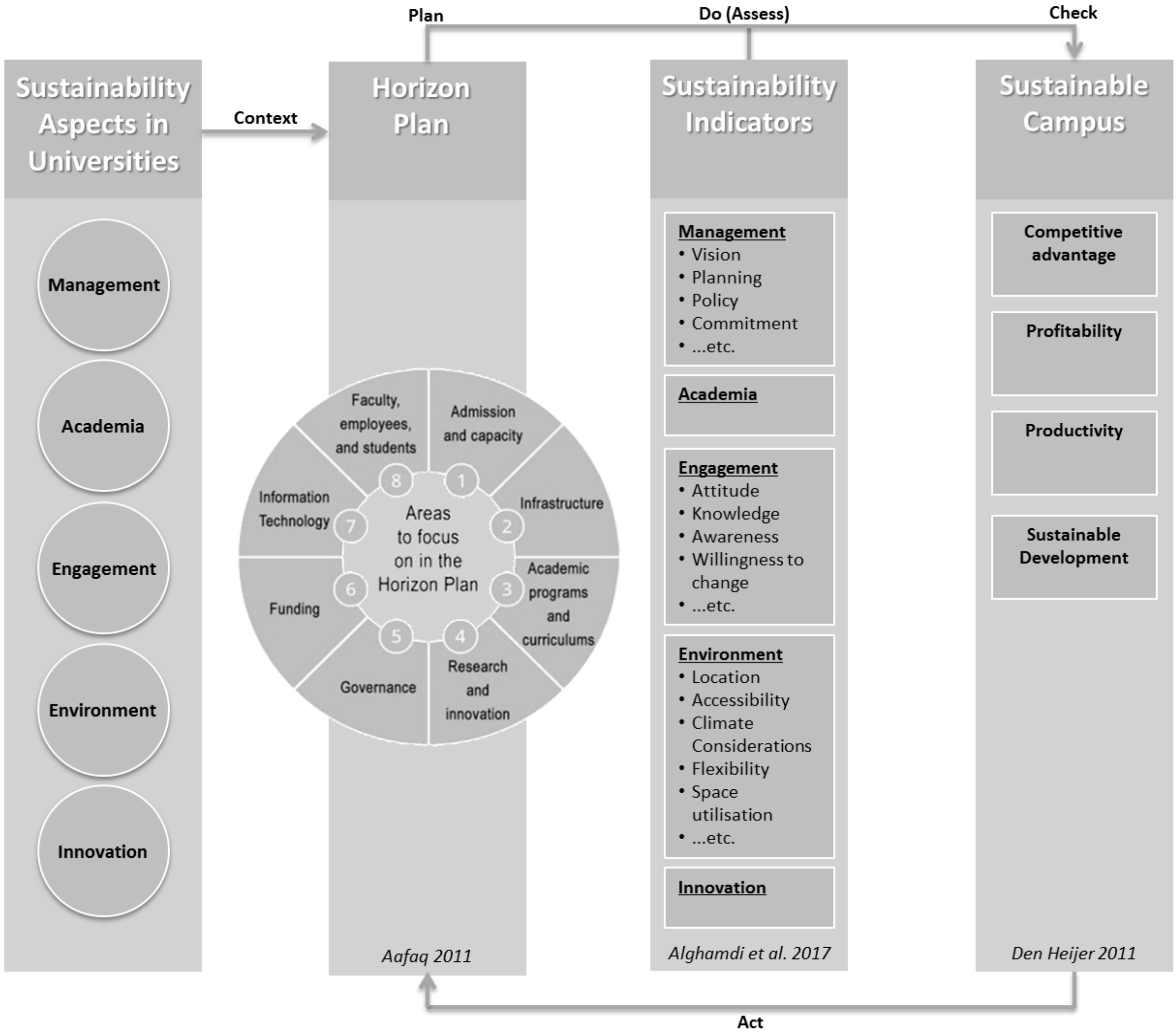


Figure 2.20: The conceptual framework of this research

The conceptual framework parallels the 'PDCA Cycle' (Deming 1986). That is 'plan, do, check, and act in a never-ending cycle of continuous improvement.' A plan has been made to improve the eight areas highlighted in the Horizon Plan for the purpose of advancing higher education in Saudi Arabia. Sustainability in university campuses can be assessed through the five aspects identified (management, academia, engagement, environment, and innovation). To check how sustainable higher education institutions are, four perspectives needed to be taken into account (competitive advantage, productivity, profitability, and sustainable development). Based on the outcome of the sustainability assessment, an institution can act by re-planning accordingly.

● Analytical framework

This study assesses and analyses some of the sustainability aspects in some of Saudi Arabian public universities. It focuses on certain areas of sustainability including:

- Management aspects
  (Vision, policy, planning, and commitments)
- Engagement aspects
  (Attitude, knowledge, and awareness of sustainability and willingness to change)
- Environmental/Physical aspects

(Location, physical accessibility, climate considerations, flexibility, and space utilisation)

Although Alghamdi et al. (2017) show that there are five sustainability aspects to be assessed in higher education institutions, only three aspects with ten indicators were examined in this research. The reasons behind selecting the abovementioned aspects and their indicators were:

- These are one of the most important indicators and hence they are the interest of this research
- These indicators are where the problem lies in most of the Saudi Arabian campuses
- These indicators have a huge consequence and working on them may assist universities to achieve a great deal of becoming sustainable
- The majority of Saudi Arabian public university campuses are under construction and hence these indicators would be of great help not only for existing universities, but also for those in the future.

2.4. Summary and conclusions

This chapter aims to systematically review the four main domains of this research: Campus planning and design, university campus management, sustainable campus, and higher education in Saudi Arabia. This chapter highlights key concepts and theories in each of the four bodies of knowledge. In doing so, important terms are defined, key models are analysed, and related studies were examined. Summaries of the main lessons learnt from each domain are as follows:

Campus planning and design

Factors that can influence the planning for higher education facilities include youth population, enrolment admission rate, needs and desire, resources and capital investment, and science and technology. The location of the university campus is still important even in the 21st century. Flexibility in educational facilities means the ability to adapt and accommodate future needs in little or maybe no effect on time, effort, cost, or performance. Factors to address when planning and designing the campus include time, size, program, and style.

University campus management

Managing the real estate is a continuous process with implicit or explicit considerations about the match between supply and demand, aiming at sourcing sufficient accommodation at the required location, time, quality, and cost. The values of managing the university campus were controlling risks, increasing real estate value, reducing the footprint, decreasing costs, increasing flexibility, increasing user satisfaction, supporting user activities, improving quality of space, supporting image, supporting culture, stimulating collaboration, and stimulating innovation.

Sustainable campus (Living lab)

Sustainable campus implies a better balance between environmental, social, and economic goals in policy making as well as a long-term view about the results of today’s campus actions and activities. ‘Living laboratory’ concept means not only research and education should emphasise sustainability topics, but also daily lives in laboratories, lecture halls, and dormitories should embody sustainable principles.

Higher education in Saudi Arabia

There have been huge investments in the education sector with a special focus on the higher education. The sector is relatively young, in comparison with other nations. A centralised system of control, gender segregation, and funding provided by the state, mean there is limited ‘autonomy and flexibility in decision-making’. A fluctuation in the youth population raises a concern about the long-term planning for space management (provision and utilisation). A feasibility study, therefore, is needed for such large university campuses.

Along with highlighting the conceptual framework and the analytical tool, the two sub-research questions were answered in this chapter: '*How can a sustainable campus be defined and assessed?*' And '*Why is sustainability important in university campuses? And why is it particularly important to Saudi Arabia?*'

How can a sustainable campus be defined and assessed?
This research defines sustainable campus as follows: When thinking about a 'sustainable university', its campus has to consider the implementation of sustainable practices (environmentally, economically, socially, and educationally) through its campus life cycle (planning, constructing, operating, maintaining, and retrofitting) through all management directions (top-down as well as bottom-up approaches) on all levels of campus (from classrooms to laboratories, transportation, procurement, housing and other services) in many ways (e.g. energy saving, water conservation, air quality, social equity, waste reduction, walkability, well-being and health) or in many different shapes and forms (e.g. flexibility, multi-functionality, optimal space utilisation).

In order to measure how sustainable the university campus is, this research develops a holistic tool grouping the sustainability in universities in five aspects as shown in figure 2.11, which includes aspects of management; academia; environment; and engagement and innovation. When assessing sustainability at universities, the terminology used will relate to these five areas of sustainability, in spite of differences.

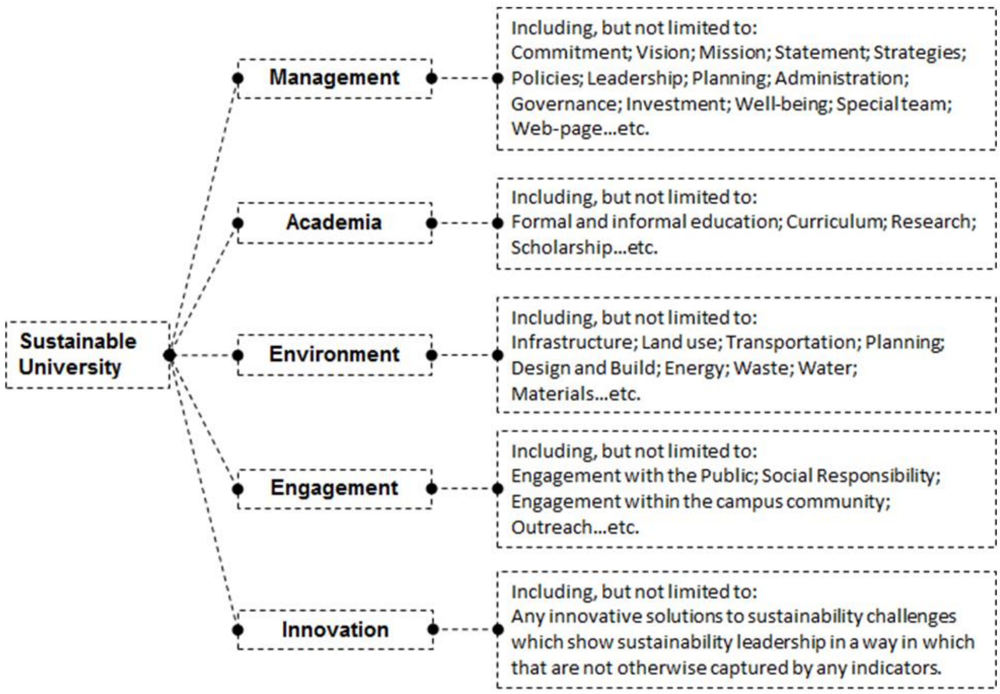


Figure 2.11: Main common criteria used in the 12 selected tools (Alghamdi et al. 2017, 108)

'*Why is sustainability important in university campuses?* And *why is it particularly important to Saudi Arabia?*'
Sustainability on campus is vitally important because of a number of reasons, the first being because of the university's role in producing policy makers, leaders, and future citizens. Cortese (2003) believes that because universities prepare most professionals who will play a critical role in the adaption of a sustainable lifestyle, they have an ethical responsibility to

promote and raise awareness, knowledge, skills, and values needed for sustainable future. Second, more obviously, the university uses a large amount of resources on its real estate to fulfil their traditional mission of research, teaching, and student services, among other functions (Kirk 2003). Third, the university campus serves higher education through offering inspiring, vibrant, and memorable spaces, which in turn influence the user's productivity, creativity, and innovation and hence adding value (Van der Voordt & Van Wegen 2005; Den Heijer 2011). Winston Churchill said that "We shape our environment and they in turn shape us".

These three reasons lead us to say that the battle for sustainable practices should be waged from and within higher education institutions. These institutions are far more than just a collection of college buildings. It enables development to be made and knowledge to be generated. In fact, university is the place where ideas can be examined in areas ranges from transport to housing to waste (Turner 1984). These ideas can then be scaled to other settings (White 2014).

Velazquez et al. (2006, 812) describe to us what type of 'sustainable campuses' would bring about this change? He and his colleagues believe that '[a] higher educational institution, as a whole or as a part, that addresses, involves and promotes, on a regional or a global level, the minimization of negative environmental, economic, societal, and health effects generated in the use of their resources in order to fulfil its functions of teaching, research, outreach and partnership, and stewardship in ways to help society make the transition to sustainable lifestyles.'

Cortese (2003, 19) raises interesting question saying that 'If higher education does not lead the sustainability effort in society, who will?' Sustainability helps leaders to shape their visions for the future and hence 'it is the vision not the definition that is transforming higher education communities' (Bookhart 2012, 92). Thomashow (2014, 2) argues that:

> *'A college or a university is an ideal venue for addressing the global climate crisis. What better place is there to conduct environmental research, to develop curricular approaches, to construct policy mechanisms, to convene multi-sector collaborations, and to implement sustainable solutions?'*

Sustainability is particularly important to Saudi Arabia because the country is vulnerable to climate change (CAT 2016). The question is what makes the Kingdom seriously challenged by global warming. The top three causes, inter alia, are:

- First, much of the landscape of Saudi Arabia is typified by semi- to hyper aridity climate with very low rainfall (FAOUN 2016). It has limited groundwater and about 2% of the country's land area is arable, challenging national food sources (Darfaoui and Al Assiri 2010, 01). Additionally, Saudi Arabia is classified by the United Nations as a water-scarce nation (UNDCWS 2016, 210).
- Second, the Kingdom has the world's largest oil reserves and it is the biggest oil exporter (WTEx 2016). Therefore, the backbone of Saudi economy is based mainly on exporting fossil fuels. The latter is considered to be one of the major causes of global warming (LSE 2016).
- Third, as a fast-growing economy, Saudi Arabian government is in a race to meet the internal demand of energy and water, given the rapid growth in urbanisation in which some of its cities are characterised globally by being one of the 'fastest growing cities' (World Bank 2016).

The Kingdom's efforts towards climate change have been classified by Climate Action Tracker as 'Inadequate' (CAT 2016). This was because, in general, the country has not shown clear commitments, pledges, and targets. For example, in its plans and actions outlined in the Intended Nationally Determined Contribution (INDC) submitted to the UNFCCC Secretariat on November 10th 2015, Saudi Arabia did not provide quantified measures (e.g. its energy efficiency, renewable energy, carbon capture and storage) (Ibid).

Saudi Arabia is very sensitive to climate change. Yet, the Saudi efforts to deal with climate change are not satisfying enough. According to the Climate Action Tracker (CAT 2016):

> *'The Saudi climate plans are highly inconsistent with the projected climate impacts for the region, an area where average warming is higher than the global average. In a 3-4 °C world, three quarters of the country will suffer from excessive dryness by the end of the century... Yet the Saudi government still has no policies in place to begin – or encourage – this shift to renewable energy'.*

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Chapter 3

Methodology

3.1 Introduction

This research was introduced previously in chapters one and two. The former has established the context and the background, while the latter has dealt with the theoretical dimensions of the research.

The aim of this chapter, however, is to show how the current study was carried out in a way that can be repeated, producing results that can be reproduced. It does so by presenting clearly and with enough details the research outline, strategy, methods, phases, and techniques.

In order to achieve the goal of this chapter, a systematic review of relevant methodology literature was carried out. This was to find the most suitable approach for this research in order to answer its questions and to define the broad rationality behind the choices made for each method and technique.

This chapter, therefore, takes the form of five sections. The second section presents the research design showing what type of knowledge paradigms this research is guided by. Next is the research strategy in which the research approach is highlighted. What follows are the methods employed to answer the raised research questions. Finally, the data collection phases and techniques are explained, along with the rationale for the choice of each technique. The chapter ends with illustrating the overall scheme through which the whole research is carried out.

3.2 Research design

Knowledge paradigm can be explained as 'a lens through which we view the world' (Collins 2010, 38). The function of such lens (or paradigm) is to help us visualise and understand a specific situation, program, or problem. Guba & Lincoln (1994, 116) emphasise the importance of the knowledge paradigm stating that 'paradigm issues are crucial; no inquirer, we maintain, ought to go about the business of inquiry without being clear about just what paradigm informs and guides his or her approach'. Creswell (2003, 6) confirms this and points out that 'stating a knowledge claim means that researchers start a project with certain assumptions about how they will learn and what they will learn during their inquiry', and this is how he and other scholars define paradigms (Mertens 1998; Lincoln & Guba 2000). There are many recognised categorisations of the paradigms. For example, Creswell (2003, 7) reviews many classifications of scholars and suggests the following four major paradigms: postpositivism ('reflects a deterministic philosophy in which causes probably determine effects or outcome'); constructivism ('individuals seek understanding of the world in which they live and work'); advocacy/participatory ('providing a voice for these participants, raising their consciousness, or advancing an agenda for change to improve the lives of the participants'); and pragmatism ('knowledge claims arise out of actions, situations, and consequences rather than antecedent conditions, as in postpositivism').

The question is now what type of knowledge paradigm this research is guided by. The research problem determines the type of design that should be used (De Vaus 2001). Another decisive factor is the research questions (Murphy & Rorty 1990). Cherryholmes (1992) and Creswell (2003, 12) believe that pragmatist researchers should 'look to the 'what' and 'how' to research based on its intended consequences – where they want to go with it.' Therefore, this research uses a pragmatism paradigm, given the nature of the research problems and the type of questions raised in chapter one. That is because this research is problem-centred, which means that this research sets out to address the issues of sustainability in public universities in Saudi Arabia. This research uses a pragmatism paradigm since it deals with real-world practice oriented. That is because this study deals with sustainability practices and operations in university campuses. It explores some aspects of sustainability and makes an attempt to address them by proposing planning guidelines and a 6-step implementation plan. Practically, finding possible solutions to the problems is one of the strong characteristics of pragmatic knowledge claims (Patton 1990). Therefore, the current research is guided by the pragmatism type of knowledge paradigms.

The following sections (strategy, methods, phases, and techniques) present further details of designing this research. As Creswell (2003, 5) points out that 'these approaches [strategy, methods, phases, and techniques] are translated into processes in the design of the research'.

3.3 Research strategy

To answer the research questions raised in chapter one, there is a need for a sound methodology. The research approach depends primarily on the type of research questions. The over-arching research question - and the sub-questions which help to guide the enquiry - aim not only to understand sustainability in Saudi Arabian university campuses, but also to explore possibilities for advancing it. The form of the main research question, shown below, provides a significant clue concerning the suitable research methods to be used (Drongelen 2001; Creswell 2003; Thomas 2011; Yin 2014).

What information, tools, and approaches will allow existing and new college buildings and campuses in Saudi Arabia to become more sustainable?

More explanatory | Specific location | Research area (or substance)

Therefore, this research utilises a case studies approach in order to answer the research questions. That is because case study – as 'a method of research' (Yin 2014, 03) or as 'a choice of what is to be studied' (Stake 2005, 443) – is for 'what', 'how', and 'why' type research questions. It is for research that does not require control of behavioural events and for studies focusing on contemporary events (Ibid). Thomas (2011, 23) defines case studies as follows: 'Case studies are analyses of persons, events, decisions, periods, projects, policies, institutions or other systems which are studied holistically by one or more methods.' He (Ibid, 37) adds that the purpose of case study is 'understanding the details of what is happening.'

Such approach was chosen since 'case studies... explore in depth a program, an event, an activity, a process, or one or more individuals' (Creswell 2003, 15). Thomas (2011, 9) states that case study is 'a focus and the focus is on one thing, looking at in depth and from many angles.' Stake (1995) indicates some of the advantages of using case studies as an approach pointing out that through case study detailed information is collected by a range of data collection techniques over a constant period of time.

Therefore, the main form of inquiry in this research is case study. The research includes two multi-part case studies: Saudi Arabian cases and United States cases. The former is considered as the main case studies where a sample of Saudi Arabian university campuses were analysed. The latter comprises cases from the United States of America for the purpose of drawing lessons from best practices available that can be adapted to the Saudi Arabian situation. These multiple cases are defined by the subject of the research: sustainability. Sustainability in universities implies a concern for management, engagement, environment, academia, and innovation (Alghamdi et al. 2017). However, the focus of this research, as stated in chapter one, is on three aspects of sustainability: management, engagement, and environment.

Designing a case study type of research is like designing anything else. Thomas (2011) shows that there are important steps to follow in order to design the research. Figure 3.1 illustrates these steps which Thomas (Ibid) highlights as interconnected. This means that there must be a logical link between the purpose of the study, research questions, literature, approach, design, methods, and process. Although it looks linear, it needs to be recursive. The latter indicates that 'it needs to go backwards and forwards, with twists and turns... as you find out new things and refine your questions and your decisions about your approach in the light of these revisions.'

Figure 3.1: The interconnected steps of designing case study research (Thomas 2011, 27)

Using the above steps, this research can be defined as follows:

- **Purpose**: The main purposes of this research are: to document the historically massive developments in higher education sector in the Kingdom, to demonstrate how sustainable Saudi Arabian public universities, and to present what potential solutions can be offered to advance sustainability practices and operations in campuses in Saudi Arabia and elsewhere.
- **Questions**: The overarching research question in this study is: what information, tools, and approach will allow existing and new college buildings and campuses in Saudi Arabia to become more sustainable?'
- **Literature review**: In order to gain a wealth of information and to be able to answer the research questions, this research focuses on four main literature domains: campus planning and design, management of university campuses, sustainable campuses, and higher education in Saudi Arabia.
- **Research approach**: This research utilises a case studies approach. Such strategy was determined by the type of the research problem, purpose, and research questions. The sample, which was selected based on some developed selection criteria, was eight campuses from Saudi Arabia and two campuses from the United States of America.
- **Research methods**: This study employed sequential mixed methods, given that inquires have been drawn from both qualitative and quantitative methods. It is also because of the variety as well as the number of techniques involved in collecting and analysing the research data. Both qualitative and quantitative methods were used to 'provide the best understanding' of the research problem (Creswell 2003, 12).
- **Type and process of case studies**: This research uses multi-part case studies; starting with cases from Saudi Arabia and then drawing some lessons from leading cases from United States of America. The study involves three stages: exploration, explanation, and conclusions. It involves iterative processes of both desk research (such as reviews of scholarly literature and professional documents) and fieldwork research (such as interviews, focus group, questionnaires, site visits and observations). All of these data collection techniques were employed in the Saudi Arabian cases, whereas only two techniques (namely scholarly literature and professional documents, and on-line interviews) were used in the American cases.

3.4 Research methods

The explanatory nature of this research is a direct result of the little research that has been undertaken on sustainable campuses in Saudi Arabia. Collins (2010) recommends a case study approach for exploratory type of research. Therefore, exploration is needed to understand sustainability in Saudi Arabian university campuses. Qualitative research is exploratory (Morse 1994), and such a method is needed as the topic is new in the Kingdom. As far as it is known, there is not enough scientific attention given to comprehensively assessing and addressing sustainability in Saudi Arabia. This means that this research started by exploring the concept of sustainable campus in Saudi Arabia. In doing so, an inductive way of research was used. Inductive was defined by Creswell & Plano Clark (2011, 41) as working from 'bottom-up, using the participants' views to build broader themes and generate a theory interconnecting the themes.' Collins (2010, 93) describes the inductive method as a research that is 'undertaken to make sense of situation and phenomena.' In order to do that, 'the researcher begins with specific observations and measures, and then moves to detecting themes and patterns in the data' (Soiferman 2010, 7). Trochim (2006) believes that qualitative method is always exploratory and hence inductive, while quantitative method is always confirmatory and hence deductive.

Therefore, a qualitative research method was used given that some of the data collection techniques (such as interviews, questionnaires, and observations) had open-ended questions. This, therefore, needs a text and image type of analysis. This type of analysis is known as content analysis. This research uses a conventional content analysis, which is defined as 'coding categories [that] are derived directly from the text data' (Hsieh and Shannon 2005, 1277). This means that codes were defined during process of data analysis. For example, interview transcriptions are organised and labelled based on the defined coded. The qualitative analysis software Atlas.ti® is used to help conducting such inquiry. Almost all parts of each interview document have been coded in order to avoid overlooking some relevant parts that may seem to be unimportant when not looking at them more closely (Friese, 2014). Each interview transcription was deductively coded based on the topics or areas of interest for the research. However, inductive way of coding was also used, since during the course of reading the interview transcription, new interesting topics emerged. Therefore, these emerging topics are also coded and analysed. Another example of qualitative analysis is analysing the strategic plans of eight public universities. These plans present the university's vision, mission, core values, and strategy. The analysis mainly focuses on some sustainability aspects that are of interest to this research. The analysis of the strategic plans was completed before conducting the interviews. During the interviews, some issues from the plans were discussed further.

Although this research is qualitatively driven, a quantitative method supplements the qualitative study by providing deeper, broader, and fuller answers to the research questions (Johnson et al. 2007). The problems of the research are identifying factors (indicators/variables) with a numerical orientation. Thus, to understand the best predictors of outcomes, a quantitative method was also employed (Creswell 2003). That is because this research used instrument based questions, especially in the questionnaires, to measure some sustainability practices and operations. The numerical data collected from the questionnaires needed a statistical analysis. For such type of analysis, the well-known statistical analysis software SPSS Statistics® was used. First, the data was coded. Second, the data transferred into the SPSS, which took a substantial amount of time and effort. Third, the data was examined by utilising a number of analytical techniques. For example, a cross tabulation test, known as Pearson's chi-square distribution, was performed to explore any relationship between two categorical variables (Field 2013, 721). Another technique was a multiple response analysis, since there were questions that have multiple choices. Therefore, a multiple response set was created in the SPSS® software to analyse such questions.

This means that both qualitative (inductive) and quantitative (deductive) methods were employed in this research. Consequently, sequential mixed methods are utilised not only to capture the best of both quantitative and qualitative approaches (Creswell 2003), but also to illustrate the complementary relationship of these methods (Yin 2014). Mixed methods help in explaining and interpreting the findings of the research. Johnson et al. (2007, 123) offer the most cited definition of mixed methods in the Journal of Mixed Methods Research saying that:

> *'Mixed methods research is an intellectual and practical synthesis based on qualitative and quantitative research; it is the third methodological or research paradigm (along with qualitative and quantitative research). It recognizes the importance of traditional quantitative and qualitative research but also offers a powerful third paradigm choice that often will provide the most informative, complete, balanced, and useful research results.'*

To sum up, this study has begun with employing a qualitative method for exploratory purposes. The study then has followed up with involving a quantitative method with a large sample so that findings can be generalisable. Practically, this research has first explored the concept of sustainable campuses in Saudi Arabia and United States to acquire more knowledge about it. The research then has studied the variables using a statistical approach to obtain a more detailed explanation. This means that text and statistical analysis was carried out. In this way, the advantages of gathering both 'closed-ended quantitative data and open-ended qualitative data' prove advantageous to better comprehending the research problem (Creswell 2003, 24).

3.5 Data collection phases and techniques

This section presents the stages, phases, and techniques used in data collection and analysis. The overall design of this research was undertaken in three main stages and seven phases, shown in table 3.1. Each stage has its own data collection phases and techniques which are explained in detail in the following sections.

Table 3.1: The three stages and seven phases of the research

Stages	Phases
Exploration	Phase 1: Identifying sources (definitions and assessment tools)
	Phase 2: Studying of cases from Saudi Arabia
	Phase 3: Re-defining the research
Explanation	Phase 4: Studying of cases from United States of America
	Phase 5: Proposing the preliminary planning guidelines
Conclusions and recommendations	Phase 6: Reviewing the proposed planning guidelines
	Phase 7: Concluding and recommending (Revised planning guidelines)

Figure 3.2 illustrates graphically the main three stages in this research. These stages and their phases are as follows:

- **Exploration Stage**: This research starts inductively with a qualitative method, since the topic of sustainable campus is fairly new in Saudi Arabia and has not been given enough scientific attention. Therefore, the exploration stage aims to understand the sustainable campus shedding more light on its concept and searching for important variables to define and measure. The first phase was to identify relevant sources and map the scholarly literature as well as other professional documents (e.g. architectural drawings of colleges and campuses including masterplans, sustainability reports, and strategic plans of universities). It includes developing a conceptual framework and an analytical tool. The Second phase was a field trip to Saudi Arabia to study eight selected cases and collect data through interviews, focus group, questionnaires, and observations. Phase three was to process the large data collected and analyse it. This phase explained many issues in the Saudi cases; the research problems were redefined, the focus was sharpened, and the research questions were reformulated.

- **Explanation Stage**: Phase three was overlapping with the previous stage. This phase also included looking at some potential cases to be studied as best practices for sustainable campuses that are suitable for Saudi Arabia. Phase four was to select cases and make a visit to collect data. The selection was based on developed criteria. Two cases were selected and they were both from the United States of America. This phase, however, did not go according to plan, as it was not possible to acquire a visiting visa. Instead, only face-to-face interviews were conducted through some telecommunications application software (e.g. Skype and Facetime). Phase five was to process and analyse the data from the scholarly literature and from the interviews so that lessons can be drawn.
- **Conclusions**: In phase five, the preliminary planning guidelines to greening the Saudi Arabian university campuses was developed. Phase six was to review the proposed guidelines by conducting a field trip to Saudi Arabia so that interviews can be undertaken with experts (policy- and decision-makers) from some public universities and the Ministry of Education in order to evaluate the applicability and feasibility of the potential solutions proposed. However, due to time constraint, experts were interviewed through some telecommunications application software (e.g. Skype and Facetime). In addition, sustainability experts from the United States were also consulted on the developed approach to advance sustainability in university campuses which led to insightful and credible feedback being obtained. The last phase, phase seven, was to further improve the guidelines and to finalise the research.

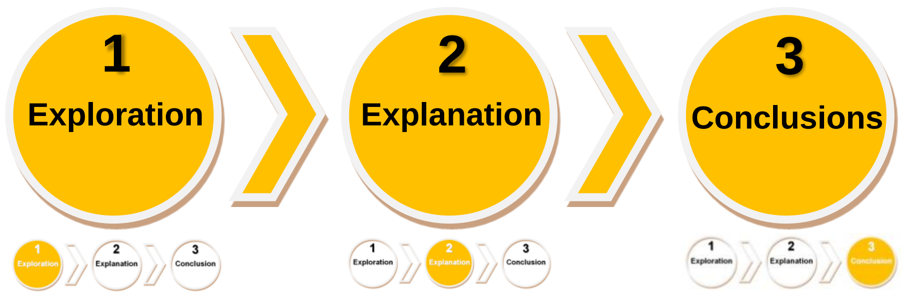

Figure 3.2: The main three stages of this research

3.5.1. First stage: Exploration

Figure 3.3 presents the three phases in this stage. Below is a detailed description of each phase and its aim, data collection techniques, and type of data.

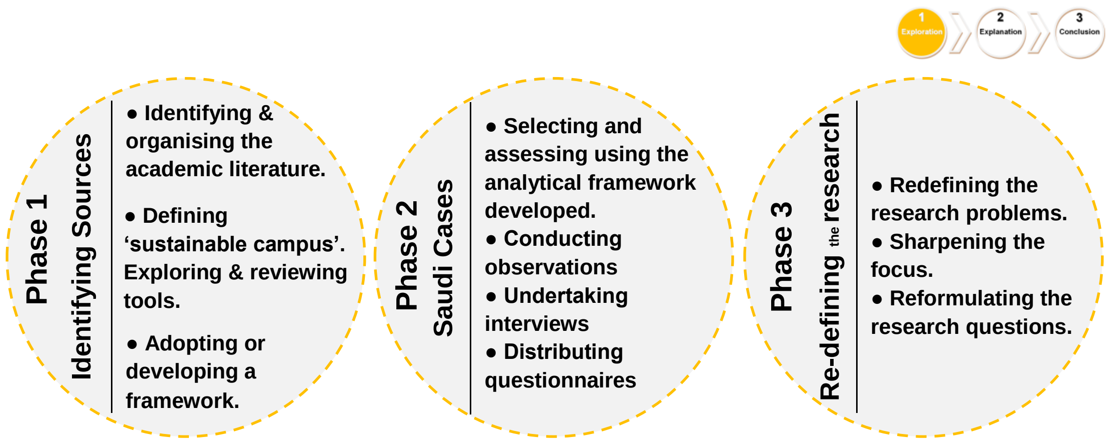

Figure 3.3: The research first stage and its three phases

Phase 1: Identifying sources (definitions and assessment tools)

- **Aim**: The first aim of this step was to both identify and organise the main references from the literature. Chapter two presents the four domains of literature this research reviewed: Campus planning and design; management of university campus; sustainable campus; and higher education system in Saudi Arabia. The second aim was to define the notion of 'sustainable campuses'. The third aim was to explore how sustainability aspects in higher education institutions can be measured. Twelve indicator-based assessment tools were analysed. The importance of this phase comes not only from searching for materials, organising them, and prioritising what is key and relevant to the research, but also from understanding how this research adds to, extends, or replicates research already completed (Creswell 2003).
- **Data collection technique**: This phase was undertaken through desk research technique through scholarly literature review (articles, books, thesis...etc.) and professional documents review (architectural drawings, sustainability reports, university strategic plans...etc.). Reviewing steps were as follows: Key words were identified. Articles collected were then grouped and prioritised based on their relevancy to this research. The literature was then mapped and structured. What followed was summarising the literature and assembling the literature review through organising the literature thematically.
- **Type of data**: The collected data was mainly qualitative.

Phase 2: Studying of cases from Saudi Arabia

- **Aim**: In order to have a comprehensive overview of sustainability in university campuses in Saudi Arabia, cases were selected and studied. The way to select these cases was based mainly on information-oriented sampling. 'Cases are selected on the basis of expectations about their information content' (Flyvbjerg 2006, 230). The process of selecting a number of important cases was basically cases that are likely to 'yield the most information and have the greatest impact on the development of knowledge' (Patton 2001, 236). This is known also as a critical-case sampling, which has been defined by Johnson & Christensen (2004) as selecting what are believed to be particularly important cases. Flyvbjerg's definition of a critical-case sampling is as 'having strategic importance in relation to the general problem [of the research]' (2006, 227). 'Although sampling for one or more critical cases may not yield findings that are broadly generalisable, they may allow researchers to develop logical generalisations from the rich evidence produced when studying a few cases in depth' (Cohen & Crabtree 2006). One of the key factors for selecting the case studies in this research ensures the fact that the sample does represent, to a large extent, the whole collection of cases and hence cases can be representative. There were eight campuses selected and the main reasons or criteria for such selection were as follows:

1. Availability of information: Cases with no available data or very difficult to access were excluded.
2. Physical characteristics of cases (size, layout, accessibility, and planning): to insure diversity in the sample, homogeneity and heterogeneity, a variety of cases was considered (e.g. a small-size campus as well as a very large-size campus; some campuses located far away from the city, others, however, are with a relatively acceptable close proximity).
3. Geographical locations in the country and hence the weather status: The sample was selected carefully to insure it covers all geographical areas in the country. This means there are campuses from the north, south, east, west, and centre. There are campuses by the sea, campuses on mountains, and campuses close to the desert. All of these geographical factors can have a huge influence on the planning and design of campuses, not only because of the topography, but also because of the weather status, which in Saudi Arabia differs from one province to another.
4. The construction stage at which these campuses are: Six cases are still under construction, whereas the other two cases are all in use and fully operational. One of these two is the oldest university in the country and the other one is regarded to be one of the most sustainable campuses in the world (Architecture & Design Journal 2010; American Institute of Architects 2010; Minutillo 2010)
5. The type of building design: Many of the newly established universities share a number of design prototypes. This means that there are college buildings that are standardised (uniform design) and that the same design can be found in other university campuses. The most popular design models were selected, analysed, and compared to one college building in an old university campus.

Therefore, the sampling in this phase was divided into two levels: macro and micro. The former focuses on the campuses as a whole, whereas the latter focuses specifically on college buildings. On one hand, there are eight university campuses selected since they all fit the criteria above mentioned. These eight universities represent one-third of the 28 public universities. On the other hand, there are five college buildings selected to be studied. That is because some of the design of these college buildings have been standardised and used in more than one university. Surprisingly enough, some of these standardised models have been used in five different universities in different geographical locations.

- **Data collection technique**: This phase is the core of this research and therefore a number of methods were employed. Both desk and fieldwork techniques were used. The former involves scholarly literature review (articles, books, thesis...etc.) and professional documents review (architectural drawings including campuses master plans and college buildings' floor plans, university strategic plans...etc.). The latter involves the conducting of interviews and focus group, distributing questionnaires, as well as conducting observations. Desk research was undertaken first to gain rich background knowledge about these campuses, college buildings, and the sustainability practices, operations, initiatives, and plans. A fieldwork research was the second step to take. Arrangements with the administration of each university for the visit were made in advance. What followed was the conducting of a direct observation in which field notes

were gathered when observing users of university campuses (academic staff, supporting staff and students) and the use of space in college buildings. A camera was used to document operations and practices. A direct observation provided a first-hand experience with users, recording events as they occurred and unusual aspects were noticed during observation (Creswell 2003). The observation was undertaken at both types of sampling; the selected campuses and college buildings. The observation took place at the beginning of the academic year in Saudi Arabia (between August and November 2015). Practically, one week was spent in each campus including visits to the selected college building. The next technique of gathering data was distributing questionnaires to students, faculty and staff members at the selected campuses and beyond whenever possible. These self-administered questionnaires were mainly targeting users: students, faculty and staff members. The questionnaire was designed with questions that measure different variables (see Appendix B). This particular method has been used to gain large amounts of information collected from a relatively large number of people in a short period of time (Popper 1959; Ackroyd & Hughes 1981). The fourth and final method of collecting data is face-to-face semi-structured interviews with some stakeholders. The reasons for choosing such a type were: First, participants can provide important historical information and background (Creswell 2003, 186). Second, interviewees are briefed about the main issues to cover during the interview, rather than giving them specific questions. This gives more freedom to follow up points as necessary. Such structure encourages the interviewees to say more on these follow-up questions (Thomas 2011, 163). Third, interview is focused; because certain areas are examined through questions allowing the respondents scope to express themselves at a reasonable length (Collins 2010, 134). Finally, the interview is open-ended and assumed a conversational manner (Yin 2014, 111) (see Appendix C). In addition, there was one focus group that was carried out with the Ministry's internal experts from the Centre for Higher Education Research and Studies. The aims of the 'focus group' were: i) to discuss particular issues in higher education facilities in Saudi Arabia with a special focus on newly founded universities, and ii) to provide feedback on some particular issues in the research project. The guided conversation was facilitated and monitored using focus materials such as photographs and some information presented on a screen to stimulate the discussion. By doing so, this research is using case study strategy through what is referred to as the triangulation technique; 'looking in from different angles and vantage points' (Thomas 2011, 68).
- **Type of data**: The collected data was qualitative and quantitative.

Phase 3: Re-defining the research

- **Aim**: Having conducted the above phase successfully, this phase was fundamentally important, since it is a step where the researcher would look back at the whole research right from the beginning in order to have a clearer direction. The goal of this phase was to further elaborate the research: being more precise, redefining the research problems, sharpening the focus, and finally reformulating the research questions. This phase overlaps with the next stage. This was because it included looking at some potential cases to be studied as best practices for sustainable campuses that are suitable for Saudi Arabia
- **Data collection technique**: Desk study was the main technique in this phase.
- **Type of data**: The collected data was mainly qualitative.

3.5.2. Second stage: Explanation

Having done the first stage, the exploration including its three phases, stage two in this research is explanation. In this stage, clarifications, justifications, and more details were illustrated so that the research becomes clearer. Figure 3.4 presents this stage and its two phases. Below is a detailed description of each phase and its aim, data collection techniques, and the type of data analysed.

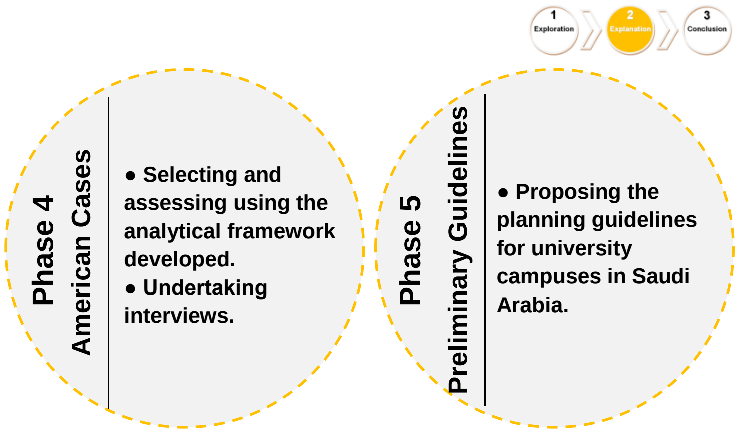

Figure 3.4: The research second stage and its phases

Phase 4: Studying of cases from United States of America

- **Aim**: Having redefined the research problems, what is next is searching for solutions from best practices available. The aim of this phase is to look for good examples in mastering sustainability from which to learn. Given that there are many qualified cases worldwide; scanning the candidates (cases) was conducted. The aim of the 'screening procedure' is to ensure identifying the appropriate cases before the formal data collection (Yin 2014, 95). Therefore, a set of defined selection criteria was proposed. The purpose of these selection criteria is to reduce the number of cases. The criteria used through which cases were selected are specifically developed in order to confirm that the selected cases are relevant to the Saudi cases. Consequently, the selected cases are believed to be addressing many of the sustainability issues in Saudi Arabian campuses including location, mobility, climate, and type and size of the cases. The use of these criteria helps maintain the sampling relevance, feasibility, and research ethic (Miles et al. 2014). The defined selection criteria used for selecting suitable cases are as follows:
  1. Cases that are ranked within the top sustainable campuses worldwide. This is based on two well-known ranking tables: the 2016 STARS Index and the 2015 UI Green Metric (STARS Index 2016; UI Green Metric 2015).
  2. Cases that are large in size, both in terms of student body and university campus. Student body has to be over 30 thousand students, whereas the campus size should be over three million square meters. That is to be comparable with the Saudi cases.
  3. Cases that are (or used to be) mainly car-based oriented. Using car should be the dominant form of transportation to and from the university campus (or maybe within the campus).
  4. Cases that are public and not privately funded (public research university).

5. Cases that have student housing on campus. Cases are preferably accommodating approximately 10% of its students, at least.
6. Cases that have available information and reasonable literature in the English language.
7. Cases that are relatively far away from their cities. For example, on the edge of/in the suburb of cities (rural campus) or surrounded by small communities.
8. Cases that are in regions that have hot, arid, and/or humid weather conditions.

Having adopted all these criteria, the two cases chosen were Arizona State University (ASU Tempe campus) and University of South Florida (USF Tampa campus).

- **Data collection technique**: This phase is one of the most important phases in this research and therefore a number of methods were employed. Both desk and fieldwork techniques were used. The former involves scholarly literature review (articles, books, thesis...etc.) and professional documents review (Architectural drawings including campuses master plans, university strategic plans, sustainability plans...etc.). The latter involved the undertaking of interviews with sustainability experts and some university decision makers. Desk research was undertaken first to gain rich background knowledge about these campuses. This also includes reviewing the sustainability practices, operations, initiatives, and plans. A fieldwork research was the second step to take. Arrangements with the administration of each university for the visit were made in advance. This step, however, did not go according to plan, because of the inability to acquire a visiting visa. Instead, only face-to-face semi-structured interviews were conducted through some telecommunications application software (e.g. Skype and Facetime).
- **Type of data**: The collected data was mainly qualitative.

Phase 5: Proposing the preliminary planning guidelines

- **Aim**: Having conducted the majority of the research phases, the objective of this phase is to develop a ‘preliminary guidance’. The guidance at this stage can be considered as a draft.
- **Data collection technique**: Desk study was the main technique in this phase through which a systematic review used for not only previous chapters, but also other relevant sources.
- **Type of data**: The collected data was mainly qualitative.

3.5.3. Third stage: Conclusions and recommendations

Having done stage one (the exploration) and stage two (the explanation), the final stage of this research is to test the review the planning guidelines proposed in the previous phase and then draw some conclusions and suggest some recommendations. Figure 3.5 displays the final stage and its two phases.

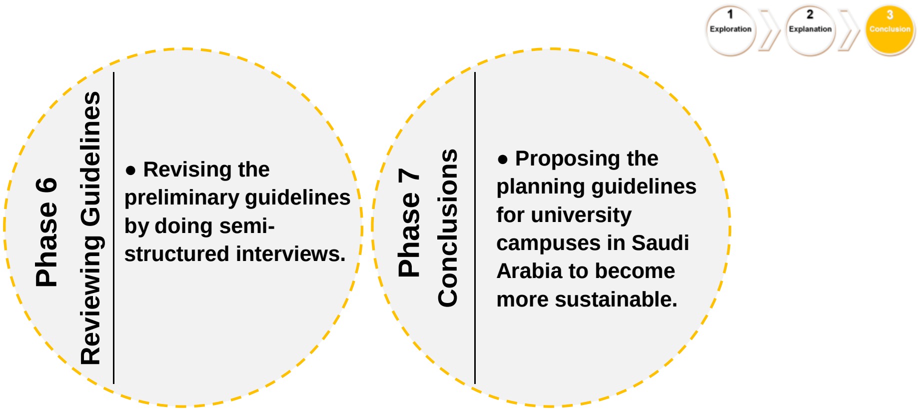

Figure 3.5: The research final stage and its two phases.

Phase 6: Reviewing the proposed planning guidelines

- **Aim**: At this phase, the research is one step away from approaching the final phase. The main goal of this phase is to test the proposed planning guidelines to check how practical and concrete it is.
- **Data collection technique**: The main technique employed at this stage is semi-structured face-to-face interviews. Experts from Saudi Arabia and from the United States of America were consulted to review the six-step sustainability approach. Decision makers in the Saudi Arabian Ministry of Education were also interviewed, given that some of the recommendations were directed to the Ministry. Participants at this phase had the potential to make a noticeable contribution to the proposed planning guidelines and the six-step sustainability approach, adding more value to this research and its outcome.
- **Type of data**: The data was mainly qualitative.

Phase 7: Concluding and recommending (Revised planning guidelines)

By this phase, the research journey has eventually reached its destination. The research comes to its end; conclusions were drawn and some recommendations were proposed. Furthermore, a reflection was reported on the research quality, limitations, and lessons learnt.

To sum up, figure 3.6 illustrates the overall research design. It sums up how this research was carried out. It shows the three main stages (exploration, explanation, conclusions and recommendations), the seven phases, the research types undertaken (desk or fieldwork), and the time frame.

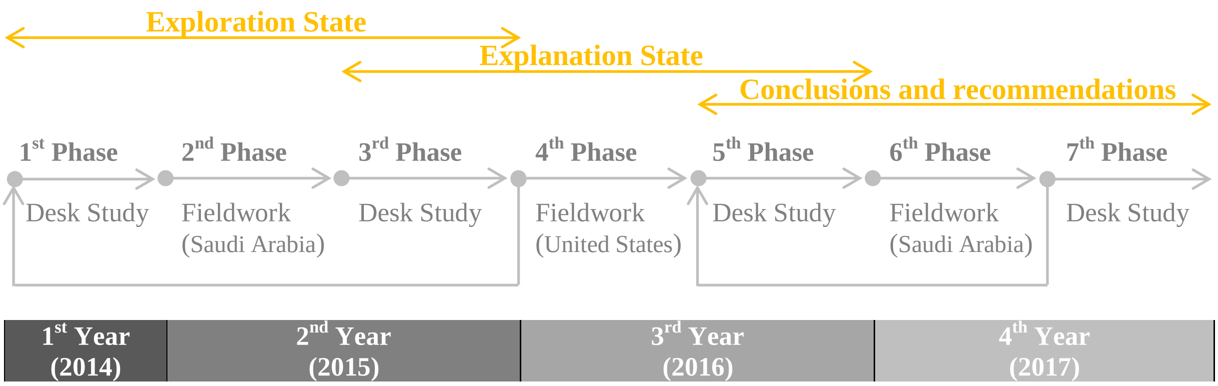

Figure 3.6: Research design

Throughout all phases of this research, data was analysed and interpreted using the following six steps. Figure 3.7 demonstrates the steps that were undertaken:

- **Step 1** is to organise and prepare the data for analysis. This includes, for example, transcribing interviews and typing up observation notes.
- **Step 2** is to read through all the data collected, develop a general sense, and reflect on its 'overall meaning, credibility, and impression of the overall depth' (Creswell 2009, 185).
- **Step 3** is to start thorough analysis with a coding process. Coding can be defined as 'the process of organising the material into chunks or segments of text before bringing meaning to information' (Rossman & Rallis 1998, 171). Coding is about clustering information together, categorising by grouping and highlighting interrelations (Tesch 1990).
- **Step 4** is to take advantage of step 3 by generating a description based on setting, people, categories or themes for analysis. It involves a detailed rendering of information about places, people, or events in a setting (Creswell 2009, 189). The aim is to identify themes to prepare them for the next step.
- **Step 5** is to advance how both themes and description can be represented in the qualitative narrative. It is to use a narrative passage to express the findings of the analysis through the use of visuals, figures, or tables as assistants to the discussions (Ibid 2009).
- **Step 6**, and as a final step, is to make an interpretation or meaning of the data raising the question of 'What were the lessons learned?' (Lincoln & Guba 1985). It is about interpreting and understanding the data collected. It can 'take many forms, be adapted for different types of designs, and be flexible to convey personal, research based, and action meanings' (Ibid 2009, 190).

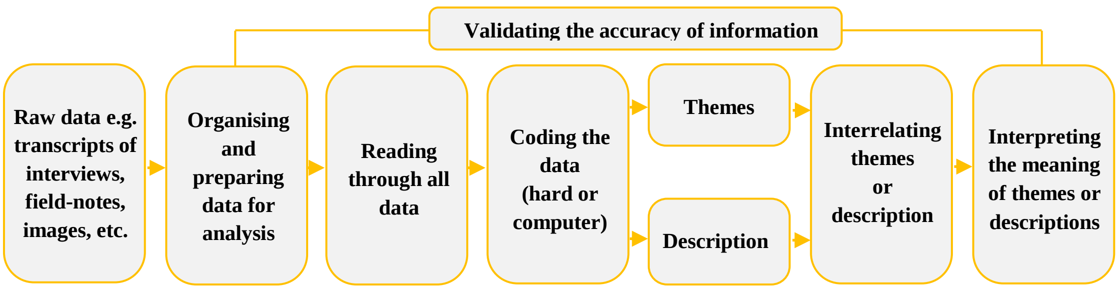

Figure 3.7: Approach to analysing and interpreting the data (Adapted from Creswell 2009, 246)

The following table, table 3.2, presents an overall view of key elements of the research. It shows the main research question, sub-research questions, objectives, methodological techniques, and finally the expected deliverable outcome of each aspect of this research.

Table 3.2: The research questions and the methods used

Main Questions	What information, tools, and approach will allow existing and new college buildings and campuses in Saudi Arabia to become more sustainable?				
Sub-Research Questions	How can ‘sustainable campuses’ be defined and measured?	Why is sustainability important in university campuses? And why is it important to Saudi Arabia in particular?	What are the main issues of sustainability in university campuses in Saudi Arabia	What lessons can the Kingdom learn about sustainable campuses in different parts of the world?	What approach can university campuses in Saudi Arabia adopt to become more sustainable?
Objectives	Acquiring knowledge about defining and measuring sustainable campuses	Highlighting the significance of sustainability especially in university campuses	Identifying sustainability issues in Saudi Arabian university campuses	Drawing lessons from best practices in the world (ASU and USF)	Developing planning guidelines and implementation plan for universities to become more sustainable
Methodological Techniques	● Literature review	● Literature review ● Interviews	(8 Case studies) ● Literature and documents review ● Observation ● Questionnaires ● Interviews	(2 Case studies) ● Literature review ● Interviews	● Interviews ● Literature review ● Best practices review
Types of Data	Qualitative	Qualitative	Qualitative and Quantitative	Qualitative	Qualitative
Intended Results	Operationalising sustainable campus and developing assessment tool for measuring environmental sustainability	Justification of the importance of sustainability in university	Sustainability assessment of university campuses in Saudi Arabia	Finding out the best practices and operations in campuses around the world	Planning guidelines and implementation plan for campuses in Saudi Arabia and elsewhere to become sustainable

This chapter ends with illustrating the overall scheme through which a link between sustainability aspects examined in this research and the data collection techniques is presented. The following two tables - table 3.3 and 3.4 shown below - highlight the evaluated sustainability indicators and the techniques used for each indicator.

Table 3.3: Data collection techniques used in Saudi Arabian cases

Sustainability aspects examined	Unit of analysis (Indicators)	Techniques used (Desk and Fieldwork)
Management	● Vision ● Commitment ● Planning ● Policy	● Scholarly literature review (articles, books, thesis...etc.) ● Professional documents review (Architectural drawings, sustainability reports, Strategic plans...etc.) ● Interviews ● Focus group ● Questionnaires
Engagement	● Attitude, knowledge, and Awareness of sustainability, and willingness to change	● Scholarly literature review (articles, books, thesis...etc.) ● Professional documents review (Architectural drawings, sustainability reports, Strategic plans...etc.) ● Interviews ● Focus group ● Questionnaires ● Observations
Environment	● Location ● Physical accessibility ● Climate considerations ● Flexibility ● Space utilisation	● Scholarly literature review (articles, books, thesis...etc.) ● Professional documents review (Architectural drawings, sustainability reports, Strategic plans...etc.) ● Interviews ● Focus group ● Questionnaires ● Observations

Table 3.4: Data collection techniques used in American cases

Sustainability aspects examined	Unit of analysis (Indicators)	Techniques used (Desk and Fieldwork)
Management	● Vision ● Commitment ● Planning ● Policy	● Scholarly literature review (articles, books, thesis...etc.) ● Professional documents review (Architectural drawings, sustainability reports, Strategic plans...etc.) ● Interviews
Engagement	● Attitude, knowledge, and Awareness of sustainability	● Scholarly literature review (articles, books, thesis...etc.) ● Professional documents review (Architectural drawings, sustainability reports, Strategic plans...etc.) ● Interviews ● Questionnaires by other researchers
Environment	● Location ● Physical accessibility ● Climate considerations ● Flexibility ● Space utilisation	● Scholarly literature review (articles, books, thesis...etc.) ● Professional documents review (Architectural drawings, sustainability reports, Strategic plans...etc.) ● Interviews

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PART II

STUDY OF CASES

Central axis, College of Engineering, Najran University, Najran

Chapter 4

Sustainability in Saudi Arabian campuses

4.1 Introduction

The main aim of this chapter is to highlight how sustainable Saudi Arabian public university campuses are, using the analytical framework tailored in chapter two. This chapter also aims at documenting the great developments in the higher education sector in the Kingdom, where two-thirds of its campuses are still under construction.

The research sub-question to be answered in this chapter is *'What are the main issues of sustainability in university campuses in Saudi Arabia?'*

In order to achieve the aim of this chapter as well as to answer the above mentioned question, a number of data-collection techniques were used. This includes desk research (e.g. scholarly literature review such as journal articles, books, thesis...etc. and professional documents review such as architectural drawings, university strategic plans...etc.) and fieldwork research (e.g. interviews, focus group, questionnaires, and observations). The analytical framework used to evaluate sustainability in Saudi Arabian campuses targets some of the sustainability aspects in universities. The three sustainability aspects were assessed through ten indicators as follows: Management aspects (Vision, policy, planning, and commitments), engagement aspects (Attitude, knowledge, and awareness of sustainability and willingness to change), and environment aspects (Location, physical accessibility, flexibility, climate considerations, and space utilisation).

This chapter takes the form of five sections. Second section begins with introducing the eight selected university campuses in which a brief description is given including some facts and figures about each campus. The third section deals with the micro scale in which a sample of college buildings is analysed. The fourth section highlights the research sample and the data-collection techniques used. The following section investigates the three selected sustainability aspects using ten indicators: Management aspects (Vision, policy, planning, and commitments), Engagement aspects (Attitude, knowledge, and awareness of sustainability and willingness to change), and Environment aspects (Location, physical accessibility, flexibility, climate considerations, and space utilisation). The last section presents an answer to the question raised in this chapter and through which the main sustainability issues in Saudi campuses are highlighted.

4.2 The selected case studies: University campuses (Macro level)

The selection criteria that were used to choose a sample of cases to be studied include availability of information, physical characteristics of cases, geographical locations in the country and hence the weather status, and the construction stage in which these campuses are at. Using this set of defined selection criteria, which were discussed in the previous chapter, eight university campuses were selected. These campuses were as follows (ordered alphabetically):

1. Al Baha University (ABU)
2. Jazan University (JNU)
3. King Abdullah University for Science and Technology (KAUST)
4. King Saudi University (KSU)
5. Najran University (NU)
6. Prince Sattam Bin Abdulaziz University (PSAU)
7. University of Hafr Al Batin (UHB)
8. University of Hail (UH)

Figure 4.1 shows the selected university campuses and their geographical locations among the main cities in Saudi Arabia. The map of the Kingdom illustrates that there is one campus from the northern part (UH), three campuses from the southern part (ABU, JNU, and NU), one from the eastern part (UHB), one from the western part (KAUST), and two from the central part (KSU and PSAU).

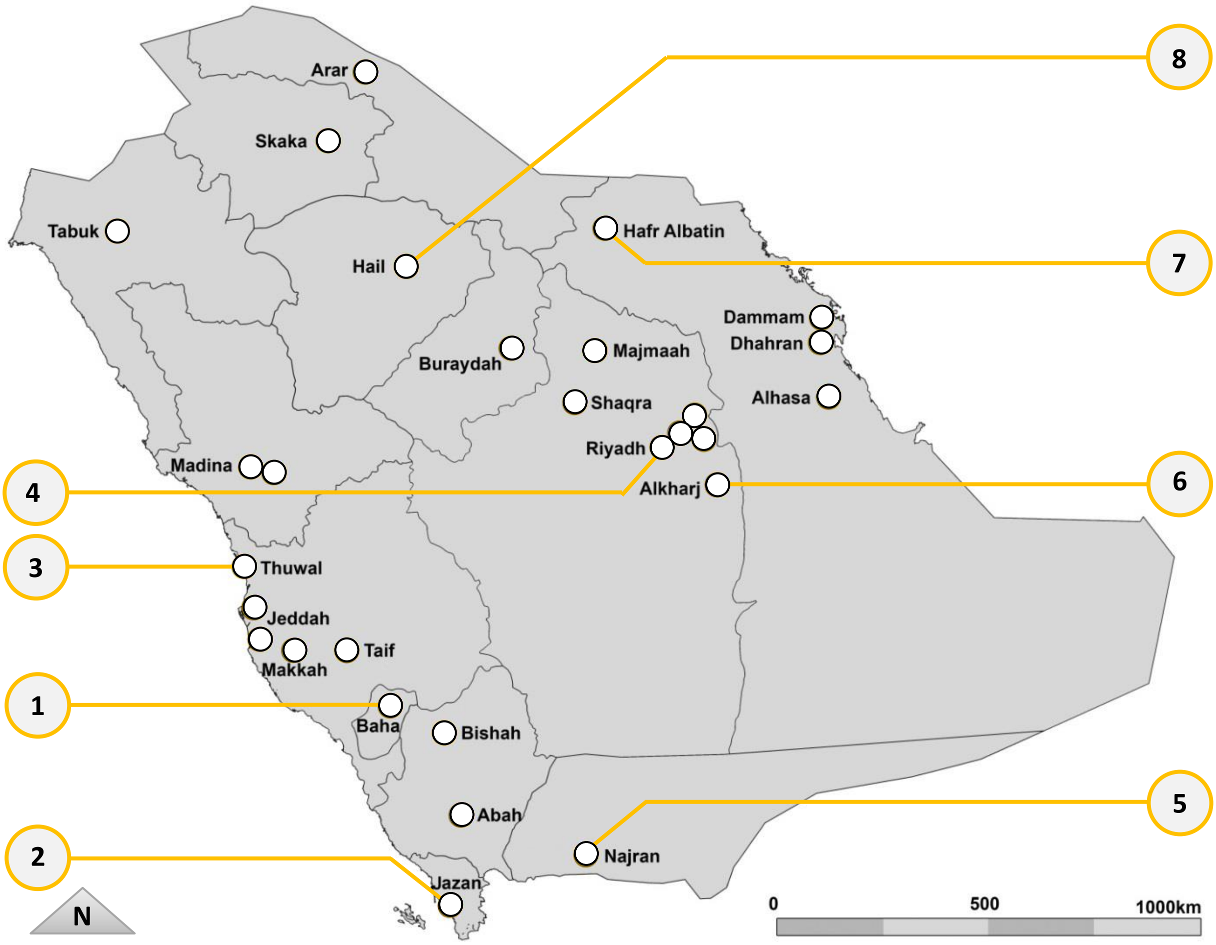


Figure 4.1: The eight selected campuses in Saudi Arabia (Adapted from Ministry of Education 2012)

4.2.1. First case: Al Baha University (ABU)

Background information

Al Baha University (ABU) is a public higher education institution that was established in 2006. The university was a branch of Umm Al-Qura University, which is a well-established institution. The ABU then became an independent institution. As a new university, the focus, to a large extent, is on teaching. Table 4.1 – which shows some statistics about the university including numbers of colleges, departments, students, and staff – indicates that only 5% of the total enrolled students were postgraduate. The vast majority of the enrolled students were undergraduate, which highlights the focus of the university, for the time being. The table also illustrates that even though the university was founded recently, it has a relatively large student enrolment. The 2015 enrolment statistics showed that the percentage of enrolled female students (51%) is relatively higher than their male counterpart (49%). The student-to-faculty ratio is 17:1, which is almost equal to the international average of 16.5:1 in public universities (OECD 2017). It is known that ‘a lower student-to-staff ratio can help students to cultivate closer relationships with their lecturers, have quicker access to essay feedback, and get involved in more interactive seminars and discussions' (Bhardwa 2017). This also has an implication on the size of classrooms needed in the university facilities. Minsky (2017) points out that 'although a low student-to-staff ratio does generally imply smaller class sizes, it is only a crude estimation of how much attention individual students will receive. At least as relevant as average class size, which often varies by degree subject within the same university, is the number of hours students spend with their teachers.' The data also shows that student housing capacity is 330 beds; given that there is only one dormitory building with 110 rooms each can house three students.

Table 4.1: Facts and figures about Al Baha University (Ministry of Education 2015)

No	Category	Data
01	Number of academic colleges	15 Divisions/Faculties
02	Number of academic departments	69 Departments/Schools
03	Number of academic majors (subjects offered)	86 Majors/Subjects
04	Full-time equivalent enrolment	25,241 Students
05	Full-time equivalent of faculty members	1,510 Members
06	Full-time equivalent of employees	865 Employees
07	Total number of high diploma students	0 Students
08	Total number of undergraduate students	24,062 Students
09	Total number of graduate students	1,179 Students
10	Total number of male students	12,295 Students
11	Total number of female students	12,946 Students
12	Number of residential students (Main campus)	330 Students

Climate

Al Baha's climate is significantly impacted by the variety of geographic features of the province. The first geographic feature is a mountainous area, known as As-Sarah, which is 2,500 meters above the sea level. In general, the climate in this area is mild in the summer and cold in the winter with temperatures ranging between 10 to 30 °C (Climate Data 2017). The other geographic feature is the coast area, known as Tehama, with a climate that is hot in the summer and warm in the winter. Despite the fact that the average rainfall throughout the entire province is 100 to 250 millimetres, annually (GAMEP 2017), the average rainfall in As-Sarah area is higher than that of Tehama.

University campus

Al Baha University (ABU) has a number of campuses throughout the province of Al Baha. It has a main campus and other satellite campuses for male and female students. The main campus was located near the town of Al Aqiq, which is about 35 kilometres away from the city of Al Baha, the capital of Al Baha province. Figure 4.2 shows the geographical location of Albaha University's main campus and satellite campuses. The university has branches located in the province's biggest towns including Baljurashi, Almandaq, Al Makhwah, and Qilwah. Most of these satellite campuses are for female students and some are for both genders.

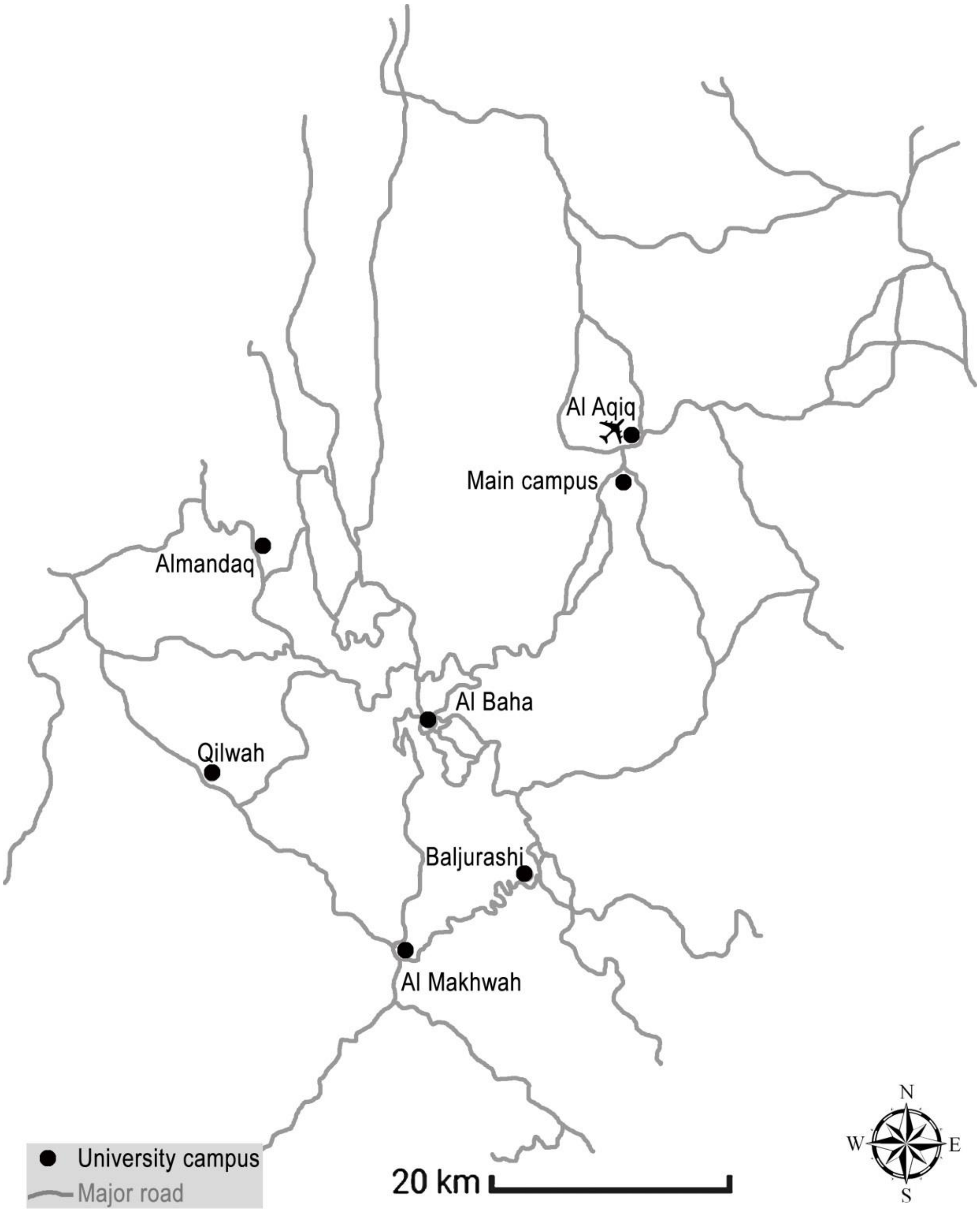


Figure 4.2: The main and other satellite campuses of ABU (Adapted from Farsi Maps 2017)

The main campus of Al Baha University is the subject of examination in this research. This is not only because it is the main campus of the university, but it is also because of availability of data and the ability to access the campus. The campus is home to many educational, research, athletic, and supporting facilities. Table 4.2 illustrates some key information about the campus of ABU. It shows the type and size of the campus, number of buildings, capacity, population, and density. The campus is characterised as a rural campus, which means that the location of the campus is remote. The campus is far away from the main cities and towns in the province of Al Baha. The size of the campus is about 6.8 square kilometres (1,680 Acres). The campus is home to 30 academic and administration buildings. The estimated campus capacity is 68 thousand students, while the estimated campus population is over 100 thousand people. This indicates that such a campus can be regarded as a city in its own right. The expected density might be around 0.02 people per km2.

Table 4.2: Facts and figures about the main campus of Al Baha University

No	Category	Data
01	Campus type	Rural
02	Campus size (campus acreage)	6.8 Square kilometres (1,680 Acres)
03	Number of buildings	30 buildings (Academic and Administrative buildings only)
04	Gross floor area of building space	Not available
05	Campus capacity (Future estimates)	68,000 students (Full-Time Equivalent)
06	Campus population (Future estimates)	114,000 people

Al Baha University's main campus can be regarded as a city in itself. Figure 4.3 demonstrates the master plan of the main campus, which shows that the campus is divided into zones and each zone has distinctive related programs or uses. The map illustrates that there are seven distinctive zones as follows:

- **Zone one**: University medical staff housing.
- **Zone two**: University teaching hospital surrounded by eight medical colleges.
- **Zone three**: University sport facilities (Football stadiums, basketball arenas, tennis courts, indoor sport halls...etc.)
- **Zone four**: Male residential buildings and also seven male college buildings.
- **Zone five**: Central zones consist of administration buildings and other supporting facilities such as the main library, main auditorium, museums, exhibition centre, and main mosque. This zone includes the staff housing and its supporting facilities such as schools, restaurants, shops, place of worships, and others.
- **Zone six**: This zone is home to female student housing, college buildings, and other supporting facilities such as female student centre.
- **Zone seven**: This zone is designated to the university endowments, which include a hotel, science park, shopping mall, and other investment functions and services planned to benefit the institution and the surrounding community.

According to the master plan, there are 21 college buildings: Seven colleges in the male zone of the campus, six in the female zone, and eight colleges around the teaching hospital. Each zone is served by a student centre. The number of college buildings built and in use, as of 2017, is four; all of which are in the male zone. Other completed buildings are the main administration building and one male residential building with a capacity of 570 beds. Staff housing and the hospital are still under construction. For female students, however, a decision has been made to rent out buildings within or close to the province's main towns. This might be because of either the long distance between the main campus and the other towns or the new urgent small campuses built for female students. The latter is known as the Urgent College Buildings for Female Students, which are planned as national projects that have their own fixed budget. Some of these projects were developed and are now in use. These projects are believed to be one of the reasons that delayed the development of college buildings and housing in the female zone in the main campus.

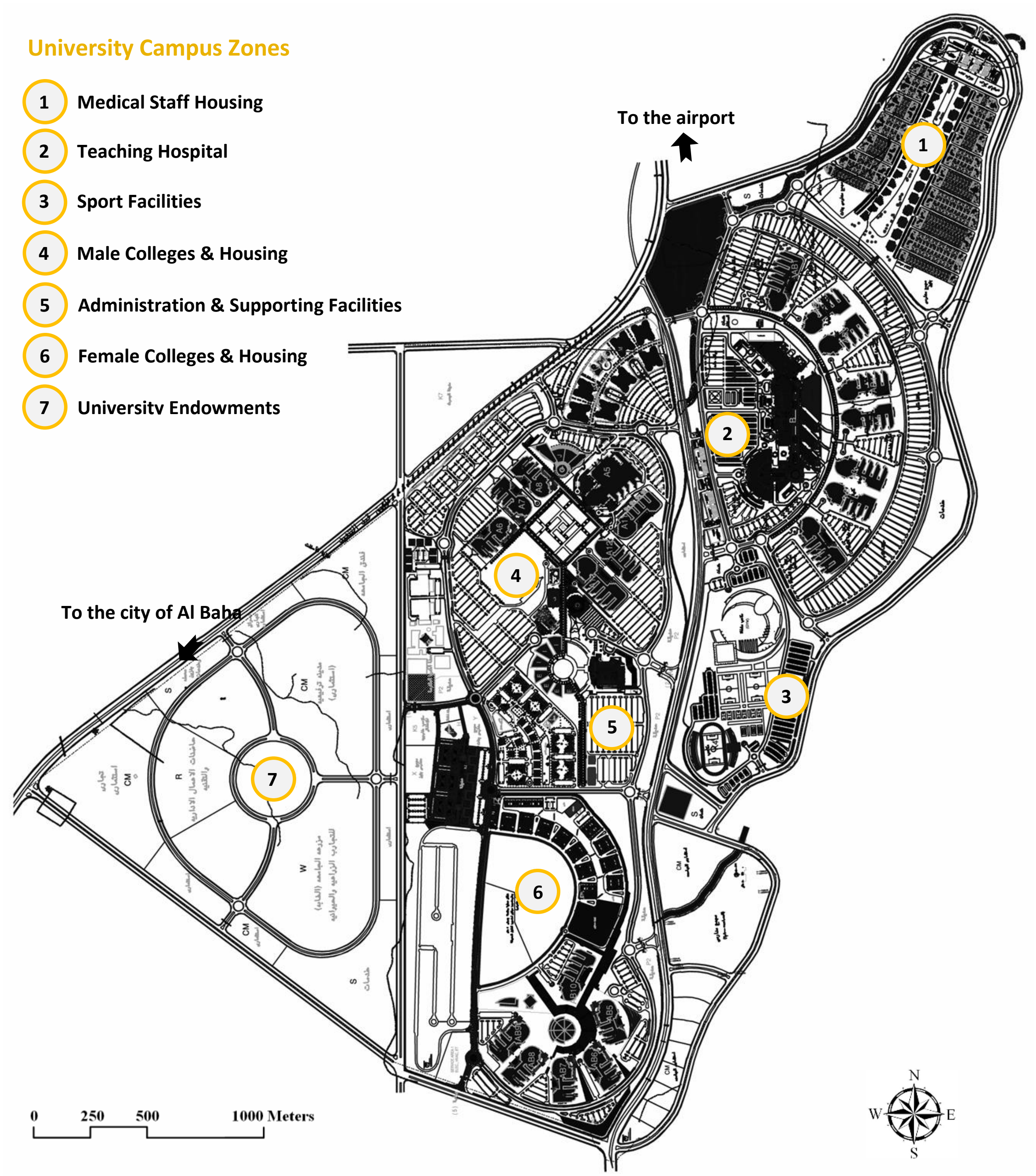


Figure 4.3: The main campus master plan of ABU (Adapted from Ministry of Education 2017)

Another observation on the master plan is the planning in general. The master plan seems to be designed considering the road that divides the campus into east and west. However, a new highway was developed and in now in use. The new road is bordering the campus from the north. This road is key, since it links the city to the airport. This means that users of this important highway might not recognise much of the campus. Visitors to the city of Al Baha will find that their first glimpse of the campus will most likely be the back of the student housing. This also means that an old road has become an internal part of the campus, despite the fact that it acts as a physical barrier separating the campus into two main zones. Lack of coordination between the municipality and the university planner is believed to be the reason for such strategic issue in the campus location and design.

Another aspect of designing the campus is the concentration of buildings. The compactness gives a number of advantages including easing the walkability, encouraging sociability, and increasing density and hence chances of encountering people (different campus users). Although the architects tried to connect the campus zones together using pedestrian spines, the topography of the site as well as the size of the campus, were not helping. The distance is relatively long and the walking network does not take users wherever they need to be. This leads to an increase in the use of cars, even within the campus boundaries, as seen in figure 4.4. For example, student housing is not connected to the medical zone, whereas the university hospital and other medical colleges are.

Figure 4.4: The use of cars to move within the campus of Al Baha University

4.2.2. Second case: Jazan University (JNU)

Background information

Jazan University (JNU) is a public higher education institution that was founded in 2005. Historically, the university colleges were supervised by two well-established universities; King Abdulaziz University and King Khaled University. The JNU was established then became an independent institution. As a new university, the focus, to a large extent, is on teaching. Table 4.3 – which shows some statistics about the university including numbers of colleges, departments, students, and staff – indicates that less than 3% of the total enrolled students were postgraduate. The vast majority of the enrolled students were undergraduate, which emphasises the focus of the university, for the time being. The table also exemplifies that despite the fact that the university was founded recently, it has a large student enrolment, which was over 60 thousand students. The 2015 enrolment statistics showed that the percentage of enrolled female students (55%) is relatively higher than their male counterparts (45%). The student-to-faculty ratio was almost 24:1, which is significantly higher than the international average of 16.5:1 in public universities (OECD 2017). This may considerably impact the quality of education and research and also the satisfaction of both students and staff. Furthermore, the data shows that there are only 660 beds available on campus, as of December 2017, which is about 1% of the total number of students.

Table 4.3: Facts and figures about Jazan University (Ministry of Education 2015)

No	Category	Data
01	Number of academic colleges	25 Divisions/Faculties
02	Number of academic departments	128 Departments/Schools
03	Number of academic majors (subjects offered)	92 Majors/Subjects
04	Full-time equivalent enrolment	62,041 Students
05	Full-time equivalent of faculty members	2,555 Members
06	Full-time equivalent of employees	1,800 Employees
07	Total number of high diploma students	3,204 Students
08	Total number of undergraduate students	58,688 Students
09	Total number of graduate students	149 Students
10	Total number of male students	27,741 Students
11	Total number of female students	34,300 Students
12	Number of residential students (Main campus)	660 Students

Climate

In general, Jazan’s climate is hot all year round, especially on the coastal area in the western areas of the province and is relatively milder in the mountainous east parts. It is quite humid, but can be parched in some months, making the weather of Jazan very oppressive (GAMEP 2017). The average temperature in Jazan is 30 °C and the annual rainfall average is 106 mm (Climate Data 2017).

University campus

Jazan University (JNU) has a number of campuses throughout the province of Jazan. It has a main campus and other satellite campuses for male and female students. The main campus was located in the northern border of the city of Jazan, the capital of the province. The campus location is by the Red Sea. Figure 4.5 shows the geographical location of the university campuses. The university has branches located in the province’s biggest towns such as Jazan, Sabya, Samtah, Abu Arish, Baish, Al Aridhah, Ad Darb, Addayer, and Farasan Island. Most of these satellite campuses are for female students and some are for both genders.

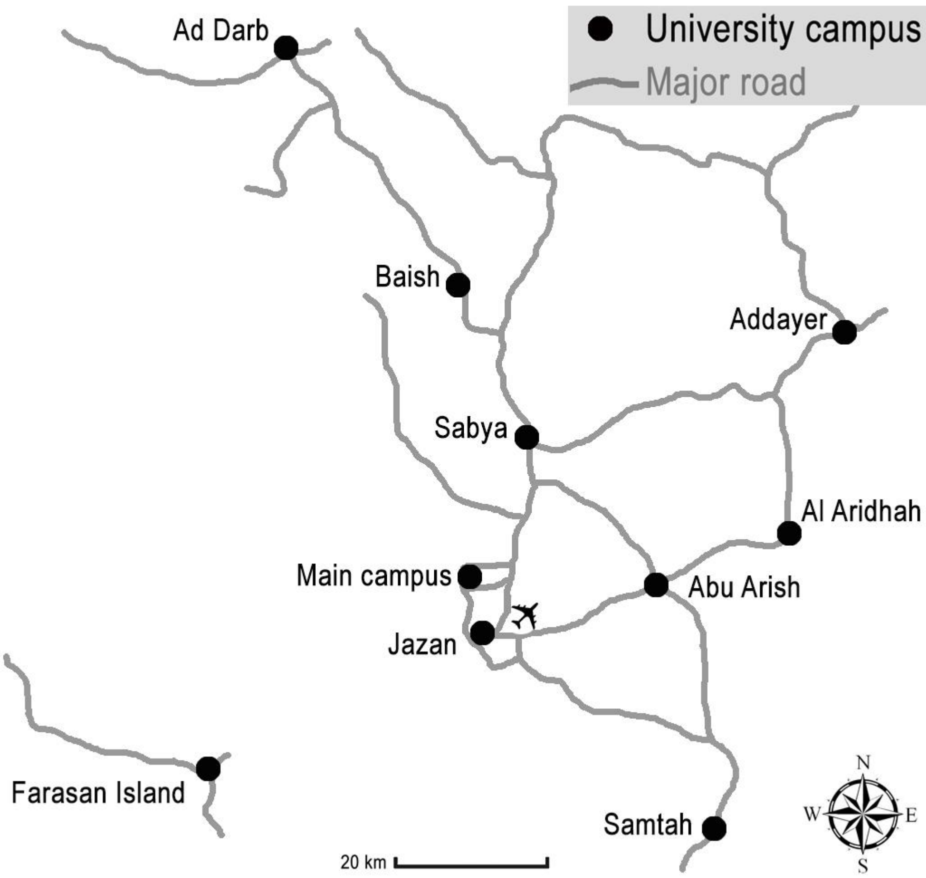


Figure 4.5: The main and other satellite campuses of JNU (Adapted from Google Maps 2017)

The main campus of Jazan University is the subject of examination in this study. This is not only because it is the main campus of the university, but it is also because of availability of data and the ability to access the campus. The campus is home to many university functions such as educational, research, athletic, and other supporting facilities. Table 4.4 demonstrates key information about the campus of JNU. It shows the type and size of the campus, the number of buildings, future campus capacity, future, and campus population.

Table 4.4: Facts and figures about the main campus of Jazan University

No	Category	Data
01	Campus type	Suburban
02	Campus size (campus acreage)	9 square kilometres (2,223 Acres)
03	Number of buildings	35 buildings (Academic and Administrative buildings only)
04	Gross floor area of building space	Not available
05	Campus capacity (Future estimates)	92,000 students (Full-Time Equivalent)
06	Campus population (Future estimates)	183,000 people

The campus is characterised as a suburban campus, which means that the location of the campus is at the edge of the urban area of Jazan city. Being located at the urban fringe of its city means that the campus is almost at the border of the city and hence there are some opportunities to share some facilities and functions with the city. The size of the campus is about 9 square kilometres (2,223 Acres). The campus is home to 33 college buildings and two administrative buildings. The estimated campus capacity is 92 thousand students, while the estimated campus population is over 180 thousand people. This indicates that such campus can be regarded as a city in its own right. The expected density might be around 0.02 people per km2.

Figure 4.6 exhibits the master plan of the main campus, which shows that the campus zones. Each zone has a distinctive function.

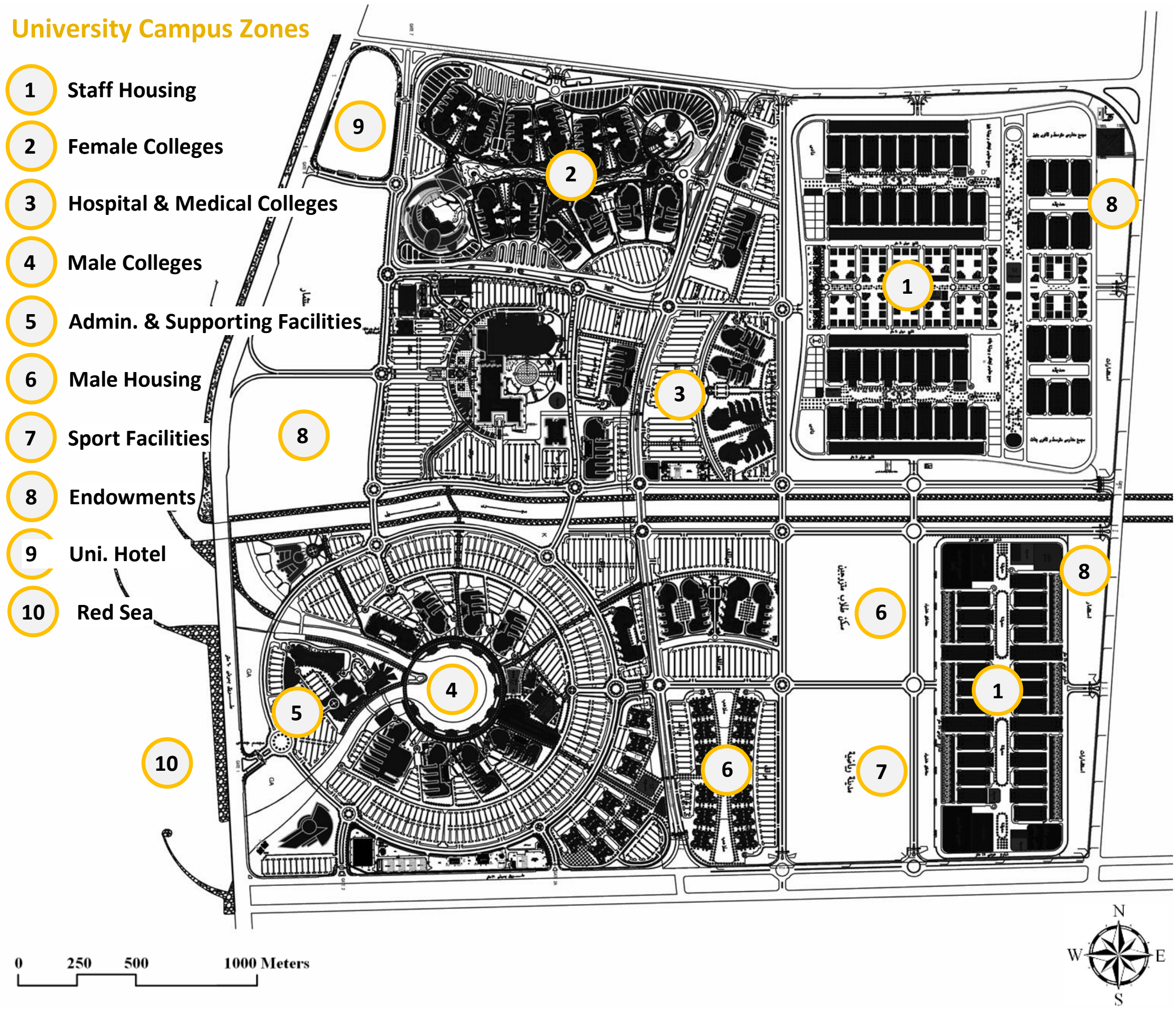


Figure 4.6: The main campus master plan of JNU (Adapted from Ministry of Education 2017)

The main university zones are as follows:

- **Zone one**: University staff housing.
- **Zone two**: This zone is home to female college buildings and other supporting facilities such as female student centre, library, and some administration.
- **Zone three**: University teaching hospital and six medical colleges.
- **Zone four**: Male college buildings placed in a circular way around a bay. This zone is home to other supporting facilities such as student centre, library, restaurant, and mosque.
- **Zone five**: This zone consists of the administration building and other supporting facilities such as the main library, main auditorium, and restaurant.
- **Zone six**: Student housing.

- **Zone seven**: University sport facilities (Football stadiums, basketball arenas, tennis courts, indoor sport halls...etc.).
- **Zone eight**: This zone is designated to the university endowments, which may include any investment functions and services planned to benefit the institution and the surrounding community.
- **Zone nine**: University hotel.

According to the master plan, there are 33 college buildings: 13 colleges in the male zone of the campus, 14 in the female zone, and six colleges next to the university teaching hospital. Each zone was served by a student centre. The number of college buildings built and in use, as of 2017, is three; two in the male zone and one in the medical zone. Other completed buildings are the main administration building (figure 4.7), the hotel (figure 4.8), staff housing, and two male residential buildings with a capacity of 570 beds each. Four college buildings, the hospital, and two student housing buildings are still under construction.

Figure 4.7: Jazan University Admin. Tower (Jazan University 2017)

Figure 4.8: Jazan University Hotel (Jazan University 2017)

Another observation on the master plan is the planning in general. Typologically, the master plan seems to be designed through strict zoning. This means that the campus is designed based on the functions that the university serves, including the male zone, female zone, medical zone, and other supporting zones such as sport, recreational, housing...etc. The main issue in such an arrangement is the weak connectivity link between these zones. For example, in order to move from one zone to the other, one needs to use an automobile. This means that a car should be used to move within the campus; not only because of the long distance or the hot and humid weather, but also because of the incomplete pedestrian network.

4.2.3. Third case: King Abdullah University for Science and Technology (KAUST)

Background information

King Abdallah University for Science and Technology (KAUST) is a private institution established in 2009. The university is located in the town of Thuwal, 85 kilometres north of Jeddah. It is the most advanced and only technological university in the Kingdom. It is a graduate-level, research-oriented, and interdisciplinary higher education institution. The aim of the university (KAUST 2017) is:

> *KAUST advances science and technology through distinctive and collaborative research integrated with graduate education. Located on the Red Sea coast in Saudi Arabia, KAUST conducts curiosity-driven and goal-oriented research to address global challenges related to food, water, energy and the environment. Established in 2009, KAUST is a catalyst for innovation, economic development and social prosperity in Saudi Arabia and the world.*

KAUST is a very well-respected higher education institution worldwide. The university was ranked first in the citation per faculty in QS World University Ranking for 2015/16, 2016/17, and 2017/18 (QS Top Universities 2017). KAUST has hundreds of patent applications and has already achieved tens of them (KAUST 2017). The university is ranked 19 in the world's leading institutions for high-quality science (Nature Index 2017). It is also recognised as one of the fastest growing research universities in the world (Al-FANAR MEDIA 2017). The institution has endowments of 20 billion USDs, which puts it at the rank of the sixth richest university in the world (The Best Schools 2017).

Table 4.5 presents some statistics about the university including numbers of departments, students, and staff. The table shows that there are three academic divisions: Biological and Environmental Science and Engineering; Computer, Electrical and Mathematical Science and Engineering; Physical Science and Engineering. The main feature in this institution is that it is based on labs. The university has ten core labs. KAUST (2017) defines these labs as:

> *The Core Labs are a prominent feature of the interdisciplinary research ecosystem at the KAUST. The Core Labs provide state-of-the-art facilities, training and services to the KAUST research community, collaborators and industrial partners. These centrally organised, shared-user facilities provide direct access to specialised research equipment, operated by expert staff with advanced degrees in science and engineering. The Core Labs consist of ten laboratories that are strategically located throughout the academic campus enabling users to transition between labs in a matter of minutes.*

The table also shows that of the one thousand students, almost 70% are overseas students. They are supported by over 850 scientists. The data shows that the vast majority of postgraduate students are PhDs (80%), while the 20% are Masters. Statistics displays that only one-third of the enrolled graduates are female. The student-to-faculty ratio is almost 1:1, which is extremely respectable percentage compared to the international standards (Bhardwa 2017). This comes as no surprise since it is graduate-level University with a total planned capacity of ‘more than 2,500 principal investigators, researchers, graduate students, and additional faculty and staff (Architecture and Design Journal 2010, 104). Furthermore, the table exhibits that virtually all KAUST students, staff and faculty members live on-campus.

Table 4.5: Facts and figures about KAUST (KAUST 2017)

No	Category	Data
01	Number of academic departments (Divisions)	3 Departments/Divisions
02	Number of Core labs	10 Core labs
03	Full-time equivalent enrolment	1,000 Students (31% Saudis & 69% International)
04	Full-time equivalent of postdoctoral researchers	400 Postdocs
05	Full-time equivalent of faculty members	154 Members
06	Full-time equivalent of research scientists	300 Scientists
07	Full-time equivalent of employees	2,200 Employees
08	Total number of graduate students	1,000 Students (80% Ph.D. and 20% MSc.)
09	Total number of male students	630 Students
10	Total number of female students	370 Students
11	Number of residential students	1,000 Students (Most students & staff live on-campus)

Climate

In general, Thuwal’s climate is hot and humid most of the year (GAMEP 2017). The average temperature in Thuwal is 28.5 °C and the annual rainfall average is 42 mm (Climate Data 2017).

University campus

KAUST campus was built as a self-contained community in the north of a small town of Thuwal on the coast of the Red Sea. Figure 4.9 shows the geographical location of the university campuses. The site context of the campus is that it was located between the town of Thuwal and the King Abdullah Economic City (KAEC), a new city that is under construction. Both KAUST campus and KAEC city are served by a high-speed train station situated between them, which link them both to Jeddah, the Kingdom’s main port city on the Red Sea and a modern commercial hub.

Table 4.6 presents some key information about the KAUST campus. It shows the type and size of the campus, number of buildings, current and future campus capacity, and current and future campus population. The campus and its community were built on a previously undeveloped land. The campus, which was officially opened in 2009, was designed and constructed in a record time of 30 months (HOK 2017) costing over 8 billion USDs (Architecture and Design Journal 2010, 114). Although the campus is suburban, it was planned to be a self-contained community providing supplies and services to its own users and visitors. The size of the campus is about 8,900 acres, making it one of the biggest campuses in the world. Almost 10% of KAUST campus land was designated to a knowledge-based business district; a science park. There are around 30 buildings in the academic and research zone of the campus with a gross floor area of almost 500 square meters. The current campus population is over 7 thousand people. At maturity, however, the total capacity of KAUST community might reach about 20 thousand inhabitants. The current density, therefore, is 0.0002 people per km2 and might be around 0.0005 people per km2 in the future.

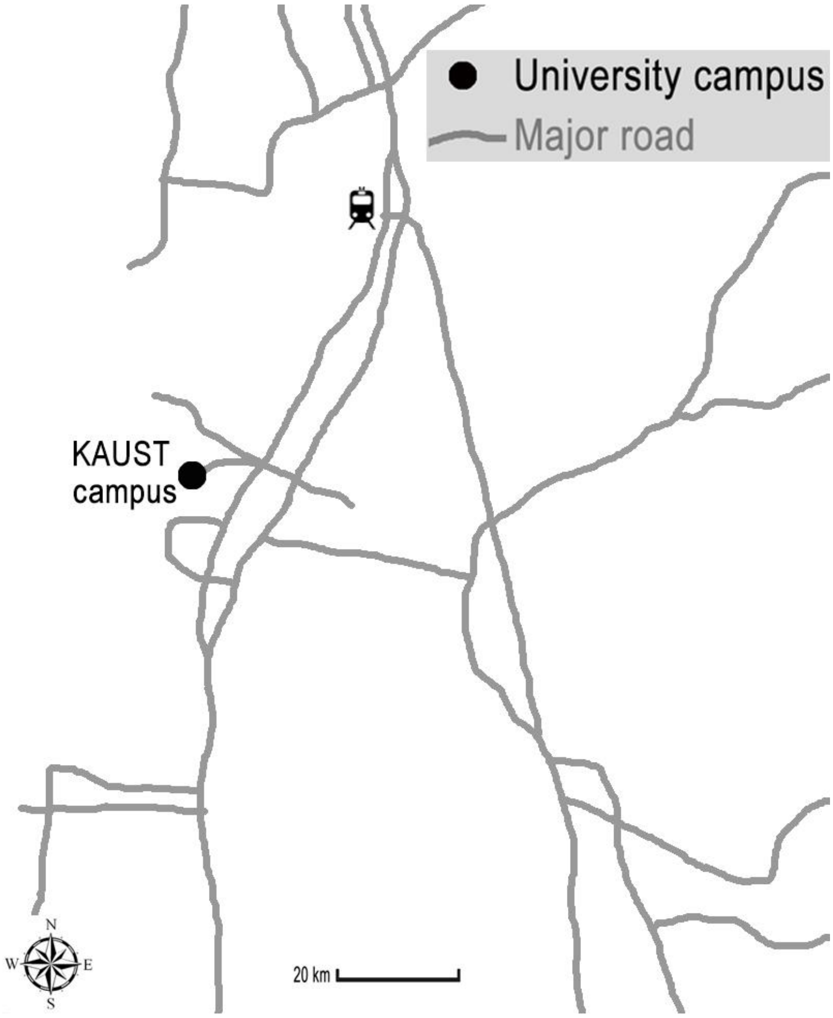


Figure 4.9: Location of KAUST campus (Adapted from Google Maps 2017)

Table 4.6: Facts and figures about KAUST (KAUST 2017; STUDIO DUPUY 2017; Minutillo 2010)

No	Category	Data
01	Campus type	Suburban
02	Campus size (campus acreage)	36 Square kilometres (8,900 Acres) (KAUST 2017)
03	Research Park (RP)	3.2 Square kilometres (790 Acres) (World Architecture News 2017)
04	Gross floor area of RP incubator	29, 175 square meters (STUDIO DUPUY 2017)
05	Number of buildings	27 buildings (Academic and Administrative buildings) (HOK 2017)
06	Gross floor area of building space	497,000 square meters (American Institute of Architects 2017)
07	Campus population	7,100 people (KAUST 2017)
08	Campus future population	20,000 people (KAUST 2017)
09	Total enrolment (Future estimates)	2,500 students (Architecture and Design Journal 2010)
10	Faculty members	850 members (KAUST 2017)
11	Employees	2,200 staff (KAUST 2017)
12	Number of beds (Future estimates)	2,500 beds

Figure 4.10 exhibits the master plan of KAUST campus, which shows that the campus zones. These zones can be grouped in five main zones as follows:

- **University campus zone** (Academic and research facilities, which consists of 27 buildings including for example labs, library, auditorium, student centre, commons and dining hall, mosque...etc.).
- **Research Park** (The business district of the university, which accounts for almost 10% of the whole development).
- **University residential zone** (Student and staff housing were designed as a single family house or apartments. The housing zones are served, among others, by a commercial centre, schools, clinic, day care, gas station, fire station, and mosque).
- **Sport and recreation facilities** (e.g. golf course, Beach Club, KAUST stadium, gymnasium hall, and others).
- **Utilities and services zones** (e.g. the desalination plant is in the north of the campus and the waste water treatment plant is in the south side of the campus).

Figure 4.11 presents the KAUST campus site plan, where a more detailed plan reveals more information. The campus was designed by the architecture firm Hellmuth, Obata, and Kassabaum (HOK). The principles which the designer relies on in the planning and design of the campus reflect the site and climate challenges. It is believed that:

> *'The KAUST campus architecture and design is a direct sustainable and efficient response to the given site and climate. Buildings are specifically located and grouped to maximize the benefits of the unique site microclimate and ecosystem, and mitigate the detriments of the sun's movement and the harsh Saudi Arabian climate'* (KAUST 2017).

In order to implement these sustainable and effective principles, the architect has borrowed five design strategies from the local culture and traditions to address the environmental challenges. These five strategies were summarised by the Architecture and Design Journal (2010, 112):

- *'Structured like traditional Arabic cities, the campus is compressed as much as possible to minimise the amount of exterior envelop exposed to the sun and reduce outdoor walking distance.*
- *As found in a traditional souk or Arabic market, shaded and passively cooled circulation thoroughfares are characterised by dramatic light and social spaces.*
- *The Arabic Bedouin tent inspired designers to create a monumental roof system that spans across the building masses to block sun on buildings facades and into the pedestrian spine, to facilitate natural ventilation and to filter light. Solar panels covering the surface capture the sun's energy.*
- *Passive ventilation strategies of the traditional Arabia house influenced the design of iconic, solar-powered wind towers that harness energy from the sun and wind to passively create air flow in pedestrian walkways.*
- *Similar to Arabic screening called 'mashrabiya', the campus shades windows and skylights with an integral shading system that reduce heat load while creating dramatic dappled light.'*

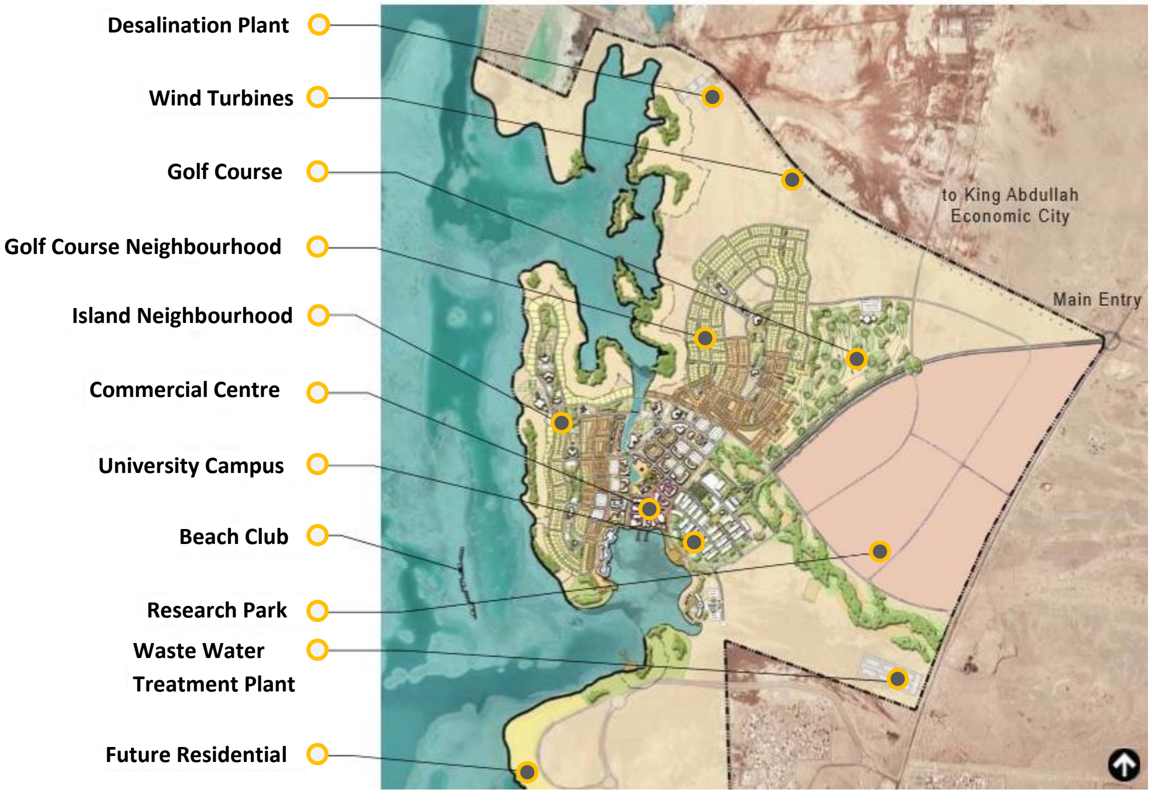


Figure 4.10: Campus master plan of KAUST (Adapted from STUDIO DUPUY 2017)

Figure 4.12 shows the result of the principle of compactness in which it affects the massing of the campus. As a consequence, the campus seems to have one single roof. The roof then is used not only for shading and filtering the daylight, but also to generate clean and sustainable power:

> *'In lieu of designing numerous stand-alone buildings, the design team opted to incorporate a monumental roof capable of connecting and shielding the campus buildings from the harsh climate. The roof will feature nearly 12,000 square meters of solar thermal and photovoltaic arrays that will harness the abundant and renewable power of the Sun, and produce up to 3,300 megawatt hours of clean energy annually. While the roof protects the buildings from excessive solar gain, atria and courtyards have been integrated throughout campus buildings to infuse natural daylight and facilitate natural ventilation into a majority of the interior spaces'* (KAUST 2017).

Figure 4.11: KAUST campus site plan (Adapted from American Institute of Architects 2010)

Figure 4.13 presents a section through the laboratories and pedestrian spine of the campus. It shows some of the passive solutions that were emulated from the local architecture and planning including the integrated shading for windows, the solar towers, and the shaded and naturally ventilated courtyards.

Figure 4.12: KAUST campus aerial rendering (American Institute of Architects 2010)

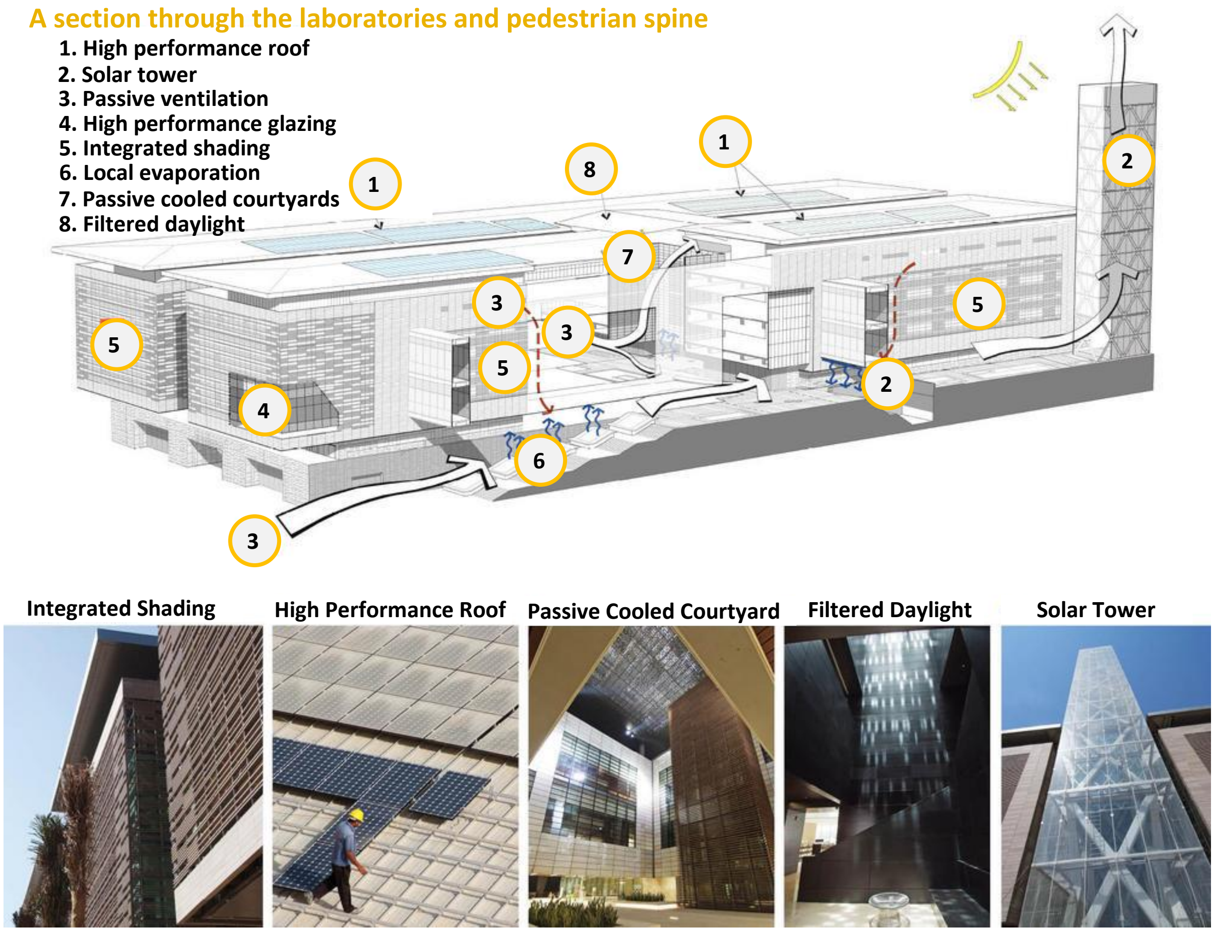


Figure 4.13: Sustainable design diagram (Adapted from American Institute of Architects 2010)

Sustainability was integrated into all aspects of the built environment; planning, designing, operation, and maintenance. The planning and operation of such campus in such climate condition promotes how to plan and design in such a region. The architect has successfully managed to merge the classical architecture of Saudi Arabia with modern technologies and styles, establishing a benchmark for sustainable design in the Middle East (GreenSource 2010). HOK (2017) highlights the planning principles saying that:

> *'The buildings' orientation limits harsh eastern and western sun exposure while taking advantage of prevailing winds from the Red Sea. Building massing, which places buildings close together, allows for the shading of adjacent buildings. Large roofs provide natural shading for buildings below, while operable and fixed shading devices provide shade most of the year. High-performance facades and glazing mitigate heat gain. The narrow buildings allow daylight to reach all perimeter spaces and selected interior spaces to reduce lighting demand. After employing as many passive strategies as possible to reduce loads, HOK's design team selected the most climate-appropriate and efficient MEP systems [Mechanical, electrical, and plumbing] to further decrease energy demands. Chilled beams, heat-recovery wheels, displacement ventilation, smart lighting controls, variable frequency drives and low-flow duct design were all incorporated.*

As a result of such a huge investment, the campus, figure 4.14, is now ‘Saudi Arabia's first LEED certified project and the world's largest LEED Platinum project’ (American Institute of Architects 2010). KAUST’s Administration buildings are believed to ‘use up to 40% less energy than the U.S. standard, its lab buildings 20 to 30 less’ (Minutillo 2010, 10). Other statistics show that 100% of wastewater is reused, 42% reduction in water use, 27% annual energy cost savings, 9% is the amount of on-site renewable energy, 80% is the amount of glassing that is shaded all year-round (HOK 2017).

Figure 4.14: The view of the campus from the Red Sea (KAUST 2017)

4.2.4. Fourth case: King Saudi University (KSU)

Background information

As the oldest, established in 1957, King Saud University (KSU) is the premier higher education institution in the country and the most prestigious public university in the Middle East (KSU 2017). It, therefore, has educated numerous members of the national business, political, and academic elite, including the royal family. The institution has achieved a high ranking in many global ranking systems such as the 2017 Academic Ranking of World University (#101), the 2018 QS World University Rankings (#221), and the 2017 Webometrics ranking (#428). Table 4.7 shows some facts and figures about the university including numbers of colleges, departments, students, staff, and others. It indicates that almost 500 majors are being taught which illustrates how comprehensive the institution is. In 2015, the student body was almost 60 thousand students, of which 60% were male and 40% were female. As the university focuses more on research, the data shows that around 9% of students were graduates. The student-to-faculty ratio is 8:1, which is far less than the international average of 16.5:1 in public universities (OECD 2017). Such ratio positively impacts the quality of education and research, despite the fact that KSU has a large student body. According to the KSU Masterplan document (2009), there were 7,415 on-campus residential students living in 36 buildings; 5,660 undergraduate and 1,755 graduate students. This means that approximately 13% of the total enrolled students live on-campus.

Climate

In general, Riyadh’s climate is a desert climate. This means that it has extremely hot temperatures in summer months with an average of 35 °C, with a mild to cold temperatures in winter months with an average of 15 °C (GAMEP 2017). The rainfall average is about 111 mm annually (Climate Data 2017). In the recent years, the city, along with others in the country, is experiencing massive dust storms drastically reducing visibility and impacting health and safety.

Table 4.7: Facts and figures about King Saud University (Ministry of Education 2015)

No	Category	Data
01	Number of academic colleges	21 Divisions/Faculties
02	Number of academic departments	120 Departments/Schools
03	Number of academic majors (subjects offered)	498 Majors/Subjects
04	Full-time equivalent enrolment	59,505 Students
05	Full-time equivalent of faculty members	7,612 Members
06	Full-time equivalent of employees	15,519 Employees
07	Total number of high diploma students	2,362 Students
08	Total number of undergraduate students	48,576 Students
09	Total number of graduate students	8,567 Students
10	Total number of male students	35,766 Students
11	Total number of female students	23,739 Students
12	Number of residential students	7,415 Students (KSU Masterplan 2009)

University campus

King Saud University (KSU) has one single campus located in the northwest of the capital Riyadh. It is about 18 kilometres away from the city centre, as seen in figure 4.15, which shows the geographical location of the KSU campus among other districts. The campus is well-connected to the street network of the city through the first and the second ring roads. It has also a metro station located in the front of its east-south gate, known as the Book's Gate.

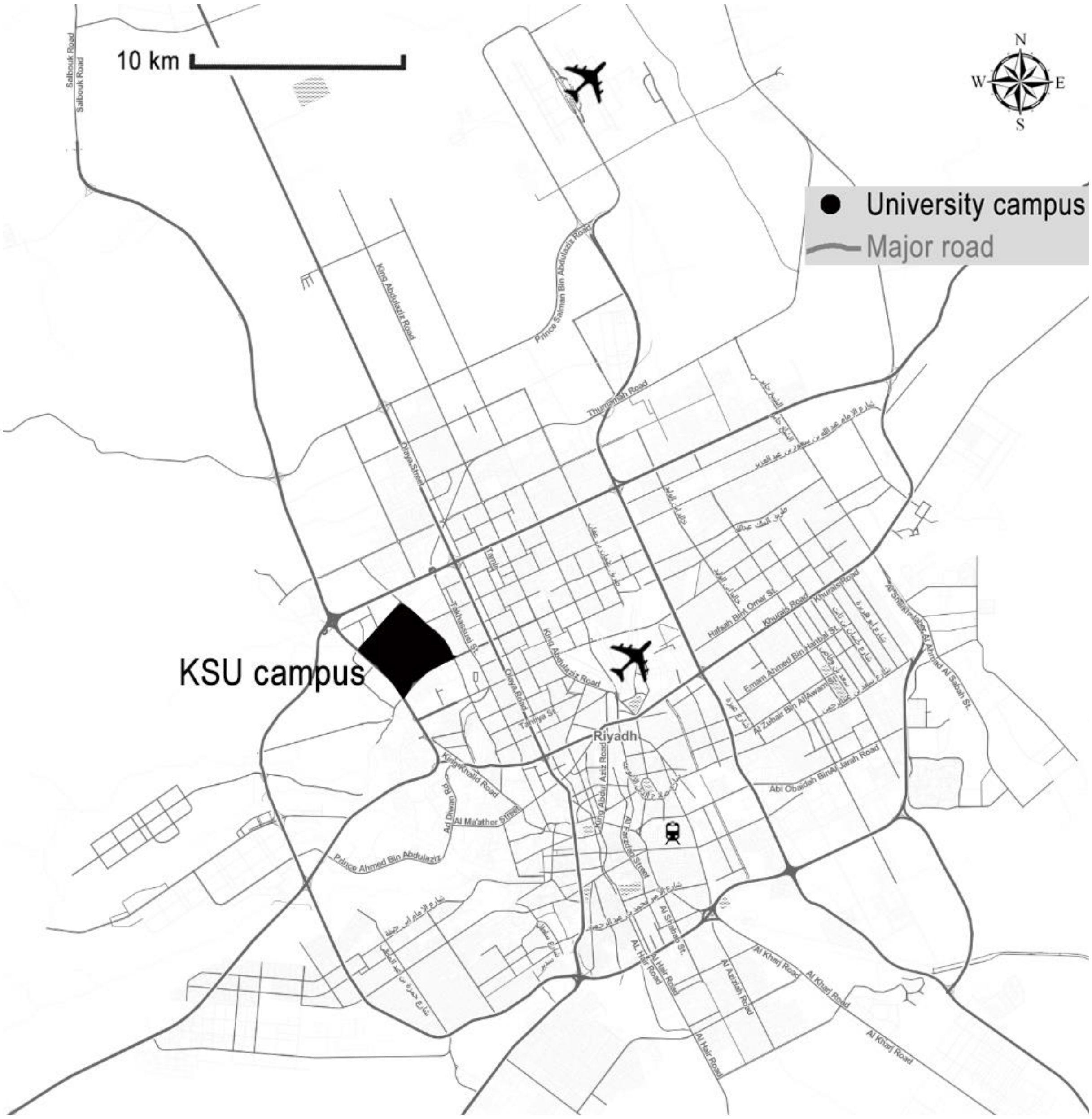


Figure 4.15: Location of KSU campus in the city of Riyadh (Adapted from Stamen Design 2017)

The campus was initiated in the 1970s and is considered the first to be built in the Arabic Gulf area. A comprehensive master plan of KSU campus was developed by Karl Schwanzer, an Australian architect (Mitchell 2015, 40). Then the firm HOK was commissioned to develop the masterplan and the design of the campus further, after the death of the Australian architect in 1975. Figure 4.16 shows the precast construction of the campus which was completed in 1984, making it the world’s then-largest precast project (KSU 2017) and also the world's then-largest fixed-price contract costing 4 billion USDs (Khan 1992, 48).

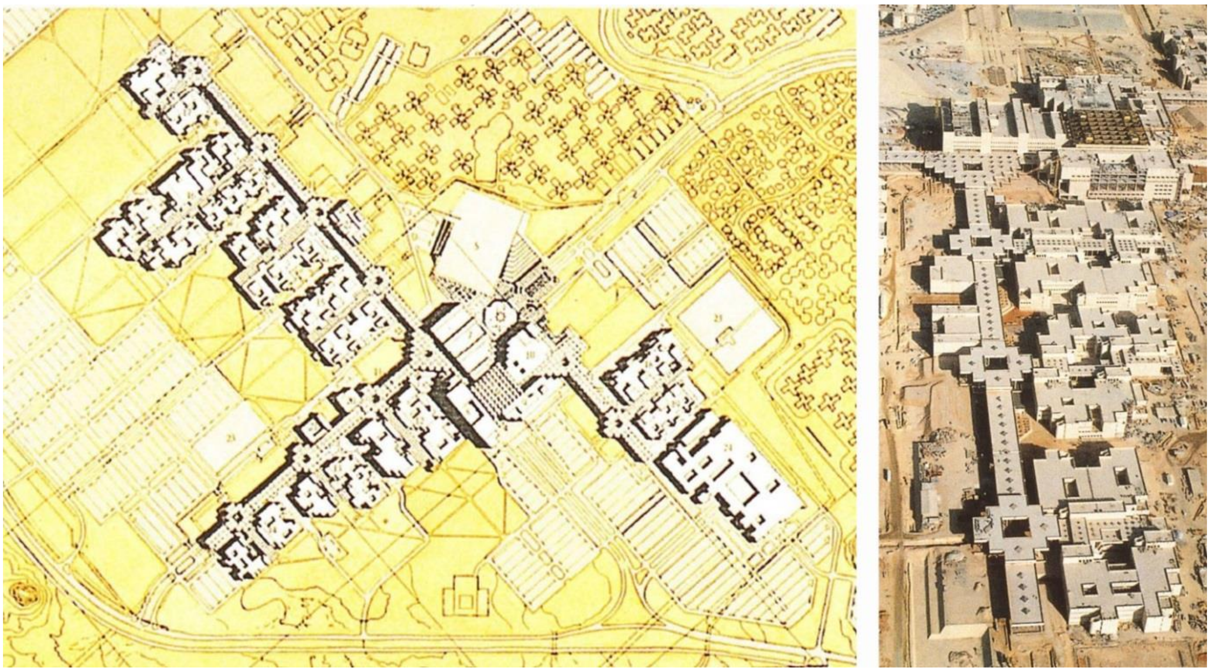


Figure 4.16: KSU male campus (Khan 1992, 50)

Table 4.8 presents some information about the type and size of the campus. The campus is categorised as urban, which means that it is located within the city boundaries. The campus is in the northwest part of the city. Although it was built as a self-contained community, the campus has the prospects of taking advantages of whatever the city can offer (e.g. facilities, utilities, and services). It occupies a district of nine square kilometres (2,223 Acres). The campus is home to 48 academic and administrative buildings. The university has one of the largest teaching hospitals in the region with a capacity of 1,200 beds. Statistics indicate that the campus population is about 118 thousands inhabitants, which means the density is around 0.02 people per km2.

Table 4.8: Facts and figures about the KSU campus

No	Category	Data
01	Campus type	Urban
02	Campus size (campus acreage)	9 Square kilometres (2,223 Acres)
03	Number of buildings	48 buildings (Academic and Administrative buildings only)
04	Campus population	117,730 people (KSU Masterplan 2009)
05	Total enrolment	59,505 students (Full-Time Equivalent) (2015)
06	Faculty members	7,612 members (regular full- and part-time members) (2015)
07	Employees	15,519 staff (regular full- and part-time employees) (2015)
08	Number of hospital beds	1,200 beds (Alriyadh 2017)

Figure 4.17 demonstrates the master plan of KSU campus. It shows the campus zones with each zone representing a distinctively different program or function. The plan illustrates that there are 11 zones in the campus as follows:

- **Zone one**: University Research Park.
- **Zone two**: This zone is home to the female college buildings and other supporting facilities such as female student centre, restaurants, and others.

- **Zone three**: University sport facilities (KSU main football stadium, other small football stadiums, basketball arenas, tennis courts, indoor sport halls and other recreational facilities).
- **Zone four**: Male residential buildings and other supporting facilities such as shops, restaurants, and place of worships.
- **Zone five**: Staff housing and its supporting facilities such as schools, restaurants, shops, place of worships, and others.
- **Zone six**: University teaching hospital and the medical colleges including Medicine, Dentistry, Pharmacy, Applied Medical Sciences, and Nursing.
- **Zone seven**: Central administration building and other supporting facilities such as the deanships building, main library, main auditorium, and main mosque.
- **Zone eight**: Colleges of arts and humanities. This includes colleges such as Arts, Tourism and Archelogy, Education, Business Administration, Law and Political Science, Languages and Translation, and the Arabic Language Institute.
- **Zone nine**: Scientific colleges including Engineering, Science, Architecture and Urban Planning, Computer and Information Science, Food and Agricultural Science, and Physical Education and Sports.
- **Zone tine**: University utilities and services.
- **Zone eleven**: University endowments. This zone is designated to the university endowments, which include a hotel, science park, shopping mall, and other investment functions and services planned to benefit the institution and the surrounding community.

The planning and design of the KSU campus have given attention to the region's climate through borrowing a number of traditional strategies. This is clear given the fact that a myriad of features of local architecture and planning can be notices. Khan (1992, 48) highlights this indicating that:

> *'Studies of older buildings in various cities of the region revealed several common characteristics. Buildings are compactly grouped to allow each building and the walkways in between to benefit from the shade of the neighbouring structures. Building materials are of a consistent warm beige tone and roofs are flat, often featuring a series of terraces. Windows are generally small to control the harsh sunlight. The overall design indicates attention to the interplay of light and shadow. The King Saud University is intended to be a contemporary expression of the massing and detailing of this indigenous architecture.'*

Analysts of the campus planning and design such as Mitchell (2015, 40) emphasises the emulation from the local architecture saying that:

> *'In terms of architectural expression, the architects relied on a precast concrete system that was adapted to incorporate visual references to traditional buildings in the Najd region.'*

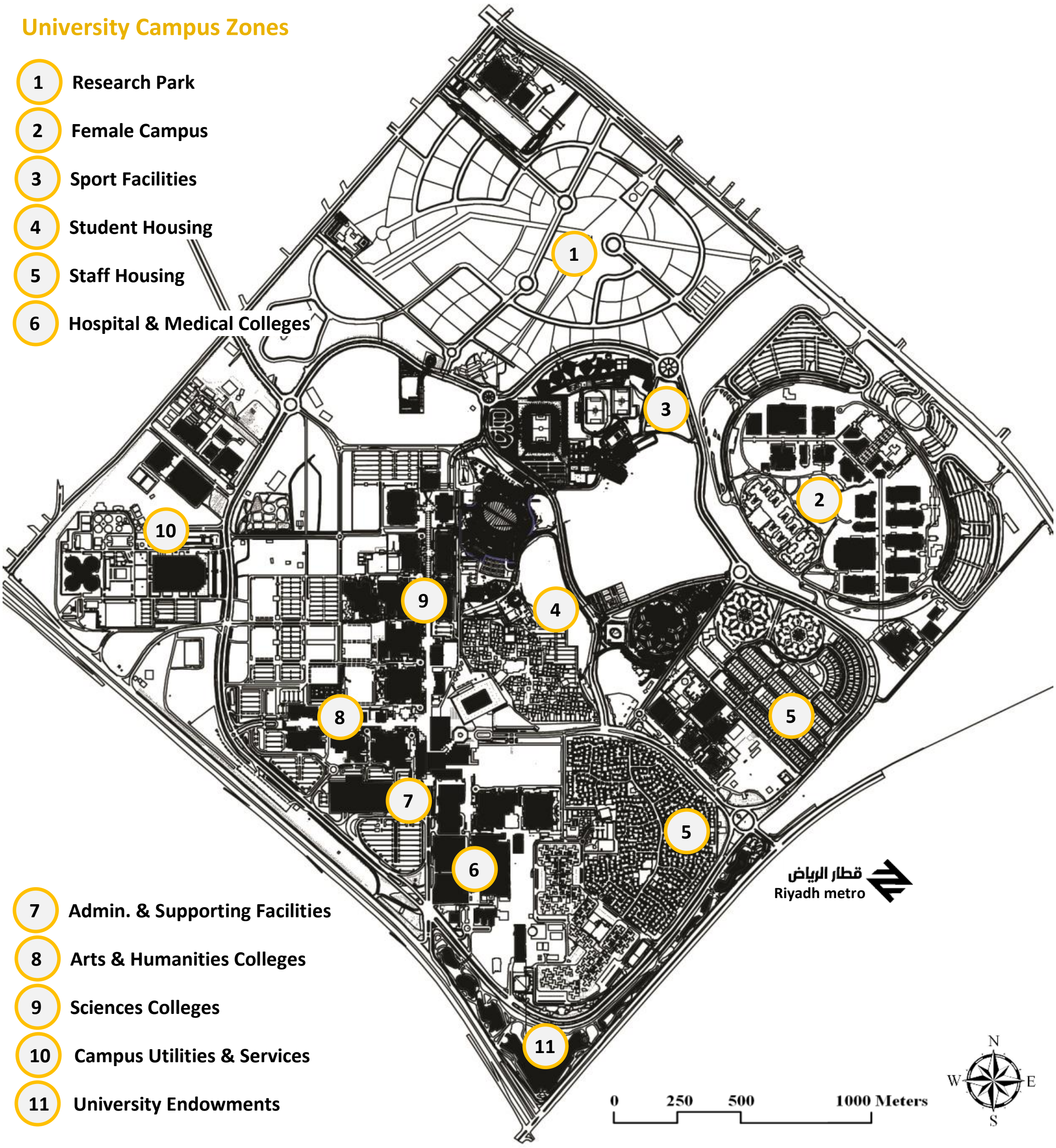


Figure 4.17: The Master Plan of KSU Campus (Adapted from KSU Project Management 2017)

The plan of the male campus shows a radiation design in which there are three pedestrian spines diverging out from the heart of the campus. The heart of the campus consists of a large air-conditioned foyer, seen in figure 4.18, surrounded from the four sides by the main administrative building (south), the main library (north), the main auditorium (east), and the deanships building (west). Three pedestrian spines, figure 4.19, depart from this open foyer to the college buildings as follows:

- **The northern spine**: Serves natural sciences colleges (Engineering, Science, Architecture and Urban Planning, Computer and Information Science...etc.)
- **The western spine**: Serves human sciences colleges (Arts, Tourism and Archelogy, Education, Business Administration, Law and Political Science...etc.)

- **The southern spine**: Serves health sciences colleges (Medicine, Dentistry, Pharmacy, Applied Medical Sciences, and the hospital). Under these three pedestrian spines, there is a network of tunnels for utilities and services such as electricity and communication cables, air-condition ducts, water and gas pipes...etc. The operating and maintaining of the whole campus facilities is undertaken through these smartly hidden tunnels.

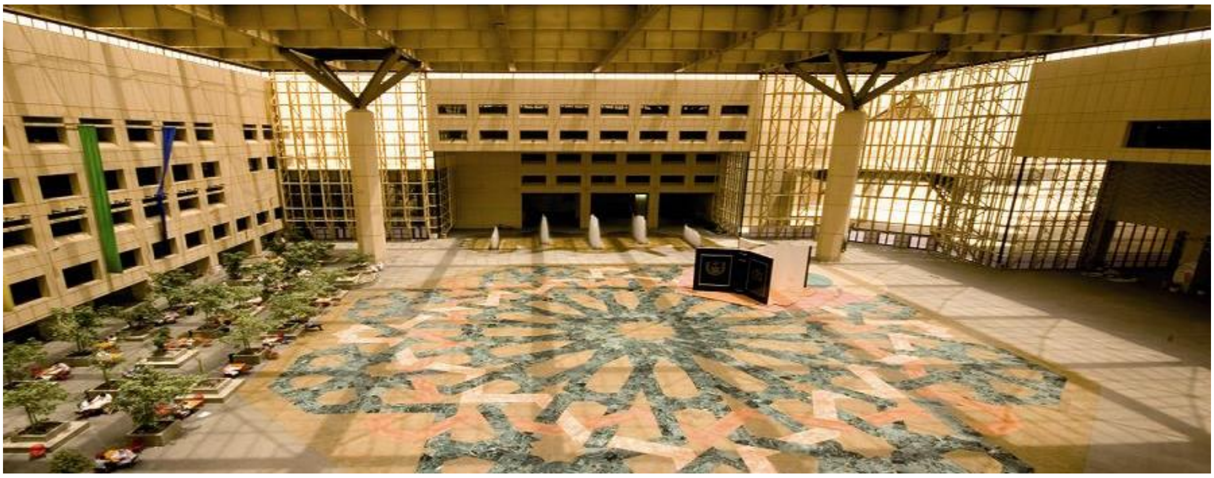


Figure 4.18: King Saud University main open atrium (KSU 2017)

Figure 4.19: King Saud University pedestrian spine

In the 2009 update of the campus masterplan, the space program was reviewed. Table 4.9 shows a summary of the space program which includes the male and female campuses. The data illustrates that in every zone of the campus, there is an increase of space square meters. The noticeable increase in the last decade was in zones such as the research park, endowment, female campus, and the medical. For example, a new campus was built for female students with a capacity of 30,000 students. Another example is the university endowments, with a value of 2.7 billion USDs (KSU 2017). Figure 4.20 shows some of the endowments that consist of facilities for office, commercial, and hospitality uses, some of which are still under construction while others are completed and in use.

Table 4.9: Space program of the male campus buildings (KSU Masterplan 2009, 66)

	Space program (Gross square meters)				
Campus Zone	**Existing 2008**	**Near-term 2013**	**Short-term 2018**	**Long-term 2028**	**New**
Academic Core	152,000	179,000	179,000	179,000	27,000
Preparatory College	16,000	0	21,000	21,000	5,000
Medical City	82,000	0	247,000	386,000	304,000
Sports City	17,000	0	39,000	62,000	45,000
Female Campus	0	0	483,000	531,000	531,000
Utilities	154,000	0	154,000	158,000	4,000
Research Park	0	0	915,000	1,830,000	1,830,000
Endowment	0	0	423,000	550,000	550,000
Campus Total	**421,000**	**179,000**	**2,461,000**	**3,717,000**	**3,296,000**

Figure 4.20: King Saud University Endowments (KSU 2017)

The university also invests massively in the housing facilities. For example, tables 4.10 shows a summary of the campus space program for residential buildings. The data illustrates that more on-campus housing will be available in the future particularly for medical staff, university faculty, students, and guest researchers and scholars.

Table 4.10: Space program of residential buildings in the male campus (KSU Masterplan 2009, 66)

	Space program (Gross square meters)				
Campus Zone	Existing 2008	Near-term 2013	Short-term 2018	Long-term 2028	New
Academic Core	0	0	0	220,000	220,000
Medical City	0	0	0	103,000	103,000
Student Housing	213,000	227,000	227,000	227,000	14,000
Faculty Housing	353,000	353,000	353,000	225,000	128,000
Endowment	0	0	5,115	5,115	5,115
Housing Expansion	12,000	228,000	228,000	439,000	427,000
Campus Total	**578,000**	**808,000**	**813,115**	**1,219,115**	**641,115**

4.2.5. Fifth case: Najran University (NU)

Background information

Established in 2006, Najran University (NU) is one of the recently founded public higher education institutions in the country. Before its independence, the university was a branch of King Khaled University, which is one of the well-established universities in the Kingdom. Table 4.11 presents some information about the university including numbers of colleges, departments, students, and staff. As a new university, the focus, to a large extent, is on teaching. The data shows that less than one percent is graduate-level students. Almost 60% of the enrolled students in 2015 were female. The student-to-faculty ratio is 11:1, which is below the international average of 16.5:1 in public universities (OECD 2017). Such low ratio is positively impacting the quality of education and research as well as students and staff satisfaction. The table also illustrates that the capacity of student housing (as of December 2017) is 480 beds. That is because there are six buildings with a capacity of 80 beds each.

Table 4.11: Facts and figures about Najran University (Ministry of Education 2015)

No	Category	Data
01	Number of academic colleges	14 Divisions/Faculties
02	Number of academic departments	70 Departments/Schools
03	Number of academic majors (subjects offered)	58 Majors/Subjects
04	Full-time equivalent enrolment	16,580 Students
05	Full-time equivalent of faculty members	1,576 Members
06	Full-time equivalent of employees	764 Employees
07	Total number of high diploma students	1,854 Students
08	Total number of undergraduate students	14,583 Students
09	Total number of graduate students	143 Students
10	Total number of male students	6,635 Students
11	Total number of female students	9,945 Students
12	Number of residential students (Main campus)	480 Students

Climate

The province of Najran has a desert climate, in general. It is hot in summer and mild to cold in winter. The average temperature in summer is about 37 °C and in winter 14 °C (GAMEP 2017). The average rain is around 133 mm (Climate Data 20).

University campus

Najran University (NU) has a number of campuses throughout the province of Najran. Figure 4.21 displays the geographical location of the main campus and satellite campuses. The main campus is located near the capital city of the province; the city of Najran. The campus is almost 50 kilometres away from the city centre of Najran. Other satellite campuses can be found in big towns such as Sharorah, Hubuna, and Yadamah.

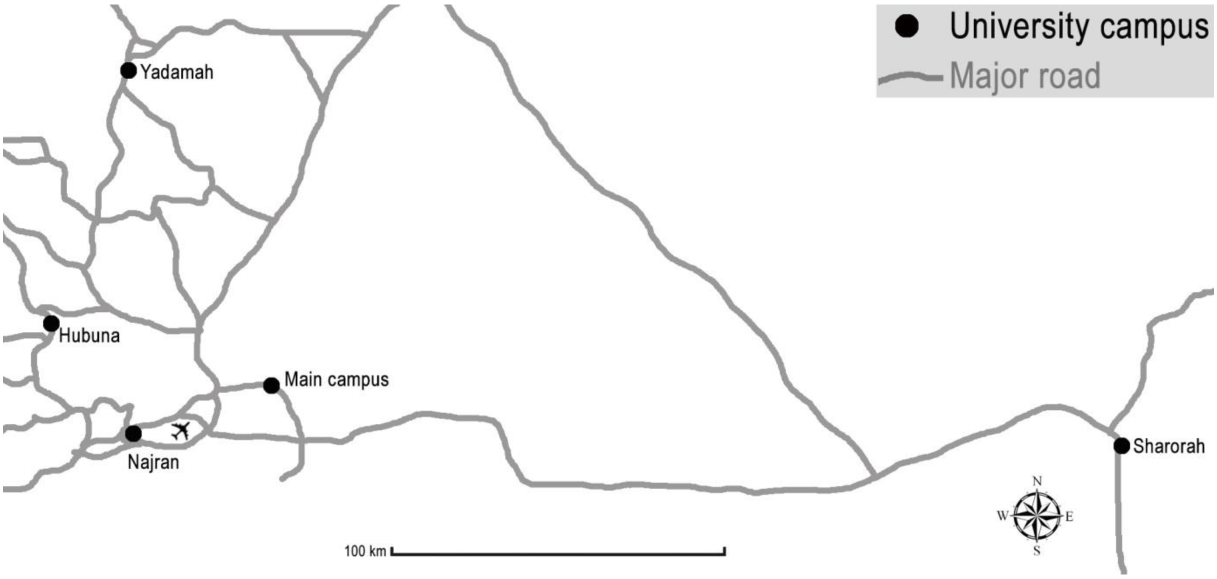


Figure 4.21: The main and satellite campuses of NU (Adapted from Google Maps 2017)

The main campus of the university is the subject of this investigation. Table 4.12 presents some facts and figures about the campus including the type and size of the campus, number of buildings, capacity, and population. It shows that the campus is suburban, given its remote location from the centre of Najran city. This means that the campus is at the far eastern border of the city and hence there are limited opportunities to share some existing facilities and functions with the city. For example, students and staff housing is needed to be built to accommodate a proportion of them and that includes all the supporting facilities such as schools, grocery, health care centre, day care...etc. The size of the campus is about 18 square kilometres (4,450 Acres), making it the largest public institution in the Kingdom. The campus is home to 30 college buildings (15 for each gender) and 10 administrative and supporting buildings. The estimated campus capacity is 75 thousand students, while the estimated campus population is over 180 thousand people. These figures point out that such a campus can be regarded as a city in its own right. The expected density might be around 0.02 people per km2.

Table 4.12: Facts and figures about the main campus of Najran University

No	Category	Data
01	Campus type	Suburban
02	Campus size (campus acreage)	18 square kilometres (4,450 Acres)
03	Number of buildings	40 buildings (Academic and Administrative buildings only)
04	Gross floor area of building space	Not available
05	Campus capacity (Future estimates)	75,000 students (Full-Time Equivalent)
06	Campus population (Future estimates)	186,000 people

Figure 4.22 shows the master plan of Najran campus. It shows the campus zones with each zone representing a distinctively different function. The plan illustrates that there are 11 zones in the campus as follows:

- **Zone one**: University endowments. This zone is designated to the university endowments, which include a hotel, shopping mall, and other investment functions and services planned to benefit the institution and the surrounding community.
- **Zone two**: This zone is home to the female college buildings and other supporting facilities such as female administrative building, student centre, library, restaurants...etc.
- **Zone three**: Female student housing.
- **Zone four**: Central administration building and other supporting facilities such as the deanships building, main library, main auditorium, and main mosque.
- **Zone five**: University teaching hospital and two of the medical colleges.
- **Zone six**: The university hotel and resort.
- **Zone seven**: This zone is home to the male college buildings and other supporting facilities such as male administrative building, student centre, library, restaurants...etc.
- **Zone eight**: Staff housing and its supporting facilities such as schools, restaurants, shops, place of worships, and others.
- **Zone nine**: University sport facilities (The main football stadium, other small football stadiums, basketball arenas, tennis courts, indoor sport halls and other recreational facilities).
- **Zone tine**: Male residential buildings and other supporting facilities such as shops, restaurants, and place of worships.
- **Zone eleven**: University utilities and services. This also includes the university storages.

The university campus was poorly planned. The two rings, one for male colleges and the other for female colleges, meant that college buildings will be positioned in a radiation pattern. Every three college buildings were grouped together, as seen in figure 4.23. Then each group was gradually changed in position as it rotates around the centre. However, this has created many large spaces in between and made walkability difficult given the combination of long distance and harsh climate. This indicates that the principles of compactness and closeness were not acted upon. Another issue with the design of the campus is the strict zoning and the link between them. For example, there is no connection between the housing of male students to their college buildings. There is a lack of a properly designed walkway to facilitate student's movement from and to their classrooms. The walking distance between student housing and the centre of the male campus is more than a kilometre, indicating that the no other option but to use the automobile.

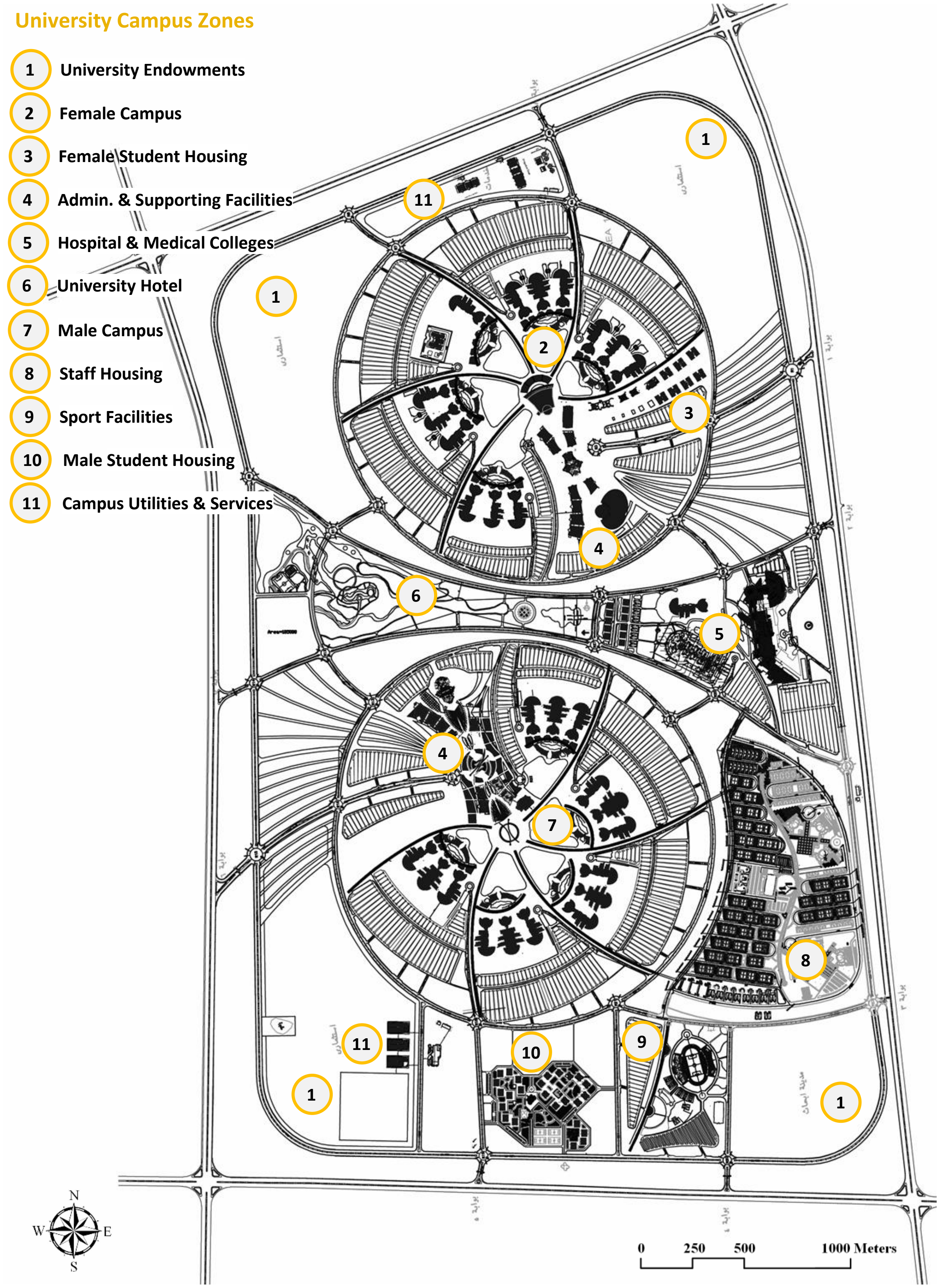


Figure 4.22: The Master Plan of Najran University (Adapted from Ministry of Education 2017)

Figure 4.23: One group of college buildings in Najran University

Although the campus of Najran University is the largest in Saudi Arabia, the university was the first to move its students from rented facilities to the newly built campus. This was possible given that the vast majority of the 20 recently established public universities use site-cast concrete for their building structure except Najran University. The latter used the pre-cast concrete system, seen in figure 4.24, even though there is no pre-cast concrete factory in the entire region of Najran. Instead, contractors have been transferring all the pre-casted concrete units from the capital Riyadh, which is 950 kilometres away from Najran. The 18-million-m2 campus is now the first campus to completely erect most of the campus facilities compared with the rest of the recently established universities in the kingdom.

Figure 4.24: The use of pre-cast concrete in Najran University

Figure 4.25 shows two distinctive buildings in Najran University campus. Both buildings are for administrative purpose and each has an auditorium with a capacity of 2,000 seats. In the top photo, a 14-story tower can be seen, which is the university’s main administration building located in the middle of the male campus. In contrast, the large building in the bottom photo with the logo of the institution on top of it presents the administrative building for female students. Both panoramic photos illustrate how vast the university campus is and what type of site the institution has to deal with. The desert's moving sand and the dust storms are two daunting challenges the university management team has to cope with on a regular basis.

Figure 4.25: The administration buildings in Najran University

4.2.6. Sixth case: Prince Sattam Bin Abdulaziz University (PSAU)

Background information

Prince Sattam Bin Abdualaziz University (PSAU) in the city of Al Kharj is one of the recently founded public higher education institutions in the Kingdom. Before its establishment in 2009, the university was a branch of King Saud University. Table 4.13 shows some facts and figures about the institution in terms of its colleges, departments, students, and staff. As a recently founded university, the focus is on teaching. This can be seen given that the vast majority of the enrolled students were undergraduate, which emphasises the focus of the university, for the time being. The 2015 enrolment data illustrated that the percentage of enrolled female students (58%) is higher than their male counterpart (42%). The student-to-faculty ratio was almost 19.5:1, which is slightly higher than the international average of 16.5:1 in public universities (OECD 2017). This higher ratio of student-to-faculty could result in compromising the quality of education and research, as well as cause a decrease in the satisfaction of both students and faculty members. Although there are no on-campus residential students yet, the capacity of student housing (as of December 2017) is 1,650 beds. That is because there are five dormitory buildings with a capacity of 330 beds each. Such capacity means that only 5% of the 30 thousand can be accommodated on-campus.

Climate

In general, Al Kharj's climate is hot in summer and cold and dry in winter (GAMEP 2017). The temperature in summer ranges between 31 °C and 48 °C, while in winter it ranges between 5 °C and 18 °C. Rainfall in general is low (GAMEP 2017).

Table 4.13: Facts and figures about the PSAU (Ministry of Education 2015)

No	Category	Data
01	Number of academic colleges	21 Divisions/Faculties
02	Number of academic departments	81 Departments/Schools
03	Number of academic majors (subjects offered)	97 Majors/Subjects
04	Full-time equivalent enrolment	30,646 Students
05	Full-time equivalent of faculty members	1,576 Members
06	Full-time equivalent of employees	764 Employees
07	Total number of high diploma students	1,113 Students
08	Total number of undergraduate students	29,445 Students
09	Total number of graduate students	88 Students
10	Total number of male students	12,816 Students
11	Total number of female students	17,830 Students
12	Number of residential students (Main campus)	1,650 Students

University campus

Prince Sattam Bin Abdualaziz University (PSAU) has a number of campuses throughout the province of Al Riyadh. PSAU has a main campus and other satellite campuses. Figure 4.26 shows the geographical location of the university campuses. The main campus was located in the western side of the city of Al Kharj. The university has branches located in other big towns such as Ad Dilam, Howtat Bani Tamim, Al Aflaj, As Sulayyil, and Wadi Addawasir. Most of these satellite campuses are for both genders. The distance between the main campus and the other campuses is a challenge for the university management team. The list below shows the distance between campuses along with a brief description about each campus:

- **Ad Dilam**: The distance between the main campus and Ad Dilam campus is about 30 kilometres. The campus is for female students and (as of 2017) one building has been completed and is now in use.
- **Howtat Bani Tamim**: The distance between the main campus and Howtat Bani Tamim campus is around 100 kilometres. The campus is for both genders and (as of 2017) one building for male and one for female students have been completed and are now in use.
- **Al Aflaj**: The distance between the main campus and Al Aflaj campus is approximately 235 kilometres. As of 2017, one building for male and one for female students have been completed and are now in use.
- **As Sulayyil**: The distance between the main campus and As Sulayyil campus is nearly 480 kilometres. As of 2017, one building for male and one for female students have been completed and are now in use.
- **Wadi Addawasir**: The distance between the main campus and Wadi Addawasir campus is almost 540 kilometres. As of 2017, one building for male and one for female students have been completed and are now in use.

The main campus of the university is the subject of this examination. Table 4.14 presents some facts and figures about the campus including the type and size of the campus, number of buildings, capacity, and population. The PSAU main campus is categorised as urban, which means that it is located within the city boundaries. It is 6 kilometres away from the city centre, which indicates that the university can benefit from sharing some facilities and services with the city of Al Kharj.

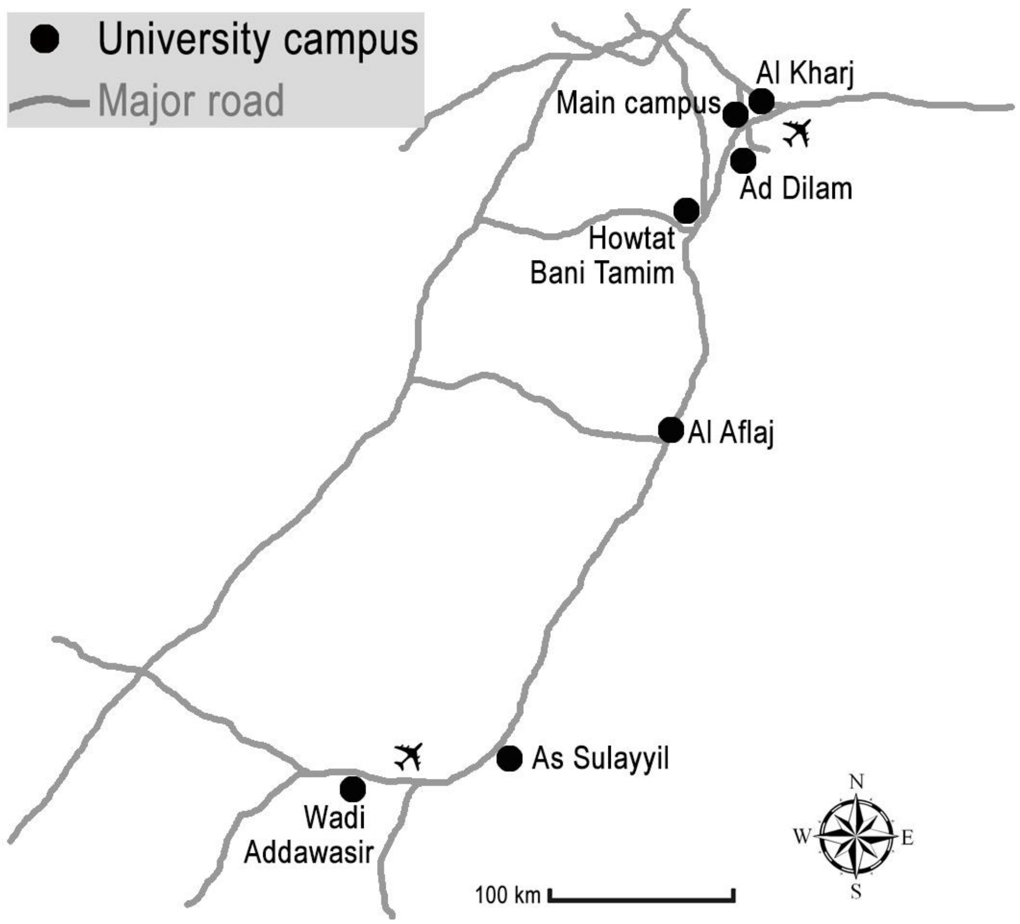


Figure 4.26: The main and other satellite campuses of PSAU (Adapted from Google Maps 2017)

The PSAU campus is only for male students and hence the size of it is 1.2 square kilometres (300 Acres), making it one of the smallest in the Kingdom. The table also shows that the campus is home to 13 buildings for academic, administrative, and supporting functions. The estimated campus capacity is 26 thousand students, while the estimated campus population is over 36 thousand people. Therefore, the expected density might be around 0.03 people per km2.

Table 4.14: Facts and figures about the main campus of PSAU

No	Category	Data
01	Campus type	Urban
02	Campus size (campus acreage)	1.2 square kilometres (300 Acres)
03	Number of buildings	13 buildings (Academic and Administrative buildings only)
04	Gross floor area of building space	Not available
05	Campus capacity (Future estimates)	26,000 students (Full-Time Equivalent)
06	Campus population (Future estimates)	36,000 people

Figure 4.28 shows the master plan of PSAU campus. It shows that there are six main zones as follows:

- **Zone one**: Central administration building and other supporting facilities such as the deanships building, main library, main auditorium, and main mosque.

- **Zone two**: This zone is home to six male only college buildings and other supporting facilities. In some buildings, two colleges are sharing the same building.
- **Zone three**: Staff housing.
- **Zone four**: University sport facilities (The main football stadium, basketball arenas, tennis courts, indoor sport halls and other recreational facilities).
- **Zone five**: Male residential buildings.
- **Zone six**: University utilities and services.

Other zones such as the female college buildings and the medical zone were sited in separate locations near the main campus. The female college buildings are located one kilometre away in the north of the main campus. The construction of female colleges was managed by the PSAU, but financed through a special program known as the Urgent College Buildings for Female Students, which are planned as national projects that have their own fixed budget.

With regards to the teaching hospital and its medical colleges, the university has a plot of land to develop them, as well as other female college buildings and other supporting facilities such as female administrative building, student centre, library, restaurants...etc. The location of the medical zone is in the south west of the city of Al Kharj and it is 10 kilometres away from the main campus. A few colleges are now under construction among them is the Medical College.

The campus was designed around a central north south axis, which has two pedestrian spines. These spines link the housing zones in the south of the campus to the colleges located on both sides of the axis. Figure 4.27 pictures a large tent in the centre of the campus which can be used for the different activities and the two pedestrian spines.

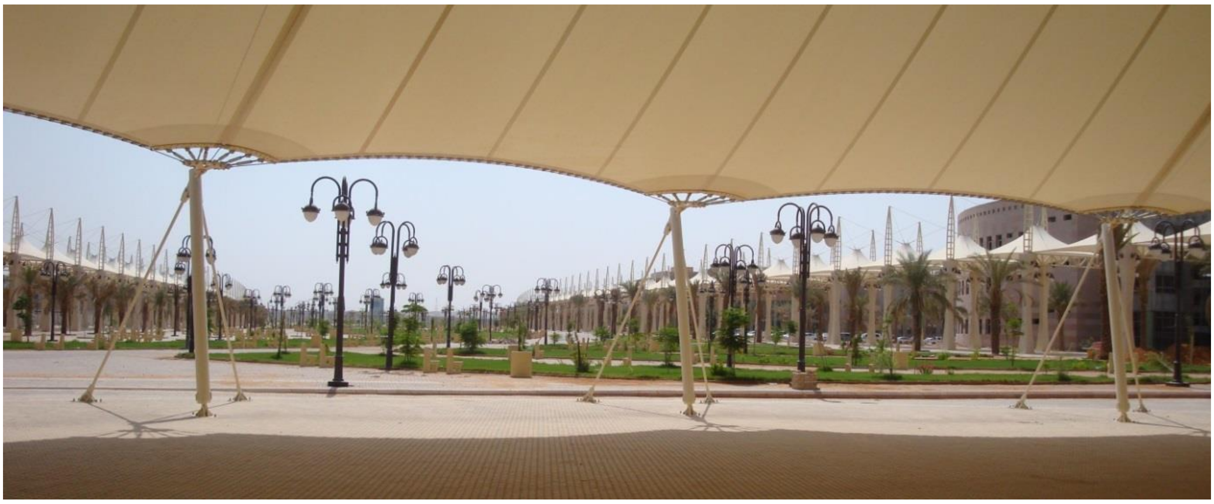


Figure 4.27: The PSAU campus centre

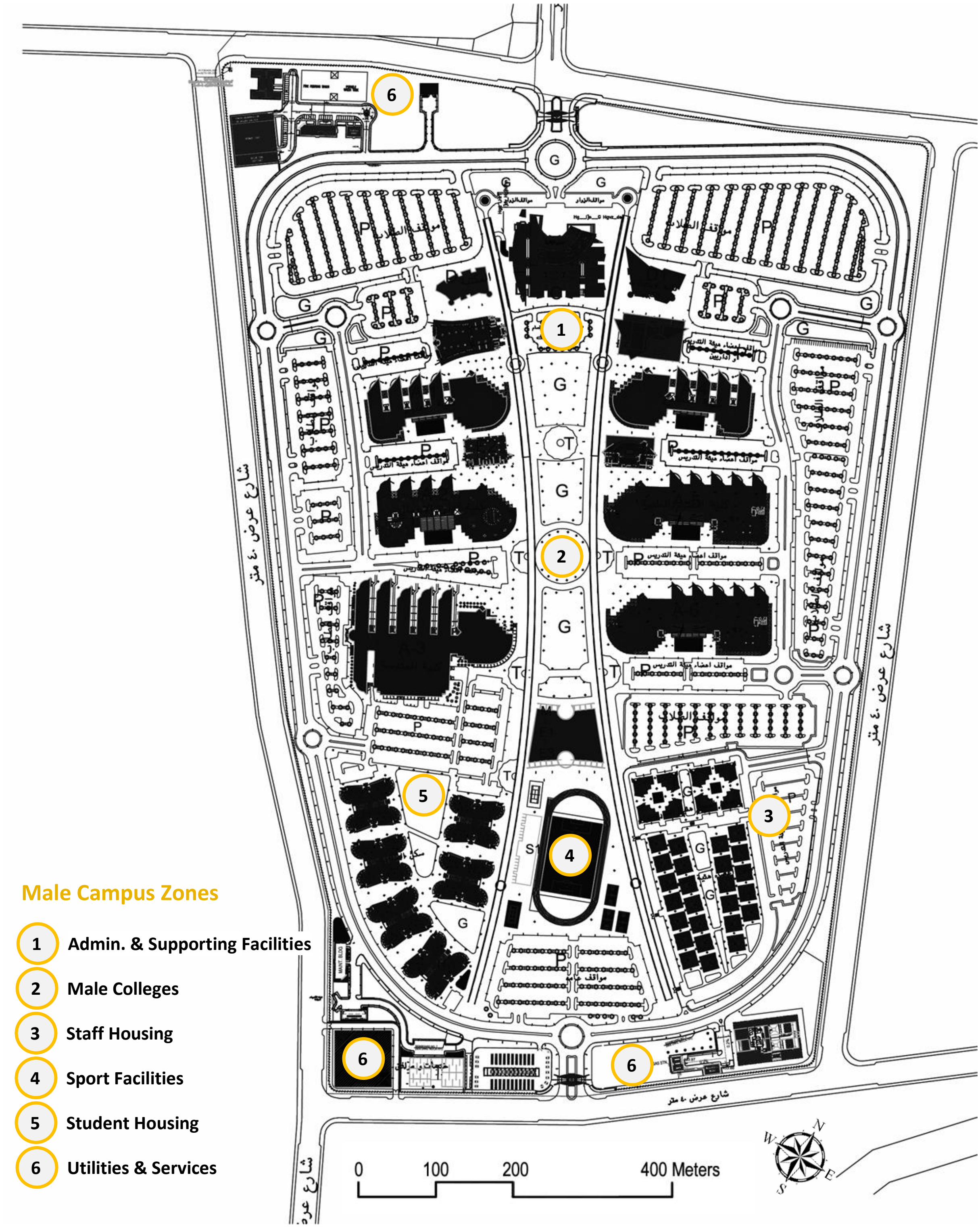


Figure 4.28: The male campus plan of PSAU (Adapted from Ministry of Education 2017)

4.2.7. Seventh case: University of Hafr Al Batin (UHB)

Background information

University of Hafr Al Batin (UHB) is one of the recently founded institutions established in 2014. The main campus was located in city of Hafr Al Batin in the Eastern Province of Saudi Arabia. Before it became an independent institution, the university colleges were branches of King Fahd University of Petroleum and Minerals and Imam Abdulrahman Bin Faisal

University. Table 4.15 displays some facts and figures about the institution including numbers of colleges, departments, students, and staff. As a very new university, there are no graduate programs yet. The total enrolment was over 15 thousand students; of whom 89% were female. The student-to-faculty ratio is 26:1, which is almost double that of the international average of 16.5:1 in public universities (OECD 2017). This could significantly impact the quality of education and research as well as the satisfaction of students and staff. Given that the university is newly established, most of its campus facilities including student housing buildings have not been built yet. However, some buildings in the staff housing, seen in figure 4.29, have been completed. It consists of 38 buildings: 13 of them were designated for high ranking university staff, while the other 25 buildings were designated for faculty members. The 13 buildings are 5 levels each and each floor is about 500 m2 apartment. On the other hand, the 25 buildings are also 5 levels each and each floor is divided into two apartments with 250 m2 each. The total capacity of the staff housing, as of 2017, is 315 families.

Table 4.15: Facts and figures about UHB (Ministry of Education 2015)

No	Category	Data
01	Number of academic colleges	10 Divisions/Faculties
02	Number of academic departments	46 Departments/Schools
03	Number of academic majors (subjects offered)	45 Majors/Subjects
04	Full-time equivalent enrolment	15,402 Students
05	Full-time equivalent of faculty members	584 Members
06	Full-time equivalent of employees	426 Employees
07	Total number of high diploma students	91 Students
08	Total number of undergraduate students	15,311 Students
09	Total number of graduate students	0 Students
10	Total number of male students	1,755 Students
11	Total number of female students	13,647 Students
12	Number of residential students (Main campus)	0 Students

Climate

The climate in the city of Hafr Al Batin is hot and dry in summer with an average temperature of 36 °C. In winter, however, it is extremely cold with an average temperature of 10 °C except in December and January where it can drop below 5 °C (Climate Data 2017). As for the rainfall, the average is 3.0 mm annually.

University campus

University of Hafr Al Batin (UHB) has a number of campuses throughout the northern part of the Eastern Province. It has a main campus and other satellite campuses for male and female students. The main campus was located 22 kilometres in the south of the city of Hafr Al Batin. Figure 4.30 presents the geographical location of University of Hafr Al Batin's main campus and its satellite campuses. The university has branches located in the province's biggest towns including Hafr Al Batin, Qaryat Al Ulya, Nairyah, and Khafji. Most of these satellite campuses are for female students and some are for both genders.

Figure 4.29: Staff housing in the University of Hafr Al Batin

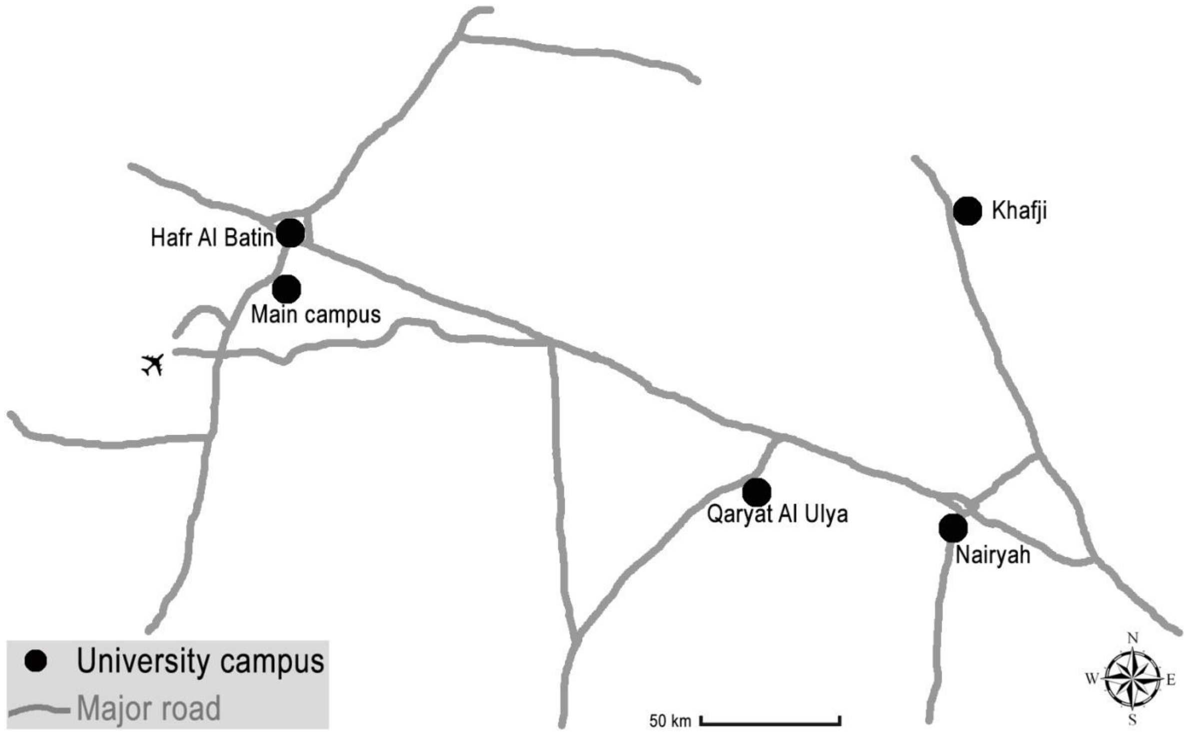


Figure 4.30: The main and other satellite campuses of UHB (Adapted from Google Maps 2017)

The main campus of the university is the subject of this examination. Table 4.16 illustrates some facts and figures about the campus including its type, size, number of buildings, capacity, and population. It shows that the campus is rural, given its remote location from the centre of Hafr Al Batin. The size of the campus is about 8 square kilometres (1,980 Acres), which is the average size of campuses for public universities in Saudi Arabia. The campus is home to almost 40 buildings, most of which are for colleges for both genders. The estimated campus capacity is 60 thousand students, while the estimated campus population is almost 120 thousand people. These figures point out that such campus can be regarded as a city, with an expected density of approximately 0.01 people per km2.

Table 4.16: Facts and figures about the main campus of UHB

No	Category	Data
01	Campus type	Rural
02	Campus size (campus acreage)	8 square kilometres (1,980 Acres)
03	Number of buildings	39 buildings (Academic and Administrative buildings only)
04	Gross floor area of building space	Not available
05	Campus capacity (Future estimates)	60,000 students (Full-Time Equivalent)
06	Campus population (Future estimates)	118,500 people

Figure 4.31 presents the master plan of Hafr Al Batin campus. It shows the campus zones with each zone representing a distinctively different function. The plan illustrates that there are 11 zones in the campus as follows:

- **Zone one**: University endowments. This zone is designated to the university endowments, which include a hotel, shopping mall, and other investment functions and services planned to benefit the institution and the surrounding community.
- **Zone two**: Central administration building and other supporting facilities such as the deanships building, main library, main auditorium, and main mosque.
- **Zone three**: This zone is home to the female college buildings and other supporting facilities such as female administrative building, student centre, library, restaurants...etc.
- **Zone four**: Female student housing.
- **Zone five**: University teaching hospital and two of the medical colleges.
- **Zone six**: This zone is home to the male college buildings and other supporting facilities such as male administrative building, student centre, library, restaurants...etc.
- **Zone seven**: Central administration building and other supporting facilities such as the deanships building, main library, main auditorium, and main mosque.
- **Zone eight**: University sport facilities (The main football stadium, other small football stadiums, basketball arenas, tennis courts, indoor sport halls and other recreational facilities).
- **Zone nine**: Male residential buildings and other supporting facilities such as shops, restaurants, and place of worships.
- **Zone tine**: University utilities and services. This also includes the university storages.
- **Zone eleven**: Staff housing and its supporting facilities such as schools, restaurants, shops, place of worships, and others.

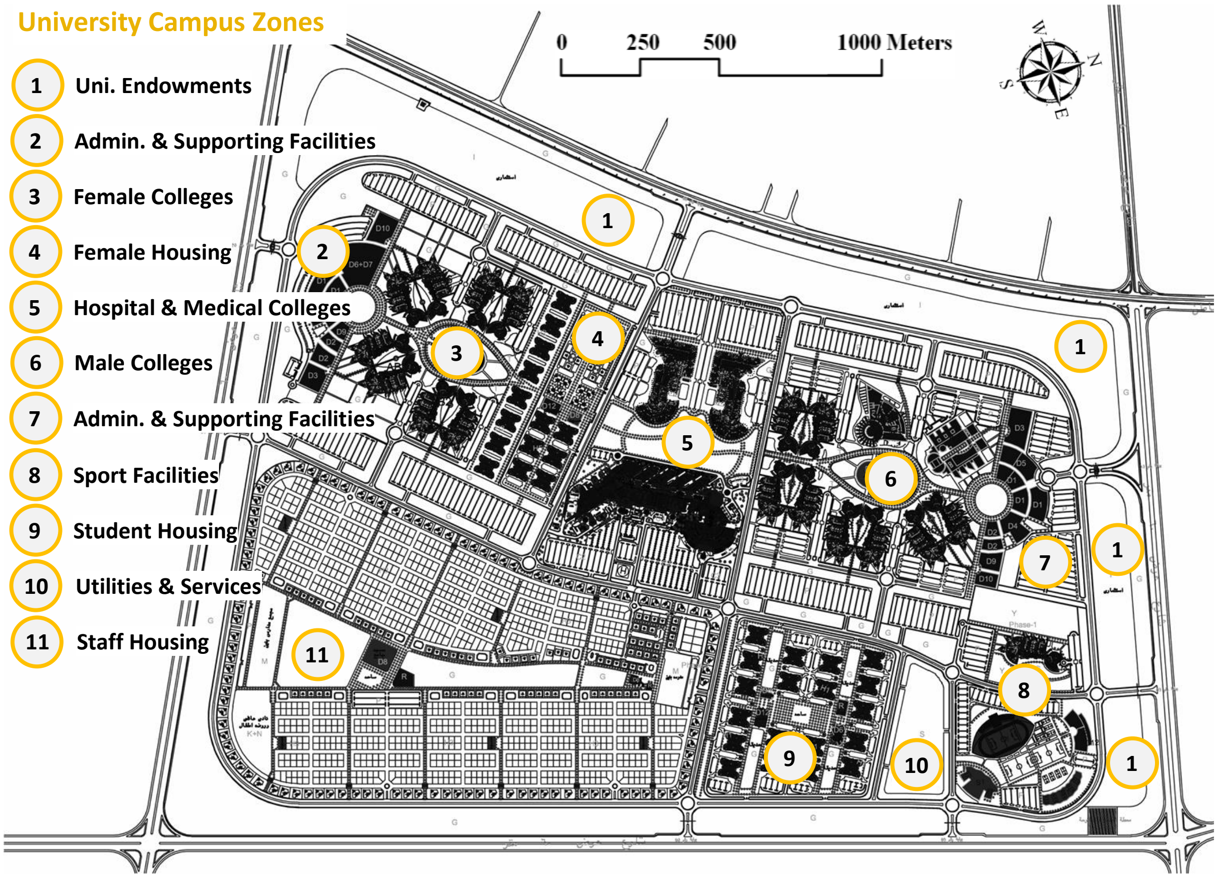


Figure 4.31: Campus master plan of the UHB (Adapted from Ministry of Education 2017)

In terms of the planning of the campus, it can be seen that the same principle of designing most of the recently established university campuses was applied. That is, two zones for college buildings (one for male students and the other for female students) and in between is the medical zone (the teaching hospital and the medical colleges). The university endowment zones were bordering the university from all directions with bigger sized plots in the north and west, given that the highway on the west of the campus is the key artery linking Hafr Al Batin with the capital Riyadh.

The campus has 20 college buildings. Of those 20, only one building is completed and in use (as of 2017). This building is the Community College, seen in figure 4.32. It is home to most of the university male colleges and departments including Colleges of Science, Engineering, Computer Science, Administration Science, and Community College. This building also houses the university administration such as the Vice Rector, Vice Rector for Research and Graduate Studies, and other management departments such as Human Resources, Registration, IT, Procurement, Operation and Maintenance, and Administrative Communications. More details on this building are presented in the following section. However, another college building is under construction in the female zone of the campus and it is expected to be completed in the near future.

Figure 4.32: Community College in the UHB

4.2.8. Eighth case: University of Hail (UH)

Background information

University of Hail (UH) is one of the recently founded public higher education institutions in the country, established in 2005 in the city of Hail. Initially, the university's Community College was the first to be founded in the region of Hail. The college was under the auspice of King Fahd University of Petroleum and Minerals, which is a well-established institution. Table 4.17 shows some facts and figures about the institution in terms of its colleges, departments, students, and staff. Similar to other recently founded universities in the Kingdom, the focus is on teaching. This can be noticed since the vast majority of the enrolled students were undergraduate (97%), which emphasises the focus of the university, for the time being. The 2015 enrolment statistics illustrated that the percentage of enrolled female students (64%) is higher than their male counterpart (36%). The student-to-faculty ratio was almost 18:1, which is very close to the international average of 16.5:1 in public universities (OECD 2017). Although there are no on-campus residential students yet, the capacity of student housing (as of December 2017) is 660 beds, given that there are two dormitory buildings with a capacity of 330 beds each. Such capacity means that almost 2% of the 35 thousand can be accommodated on-campus.

Climate

The province of Hail has a desert climate, in general. It is hot in summers and cold in winters. The average temperature in summer is about 30 °C and in winter 11 °C (GAMEP 2017). The average rain is around 122 mm (Climate Data 20).

University campus

University of Hail (UH) has a number of campuses throughout the province of Hail. Figure 4.33 illustrates the geographical location of the main campus and the university satellite campuses. The main campus is located near the capital city of the province; the city of Hail. The campus is around 20 kilometres away from the city centre of Hail. Other satellite campuses can be found in big towns such as Baqaa, Ash Shinan, Al Ghazalah, Sumaira'a, Ash Shamli, and Al Hait.

Table 4.17: Facts and figures about University of Hail (Ministry of Education 2015)

No	Category	Data
01	Number of academic colleges	20 Divisions/Faculties
02	Number of academic departments	99 Departments/Schools
03	Number of academic majors (subjects offered)	69 Majors/Subjects
04	Full-time equivalent enrolment	35,611 Students
05	Full-time equivalent of faculty members	1,935 Members
06	Full-time equivalent of employees	1,065 Employees
07	Total number of high diploma students	729 Students
08	Total number of undergraduate students	34,577 Students
09	Total number of graduate students	305 Students
10	Total number of male students	12,759 Students
11	Total number of female students	22,852 Students
12	Number of residential students	1,140 Students

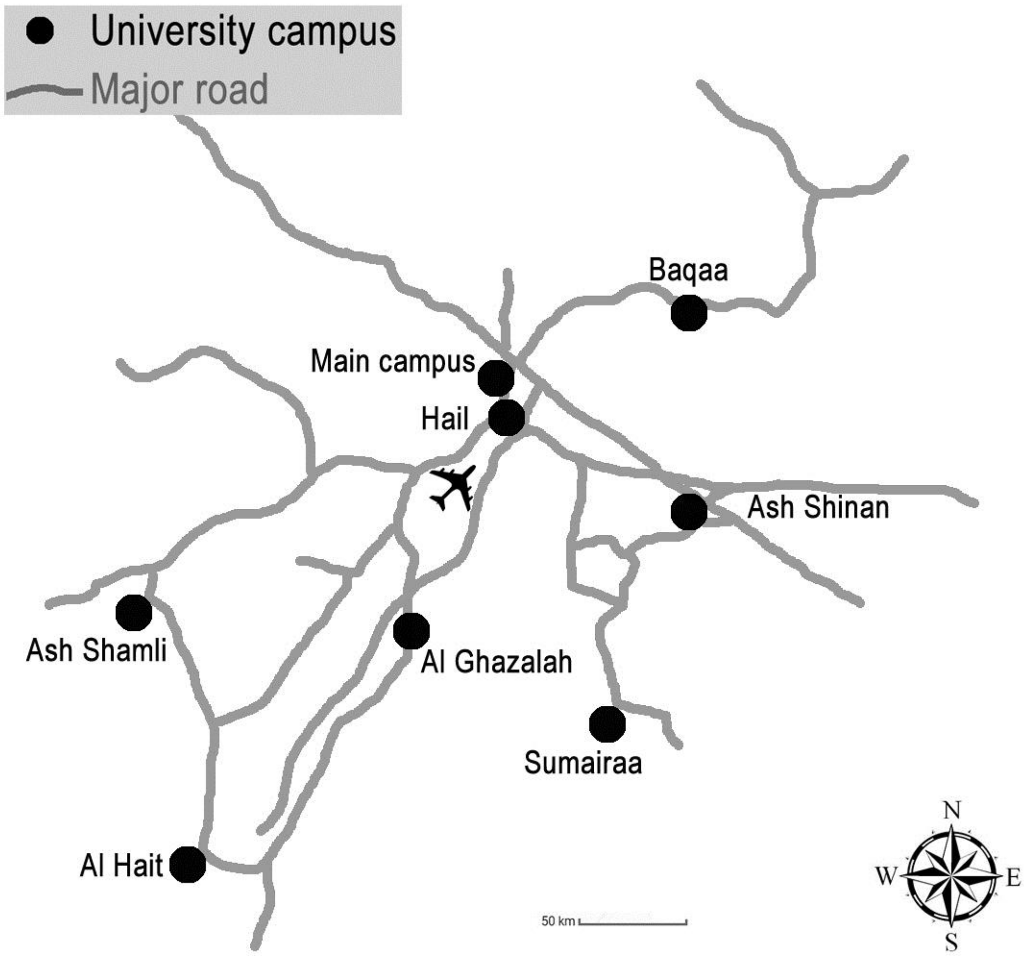


Figure 4.33: The main and other satellite campuses of UH (Adapted from Google Maps 2017)

The main campus of the university is the subject of this research. Table 4.18 shows some facts and figures about the campus including the type and size of the campus, number of buildings, capacity, and population. It highlights that the campus is suburban, given its remote location from the centre of Hail. This indicates limited opportunities to share some existing facilities and functions with the city. That includes supporting facilities such as housing, schools, grocery, health care centre, day care...etc. It is also a challenge to connect the campus with the city infrastructure such as water, electricity, gas, telecommunications, and so on. The size of the campus is over 11 square kilometres (2,270 Acres), which can be considered as one of the largest campuses in the Kingdom. The campus is home to over 24 college buildings (14 for male and 10 for female). The estimated campus capacity is 54 thousand students, while the estimated campus population is over 90 thousand people. Therefore, the expected density might be around 0.01 people per km2.

Table 4.18: Facts and figures about the main campus of UH

No	Category	Data
01	Campus type	Suburban
02	Campus size (campus acreage)	11.2 square kilometres (2,270 Acres)
03	Number of buildings	32 buildings (Academic and Administrative buildings only)
04	Gross floor area of building space	Not available
05	Campus capacity (Future estimates)	54,000 students (Full-Time Equivalent)
06	Campus population (Future estimates)	90,000 people

Figure 4.34 presents the master plan of Hail campus. It shows the campus zones with each zone representing a distinctively different function. The plan illustrates that there are 13 zones in the campus as follows:

- **Zone one**: University endowments. This zone is designated to the university endowments, which include a hotel, shopping mall, and other investment functions and services planned to benefit the institution and the surrounding community.
- **Zone two**: The research park, which is a business district of the university.
- **Zone three**: University utilities and services. This also includes the university storages.
- **Zone four**: Staff housing and its supporting facilities such as schools, restaurants, shops, place of worships, and others.
- **Zone five**: This zone is home to the female college buildings and other supporting facilities such as female administrative building, student centre, library, restaurants...etc.
- **Zone six**: Central administration building and other supporting facilities such as the deanships building, main library, main auditorium, and main mosque.
- **Zone seven**: Recreational facilities
- **Zone eight**: University teaching hospital and medical staff housing.
- **Zone nine**: Male residential buildings and other supporting facilities such as shops, restaurants, and place of worships.
- **Zone ten**: This zone is home to the male college buildings and other supporting facilities such as male administrative building, student centre, library, restaurants...etc.
- **Zone eleven**: University sport facilities (The main football stadium, other small football stadiums, basketball arenas, tennis courts, and indoor sport halls).
- **Zone twelve**: Shopping mall.
- **Zone thirteen**: The university hotel.

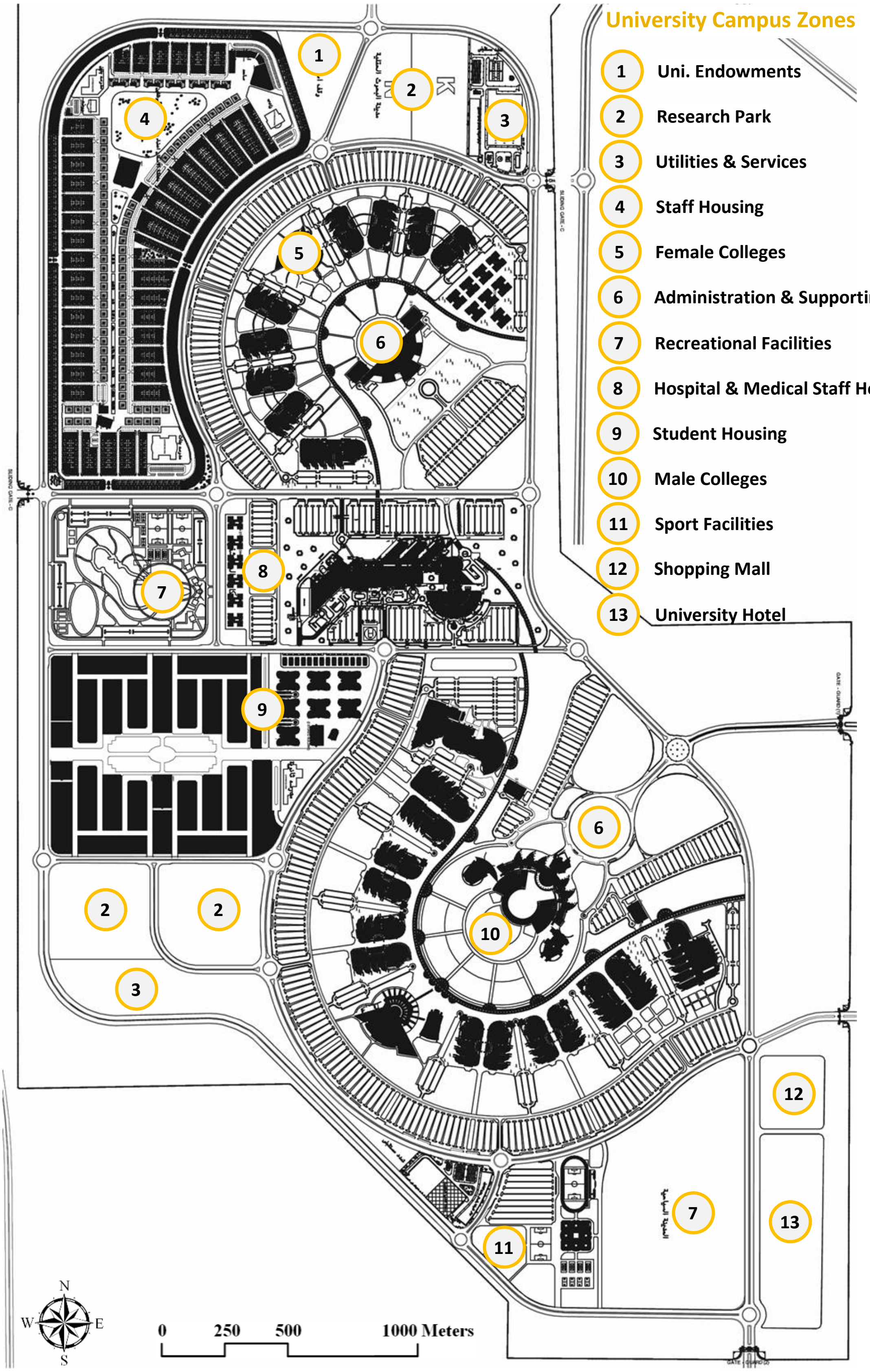


Figure 4.34: Campus master plan of the UH (Adapted from Ministry of Education 2017)

The design of the campus does not differ much from other campuses of recently established universities in the country. The same principle of planning can be clearly seen. That is two zones for college buildings (one for male students and the other for female students) and in between is the medical zone (the teaching hospital and the medical staff housing). Housing zones (staff and students) were located near the zones of colleges for easy access. However, the university zones are explicitly divided by the street network, which acts as defining boarders. The linearity of arranging the college buildings in both the female and male zones does not permit easy access, given the long distance between colleges. This does not only negatively impact connectivity between the university academic departments, but also does not help in addressing climate challenges. Comparing University of Hail's endowments with its counterpart in the Kingdom, it can be said that the university is in a better position. This is because the university has already finished constructing the hotel and the shopping mall, seen in figure 4.35. The hotel is now operated by a well-known international company Millennium Hotels, which operates over 120 hotels worldwide.

Figure 4.35: University of Hail's Hotel and Shopping Mall

The campus has 24 college buildings, 14 for male and 10 for female. On one hand, only three buildings were completed and in use (as of 2017) in the male students' zone. There are four other college buildings under construction. Figure 4.36 shows the main issue with constructing college buildings; no clear justification for the prioritisation in building colleges. College buildings can be seen at the beginning and the end of the big arch of car parking and some are in-between. The gap between buildings has created a number of issues. First is the physical accessibility problem in which students as well as staff need to use their own cars to move between colleges. Second is the stretch of infrastructure (water and gas pipes, electricity and telecommunication cables...etc.). Third is the principle of closeness and compactness in order to meet the challenge of desert climate. It seems that there was no clear plan for growth and expansion. If, during the first phase of building, these colleges been built closer to each other starting from one end of the arch, things would have been better in many ways economically, environmentally, academically, and brought about a greater degree of satisfaction of campus users (students, faculty, staff, and visitors).

On the other hand, the female students' zone has not been constructed compared to that of male. The main reason is believed to be the utilisation of existing facilities within the city of Hail. The university decided to invest more in the female complex in Baqaa Road instead of building new colleges for female students in the main campus, which is 20 kilometres away from the city centre of Hail. The female complex is less than 10 kilometres away from the city centre of Hail. It is now home to over 18 thousand female students, which is 82% of the total number of female students in the University of Hail (as of 2017). Another reason for not building female colleges in the main campus could be because of the long distance between the main campus and the city of Hail.

Figure 4.36: University of Hail's Male Zone (Google Maps 2017)

4.3 The selected case studies: College buildings (Micro level)

Having briefly reviewed the eight selected campuses (macro level), this section addresses the micro level; the college buildings. The purpose of this section is to briefly describe some of the characteristics of college buildings in Saudi Arabia including floor plans, architectural, structural, and mechanical elements, space program and estimated capacity. The four analysed samples of college buildings are as follows:

- First: Community College, University of Hafr Al Batin, Hafr Al Batin, East of the country
- Second: College of Engineering, Najran University, Najran, South

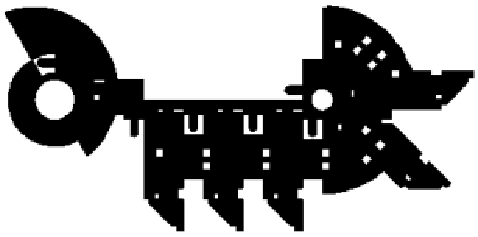
- Third: College of Languages and Translations, King Saud University, Riyadh, Centre
- Fourth: College of Science, University of Hail, Hail, North.

Of these four colleges, three colleges are from the 20 recently founded universities, while only one (College of Languages and Translations) is from a well-established university (King Saud University). The three college buildings (Community, Engineering, and Science) are prototypes that can be found in many campuses in different universities around the country.

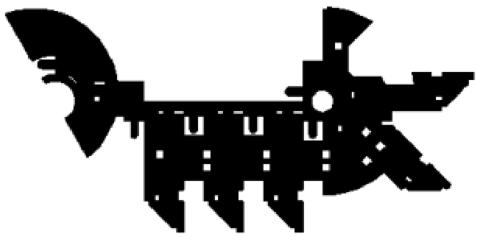
4.3.1. First sample: Community College building

Overall building description

This building is the Community College at the University of Hafr Al Batin, City of Hafr Al Batin, Eastern Province. It is a prototype that has been used in a number of new university campuses around the country such as Northern Borders University and University of Tabuk. This standardised college is a 3-story building with a total gross area of 31,220 square meters. The uniform design building was designed by a local firm Alnaim and his alliances (Farhat Urban Consultants and MBS Engineering Consultants). It was officially opened in 2012. The planned seating capacity of this college building is for 3,073 full-time equivalent students, excluding the seating capacity of laboratories and workshop halls. For the academics and supporting staff, there are 357 offices with a small proportion of offices that can accommodate more than one person. The layout of the building has three distinct zones with a couple of wings as demonstrated in the next diagrams. For the horizontal circulation, there is a hallway that links the main entrances of the building. Vertically, the building has 12 equally distributed staircases and six elevators in different sizes. The building has a number of courtyards placed in different parts to naturally light and ventilate internal spaces. For the accessibility, there are two main entrances, nine sided entrances, 21 emergency exits and one door for services. All entrances can be accessed by handicapped people through accessible ramps.



Second Floor



First Floor

Ground Floor (Ministry of Education 2017)

Floor plans

On the ground floor, the foyer with its centred fountain, the main circulation hallway, a small-sized and large-sized auditoriums (110 and 336 seats respectively), Student Affairs Administration, Admission and Registration Department, offices for academic staff, and cafeteria are all located. A large proportion of the ground floor has been designated to the 28 laboratories, workshops, and other supporting facilities which have been located in the five wings. The total gross area of this floor is 11,050 square meters. There are only 1,006 seats planned for students in this floor and 38 offices for academic and supporting staff with a small proportion of offices that can accommodate more than one person. On the first floor, a large part of it has been assigned to classrooms and other supporting facilities. The planned seating capacity for students is 2,402 seats with capacity ranging between 20 to 45 seats. The rest of the floor is designated to 50 offices for academic and supporting staff with a small proportion of offices accommodating more than one person. Other facilities and services such as printing rooms, archives, small cafeteria, staff lounges with mail boxes, cleaning rooms are located in different parts of the floor. The total gross floor area is 9,330 square meters. On the second floor, there are the library and reading halls, the Dean office, offices for the Vice Dean for Academic Affairs, Vice Dean for Administrative Affairs, and Vice Dean for Development and Quality, and prayer's hall. Additionally, there are some classrooms with a planned capacity of 225 seats for students as well as 170 offices for staff with a small proportion of offices accommodating more than one person. The total gross floor area is 8,400 square meters.

Architectural, structural, and mechanical elements

In the construction of this college, reinforced concrete has been used in all the elements of the building structure. The college envelope has been built with a traditional method using walls of hollow concrete bricks. For the external skin, polished and rough granite stones were chosen for cladding. There are also decorative walls, which have been constructed about 4.5 meters away from the external walls. These decorative walls are coloured with slightly darker brown paints. However, it is noted that in other college buildings, such decorative walls have not been used. A decision has been made to eliminate such walls for two reasons. First, it was proven that it has very little effect on the thermal performance of the building (Abanomi 2014). Second, the cost of constructing such walls is high. The materials used for the interior dividers are either walls of concrete block (sized between 10 to 20 centimetres, usually used between labs and workshops or classrooms), or partitions of aluminium with glass or gypsum (sized 10 centimetres with 8 centimetres glass, usually used for offices). As for the mechanical systems, including heating, ventilation, and air conditioning (HVAC), the water cooled chillers system is used with air handling units and fans for air supply and return throughout the whole building.

Community College, UHB

Space program and capacity

Table 4.19 presents some figures about the types of space and their planned capacity. The college building total gross floor area (GFA) is 28,780 square meters. The planned seating capacity of the building for students is 3,633 seats, whereas the planned capacity for faculty and staff members is more than 384 seats. The performance indicator for space management is about 8 m2 per student.

Table 4.19: Space program of Community College building, University of Hafr Al Batin

Floor	Space type	Quantity	Capacity (No. of seats in classrooms & in staff offices)
Ground 11,050 m2	Auditoriums	02	446
	Staff offices	38	48 (some offices have the capacity of 2 people)
	Labs/workshops/studios	28	560 (on average, 20 seats per lab)
	Meeting rooms	01	(between medium and Large sizes)
	Archives	10	
	Washroom	08	32 Toilets
First 9,330 m2	Classrooms	72	2,402
	Staff offices	50	82 (some offices have the capacity of 2 people)
	Meeting rooms	04	
	Archives	02	
	Washroom	07	29 Toilets
Second 8,400 m2	Classrooms	02	225
	Staff offices	170	254 (some offices have the capacity of 2 people)
	Meeting rooms	11	(between medium and Large sizes)
	Archives	02	
	Washroom	15	39 Toilets

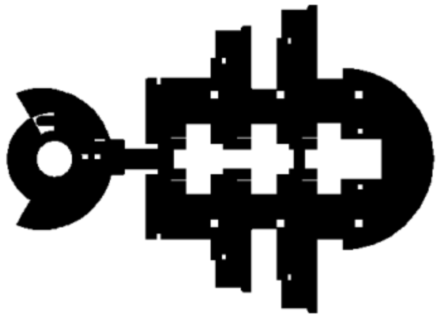
4.3.2. Second sample: College of Engineering building

Overall building description

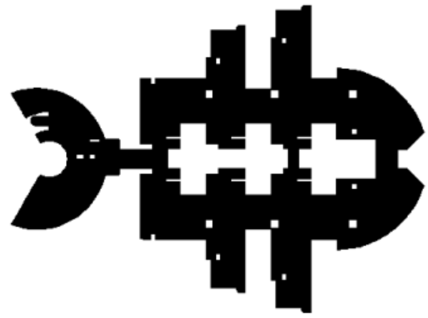
This college has been built in Najran University. The College of Engineering is a 3-story building with a basement designed by Takwenat Consulting Engineers (TCE). The total gross area of this fish-like building is 41,231 square meters. The building was officially opened in 2013. The planned seating capacity of this college building is 3,923 Full-time Equivalent (FTE) students. For the academics and supporting staff, there are 483 offices with a small proportion of offices accommodates more than one person. The layout of the building has been made up of almost similar parts facing each other around an axis. The axis in this case is the main circulation hallway which is about 180 meters long; open to 3-level high acting like a pedestrian thoroughfare. The latter does not exist on the first and second floors; instead there are series of corridors linking the three distinct parts of the building. For the vertical circulation, the building has 19 equally distributed staircases and 6 elevators with different sizes and functions. The building has a number of courtyards placed in different parts to naturally light and ventilate spaces surrounding, as presented in the plan. For the accessibility, there are 2 main entrances, 4 sided entrances, 10 emergency exits and 2 doors for services. All entrances can be accessed by handicapped people through accessible ramps.

Floor plans

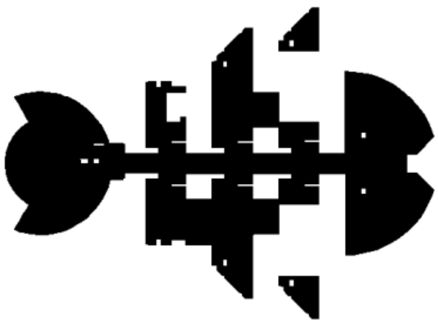
In the ground floor, the foyer with its centred fountain, the main circulation hallway, open gallery, two auditoriums with 160-seat capacity each, multi-purpose hall, prayer hall and cafeteria are all located. A large proportion of the building has been designated to the 16 laboratories and other supporting facilities which have been located in the six symmetrical wings. The total gross area of this floor is 10,925 square meters. The planned seating capacity is for 608 students on this floor and 22 offices for academic and supporting staff, with a small percentage of offices that can accommodate more than one member of staff. On the first floor, a large part of it has been assigned to classrooms and other supporting facilities. The planned seating capacity for students is 2,917 seats with capacity ranging between 15 to 60 seats. The rest of the floor is designated to 58 offices for staff with a small proportion of offices accommodating more than one person. A couple of laboratories and workshops as well as Student Affairs Administration and Admission and Registration Department are positioned on this floor. The total gross floor area is 11,450 square meters. On the second floor, there are the library and reading halls, the Dean office, offices for the Vice Dean for Academic Affairs, Vice Dean for Administrative Affairs, and Vice Dean for Development and Quality, and prayer's hall. Additionally, there are some classrooms with a planned capacity of 230 seats for students and 384 offices for faculty and staff members. Other facilities and services such as printing rooms, archives, small cafeteria, staff lounges with mail boxes, cleaning rooms are located in different parts of the floor. The total gross floor area is 12,110 square meters. In the basement, loading dock, 18 laboratories and workshops, 6 classrooms with a total seating capacity of 168 seats, and 19 offices for staff can be found. Other supporting facilities such as equipment rooms, network rooms, control room, and first aid room are all located on the basement. The total gross area of the basement is 6,746 square meters.



Ground Floor



Second Floor



First Floor

Basement Floor (Ministry of Education 2017)

Architectural, structural, and mechanical elements

In the construction of this college, reinforced concrete has been used in all the elements of the building structure. However, the college envelope has been built using precast concrete cladding. Unlike the rest of new universities, Najran University has chosen to use precast concrete panels for the external skin of its college buildings and other facilities. It is known that in such large development, a precast façade has more advantages than the traditional method of walls made of hollow concrete bricks.

College of Engineering, Najran University

The advantages of the precast system are: quality, durability, weather-proof, low life-cycle-cost, energy-efficient, accelerating the construction time, reducing waste, especially at the construction site and finally the ability to incorporate windows in panels. The decision in which precast concrete cladding used in Najran University has given the University the lead among the 20 recently founded universities in executing most of it facilities in a short span of time has allowed the University to move all of its students on the campus including student dormitory and staff housing. The materials used for the interior dividers are either walls of concrete block (sized between 10 to 20 centimetres, usually used between labs and workshops or classrooms), or partitions of aluminium with glass or gypsum (sized 10 centimetres with 8 centimetres glass, usually used for offices). As for the mechanical systems, the heating, ventilation and air conditioning (HVAC), the water cooled chillers system is used with air handling units and fans for air supply and return throughout the whole building.

Space program and capacity

Table 4.20 shows some figures about the types of space and their planned capacity. The building total gross floor area (GFA) is 41,231 square meters. The planned seating capacity of the building for students is 4,603 seats, while the planned capacity for faculty and staff members is more than 528 seats. The performance indicator for space management is around 9 m2 per student.

Table 4.20: Space program of College of Engineering building, Najran University

Floor	**Space type**	**Quantity**	**Capacity (No. of seats in classrooms & in staff offices)**
Basement 6,746 m2	Classrooms	06	168
	Staff offices	19	27 (some offices have the capacity of 2 people)
	Labs/workshops/studios	18	360 (on average, 20 seats per lab)
	Store	09	
	Service rooms	02	
	Washroom	04	08 Toilets
Ground 10,925 m2	Auditoriums	02	320
	Classrooms	08	288
	Staff offices	22	22
	Labs/workshops/studios	16	320 (on average, 20 seats per lab)
	Archives	21	
	Washroom	08	41 Toilets
First 11,450 m2	Classrooms	97	2,917
	Staff offices	85	95 (some offices have the capacity of 2 people)
	Meeting rooms	03	
	Archives	06	
	Washroom	09	37 Toilets
Second 12,110 m2	Classrooms	07	230
	Staff offices	384	384
	Meeting rooms	09	
	Store	06	
	Archives	01	
	Washroom	12	41 toilets

4.3.3. Third sample: College of Languages and Translation building

Overall building description

This college building is chosen from an old university for the purpose of comparing existing college buildings with new colleges. It was designed by an in-house design team at the Directorate General of Projects and Maintenance, King Saud University (KSU). It was officially opened in 2012. This college is a 3-story building with a total gross area of 17,830 square meters. The planned seating capacity of this college building is 3,610 Full-time Equivalent (FTE) students. All classrooms are located on the ground and first floors. For the academics and supporting staff, which are located on the top floor, there are 169 offices with a small proportion of offices accommodating more than one person. The layout of this building consists of three simple rectangles with the middle one functioning as a circulation link where the main staircase is centred in the middle of the courtyard as displayed in the next diagram. For the horizontal circulation, a network of corridors has been designed to ensure easy access to all parts of the building. Vertically, the building has five equally distributed staircases and two elevators. The building has three courtyards placed in the three different parts to naturally light and ventilate internal spaces. For the accessibility, there are three main entrances and 2 emergency exits. All entrances can be accessed by handicapped people through accessible ramps.

Second Floor

First Floor

Ground Floor (Ministry of Education 2017)

Floor plans

The whole ground floor is designed to accommodate typical teaching classrooms. There are 33 lecture halls with a seating capacity of 1,747 seats. However, half of the floor has been designated to 16 computer laboratories given the need of this type of college. The planned capacity of labs is 477 computers. There are three accessible court yards. This is also one store. However, there are no offices for academic or supporting staff on this floor. The total gross area of this floor is 5,530 square meters. On the first floor, only classrooms can be found. It has a 160-seat auditorium, 46 typical classrooms with a planned seating capacity of 1, 659 seats, which ranges between 15 and 70 seats. This floor also has two halls that have different configuration. These two halls are planned to be clustered workstations, mainly for graduate students with a total capacity of 44 desks. On the second floor, the cafeteria and the prayer hall are located. The total gross floor area is 6,150 square meters. This floor is designed to be for academics and supporting staff only. The Dean office, offices for the Vice Dean for Academic Affairs, Vice Dean for Administrative Affairs, and Vice Dean for Development and Quality are on this floor too. There are 169 offices with some offices accommodating more than member of staff. The total gross floor area is 6,150 square meters.

Architectural, structural, and mechanical elements

College of Languages & Translation, KSU

In the construction of this college, precast concrete has been used in all the elements of the building structure including columns, beams, and stairs. Additionally, the college envelope has been built using precast concrete cladding. This construction method has been used in all KSU facilities since the beginning of building the campus in the 1980s. As mentioned earlier, in such large development as university campuses, precast method has far more advantages than the traditional method. The materials used for the interior dividers are demountable partitions made of metal. These demountable panels mean a high degree of flexibility that easily allow expansion and/or contraction of the educational spaces as well as offices. The other systems for instance lighting, air-conditioning, and fire are all distributed through the ceiling in a way which permits a variety of space configurations. As for the mechanical systems, the heating, ventilation and air conditioning (HVAC) system, King Saud University uses a central system for the entire academic zone in which the conditioned air is provided from the central chilling plant through the central utilities tunnels. These tunnels are used for all kinds of services and utilities.

Space program and capacity

Table 4.21 shows some figures about the types of space and their planned capacity. The building total gross floor area (GFA) is 17,830 square meters. The planned seating capacity of the building for students is 4,043 seats, while the planned capacity for faculty and staff members is more than 216 seats. Therefore, the performance indicator for space management is 4.4 m2 per student.

Table 4.21: Space program of College of Languages and Translations building, King Saud University

Floor	**Space type**	**Quantity**	**Capacity (No. of seats in classrooms & in staff offices)**
Ground	Classrooms	33	1,747
5,530 m2	Computer Labs	16	477
	Store	01	
	Cleaning rooms	01	
	Washroom	03	15 Toilets
First	Auditoriums	01	160
6,150 m2	Classrooms	46	1, 659
	Workstations	02	44
	Cafeteria	01	
	Prayer Hall	01	
	Cleaning rooms	01	
	Washroom	03	15 Toilets
Second	Staff offices	169	216 (some offices have the capacity of 2 people)
6,150 m2	Meeting rooms	02	
	Staff lounge	02	
	Archives	02	
	Balcony	03	
	Washroom	04	17 Toilets

4.3.4. Fourth sample: College of Science building

Overall building description

This prototype of colleges is the most popular design and has been used in a number of new university campuses around the country including Al Baha University, Jazan University, Al Jouf University, Prince Sattam Bin Abdulaziz University, and University of Hail. This standardised college is a 3-story building with a total gross area of 25,940 square meters. It was designed by Alnaim and his alliances (Farhat Urban Consultants and MBS Engineering Consultants) and was opened officially in 2012. The planned seating capacity of this college building is 2,232 full-time equivalent students, excluding the seating capacity of laboratories and workshop halls. For the academics and supporting staff, there are 195 offices with a small proportion of offices accommodating more than one person. The layout of the building has two distinct zones with a couple of wings as illustrated in the next diagrams. For the horizontal circulation, there is a hallway that links the main entrances of the building. Vertically, the building has 12 equally distributed staircases and 11 elevators with different sizes and functions. The building has a number of courtyards placed in different parts to naturally light and ventilate internal spaces. As for the accessibility, there are two main entrances, six sided entrances, 10 emergency exits and one door for services. All entrances can be accessed by handicapped people through accessible ramps.

Second Floor

First Floor

Ground Floor (Ministry of Education 2017)

Floor plans

On the ground floor, the foyer with its centred fountain, the main circulation hallway, a 150-seat auditorium, Student Affairs Administration, Admission and Registration Department, offices for academic staff and cafeteria are located. A large proportion of the building has been designated to the 28 laboratories, workshops, and other supporting facilities, which have been located in the four paralleled wings. The total gross area of this floor is 9,500 square meters. There is only 150 planned seating capacity for students in this floor and 38 offices for academic and supporting staff with a small proportion of offices that can accommodate more than one person. On the first floor, a large part of it has been assigned to classrooms and other supporting facilities. The planned seating capacity for students is 1,642 seats with capacity ranging between 25 to 85 seats. The rest of the floor is designated to 27 offices for staff with a small proportion of offices accommodating more than one person. A couple of laboratories and workshops are positioned on this floor. Other facilities and services such as printing rooms, archives, small cafeteria, staff lounges with mail boxes, cleaning rooms are located in different parts of the floor. The total gross floor area is 8,040 square meters. On the second floor, the library and reading halls, the Dean office, offices for the Vice Dean for Academic Affairs, Vice Dean for Administrative Affairs, and Vice Dean for Development and Quality, and prayer’s hall are located. Additionally, there are some classrooms with a planned capacity of 440 seats for students as well as 130 offices for staff with a small proportion of offices accommodating more than one person. The total gross floor area is 8,400 square meters. On the roof floor, service rooms for different systems can be found. A 50-square meter animal house and other facilities have also been located on the roof floor with special and direct access from the related laboratories on the ground floor.

Architectural, structural, and mechanical elements

In the construction of this college, reinforced concrete has been used in all the elements of the building structure. The college envelope has been built with a traditional method using walls of hollow concrete bricks. For the external skin, polished and rough granite stones were chosen for cladding. There are also decorative walls, which have been constructed about 4.5 meters away from the external walls. These decorative walls are coloured with slightly darker brown paints. However, it is noted that in the second phase of constructing college buildings, such walls have not been used. A decision has been made to eliminate such walls for two reasons. First, it was proven that it has very little impact on the thermal performance of the building (Abanomi 2014). Second, it has a high price tag. The materials used for the interior dividers are either walls of concrete block (sized between 10 to 20 centimetres, usually used between labs and workshops or classrooms), or partitions of aluminium with glass or gypsum (sized 10 centimetres with 8 centimetres glass, usually used for offices). As for the mechanical systems, including heating, ventilation, and air conditioning (HVAC), the water cooled chiller system is used with air handling units and fans for air supply and return throughout the whole building.

College of Science, University of Hail

Space program and capacity

Table 4.22 illustrates some figures about the types of space and their planned capacity. The building total gross floor area (GFA) is 25,940 square meters. The planned seating capacity of the building for students is 2,424 seats, while the planned capacity for faculty and staff members is more than 295 seats. The performance indicator for space management is approximately 11 m2 per student.

Table 4.22: Space program of College of Science building, University of Hail

Floor	Space type	Quantity	Capacity (No. of seats in classrooms & in staff offices)
Ground 9,500 m2	Auditoriums	01	150
	Staff offices	38	58 (some offices have capacity of 2 or more people)
	Laboratory / workshops	28	560 (on average, 20 seats per lab)
	Meeting rooms	03	
	Seating areas	01	
	Archives	03	
	Cleaning rooms	09	
	Washroom	12	44 Toilets
First 8,040 m2	Classrooms	36	1,274
	Staff offices	27	47 (some offices have capacity of 2 or more people)
	Meeting rooms	02	
	Seating areas	04	
	Archives	03	
	Cleaning rooms	18	
	Washroom	09	36 Toilets
Second 8,400 m2	Classrooms	11	440
	Staff offices	130	190 (some offices have capacity of 2 or more people)
	Meeting rooms	09	
	Seating areas	04	
	Archives	01	
	Washroom	15	43 Toilets

4.4 Data analysis and interpretation

This section highlights the research sample and the data-collection techniques used. This research sets out to investigate three sustainability aspects through ten indicators as follows: Management aspects (Vision, policy, planning, and commitments), engagement aspects (Attitude, knowledge, and awareness of sustainability and willingness to change), and environment aspects (Location, physical accessibility, flexibility, climate considerations, and space utilisation). In order to examine these aspects and these indicators, a number of techniques were employed. This includes the following methods:

- Desk research (e.g. scholarly literature review such as articles, books, thesis...etc. and professional documents review such as architectural drawings, university strategic plans...etc.)
- Fieldwork research (e.g. interviews, focus group, questionnaires, and observations). The analytical framework used to evaluate sustainability in Saudi Arabian campuses targets some of the sustainability aspects in universities.

4.4.1. Scholarly literature review

A number of researches have been undertaken in addressing specific areas of sustainability in some Saudi Arabian public and private universities. These studies include Latorre (2012), Alhefnawy (2014), Abanomi (2014), Alshuwaikhat et al. (2016), Almufadi and Irfan (2016), Adenle and Alshuwaikhat (2017), Alshuwaikhat et al. (2017a), and Alshuwaikhat et al. (2017b). The works of those scholars not only has been reviewed, but also used to confirm some of the findings of this research.

4.4.2. Professional documents review

A number of professional references have been reviewed for the purpose of analysing certain issues of interest to the research such as planning, design, capacity, commitment, policies, and so on. These references include architectural drawings (university campus master plans and college building floor plans), university strategic plans, and other related reports.

4.4.3. Interviews and focus group

In total, there were 27 people interviewed in Saudi Arabia, which is about 56% of the 48 officials planned to be interviewed. Those people were:

- 19 interviewees were from public universities
- 6 interviewees were from the Ministry of Education (Higher Education Division)
- 2 interviewees were from the private sector (The architect and the Ministry's advisor)

Table 4.23 presents the positions and numbers of interviewees and their organisations. It shows that the majority of people interviewed were from public universities (70%). The responsibilities of those interviewees vary from operational day-to-day activities such as construction, operation, and maintenance to strategically planning for their institutions. On the other hand, 22% of the interviewees were from the Ministry of Education including Operation and Maintenance Supervisor, Consultants from the Ministry's Research Centre, and the Deputy Minister for Buildings, while 8% of the interviewees were from the private sector; they are the Ministry's independent advisor body (King Abdullah Institute for Research and Consulting Studies, King Saud University, who has been appointed by the Ministry to help carrying out the design review of new university campuses) and the architectural firm (Alnaim Architects, Engineers, and Urban Planners and their alliances Farhat Urban Consultants and MBS Engineering Consultants, who was appointed to plan and design the majority of new campuses for the recently established universities in Saudi Arabia).

Table 4.23: Numbers and positions of people interviewed

No	Positions	Organisations	No. of people interviewed
01	Facility or Project Managers	Universities	8
02	Operation and Maintenance Supervisor	Universities	2
03	Head of Directorate of Study and Design	Universities	2
04	Vice Rector / Dean of Development and Quality	Universities	4
05	Rectors / Acting Rectors	Universities	3
06	Architects or Planners	Private Sector	1
07	Independent Advisor	Private Sector	1
08	Operation and Maintenance Supervisor	Ministry	1
09	Internal Consultants (Higher Education Research Centre)	Ministry	4
10	Deputy Minister for Buildings	Ministry	1
	Total		27

4.4.4. Questionnaires

The research sample represents a population size of 1,436,547 people, which includes 1,307,481 students (91%), 63,363 faculties/academics (4%), and 65,703 supporting staff (5%) in all Saudi public universities in the academic year 2015-2016 (Ministry of Education 2016). To insure fair sampling, the distribution and representation were considered through the use of selection criteria. The criteria include for instance the age of the institution, size of student body, size of university campuses, and location in the country (North, South, East, West, and Centre). Furthermore, at a margin of error of 2% and a confidence level of 95%, the required sample size is approximately 2,400 people. Additionally, if the estimated response rate is 50%, then the number of individuals to be asked to participate is about 4,700. However, only 3,500 questionnaires were distributed in nine public universities, which is one-third of universities in Saudi Arabia, six of which are recently founded and three are well-established.

The total number of returned questionnaires is 1901. The actual response rate, which was 55% at just 12 weeks, is generally higher than anticipated. It is known that 50% is sufficiently enough as a response rate to scan the population (Babbie 1992). The actual margin of error is 2.25%, at the confidence level of 95%. This means that the sample is statistically significant and is representative of the population.

The questionnaire was adapted and developed from ‘Student Sustainability Survey’ by University of Arizona (2014), ‘Sustainability Skills Survey: Staff Questionnaire’ by Bunting et al. (2012), and ‘Arizona State University Student Sustainability Survey’ by Arizona State University (2011). The self-administered questionnaire was mainly designed to measure different variables to test the targeted groups about knowledge on fundamental sustainability terms and issues including, but not limited to, attitude, awareness, behaviour, and willingness to change. It does so by using both closed- and open-ended questions, which both provide qualitative and quantitative data, giving richness and depth of information. This questionnaire is meant to gauge sustainability at the operational level from the point of view of users of the educational facilities including students (graduates and postgraduates), academics (faculty members) and supporting staff (researchers, technicians, and administrative employees).

In the questionnaire, there are three targeted groups: students, faculty members, and university staff members (supporting staff). Table 4.24 presents the number and percentage of participants per university. The respondents consist of 1584 (83%) students, 202 (11%) academics and 115 (6%) administrative staff. It has to be highlighted that the questionnaires were distributed not only in the selected eight universities, but also in other public universities. Statistics indicate that large contributions came from KSU, UH, PSAU, and JNU, whereas few respondents came from IUM and KAU with yet no participation from academics or staff.

Table 4.24: Number of respondents for the research questionnaire

No	Name of the institution	Code	Number of participants			Total
			Student	Faculty	Staff	
01	King Saud University	KSU	307	17	11	335
02	Islamic University of Medina	IUM	73	0	0	73
03	King Abdulaziz University	KAU	65	0	0	65
04	Jazan University	JNU	250	36	10	296
05	University of Hail	UH	272	37	18	327
06	Al Baha University	ABU	158	18	1	177
07	Najran University	NU	94	25	26	145
08	Prince Salman Bin Abdualaziz University	PSAU	258	36	7	301
09	University of Hafr Al Batin	UHB	107	33	42	182
	Total		1584 (84%)	202 (10%)	115 (6%)	1901 (100%)

Table 4.25 gives a detailed overview of the number and percentage of respondents in relation to their academic departments. The Biology Department is by far the largest with 242 participants which represents almost 13% of the whole sample. A large proportion of the questionnaires was completed by participants from Electrical Engineering, Preparatory Year, Mathematics, Architecture, Chemistry, English, Civil Engineering, and Physics.

Table 4.25: Number and percentage of respondents based on their departments

No	Academic departments	No. of respondents	% of respondents
01	Biology	242	12.7
02	Electrical Engineering	187	9.8
03	Preparatory Year	165	8.7
04	Mathematics	148	7.8
05	Architecture	140	7.4
06	Chemistry	112	5.9
07	English	108	5.7
08	Civil Engineering	88	4.6
09	Physics	87	4.6
10	Tourism and Archaeology	60	3.2
11	Computer Engineering	59	3.1
12	Periodontics and Community Dentistry	45	2.4
13	Religion	44	2.3
14	Special Education	41	2.2
15	Modern Languages	38	2
16	Urban Planning	37	1.9
17	Mechanical Engineering	33	1.7
18	Law	26	1.4
19	Non-destructive Testing (NDT)	16	0.8
20	Management	13	0.7
21	Industrial Engineering	11	0.6
22	Health Information Management	8	0.4
23	Pharmacy	7	0.4
24	Arabic	6	0.3
25	Plant Production	6	0.3
26	Chemical Engineering	5	0.3
27	Accounting	4	0.2
28	Management Information System	3	0.2
29	IT	3	0.2
30	Nuclear Engineering	3	0.2
31	Electrical/Electronic Engineering Technology	2	0.1
32	Dental Surgery	2	0.1
33	Plant Protection	1	0.1
34	Linguistics	1	0.1
35	Psychology	1	0.1
36	Agricultural Extension	1	0.1
	Not Applicable	112	5.9
	No Answer	36	1.9
	Total	1901	100%

4.4.5. Observations

One of the tools of data-collection was conducting a direct observation. An 81-day filed trip was taken visiting eight main campuses and four branches in different cities around the Kingdom, seen in figure 4.37. The trip took place at the beginning of the academic year in Saudi Arabia (between August and November 2015). One week was spent in each campus. Interviews were conducted and questionnaires were distributed and collected plus a direct observation was also undertaken. Field notes were gathered; observing users of university campuses (academic staff, supporting staff and students) and the use of space in the college buildings. A camera was used to document operations and practices through which 3,476 photos and 55 videos were taken. Direct observation provided a first-hand experience with users, recording events as they occurred and noticing any unusual aspects (Creswell 2003).

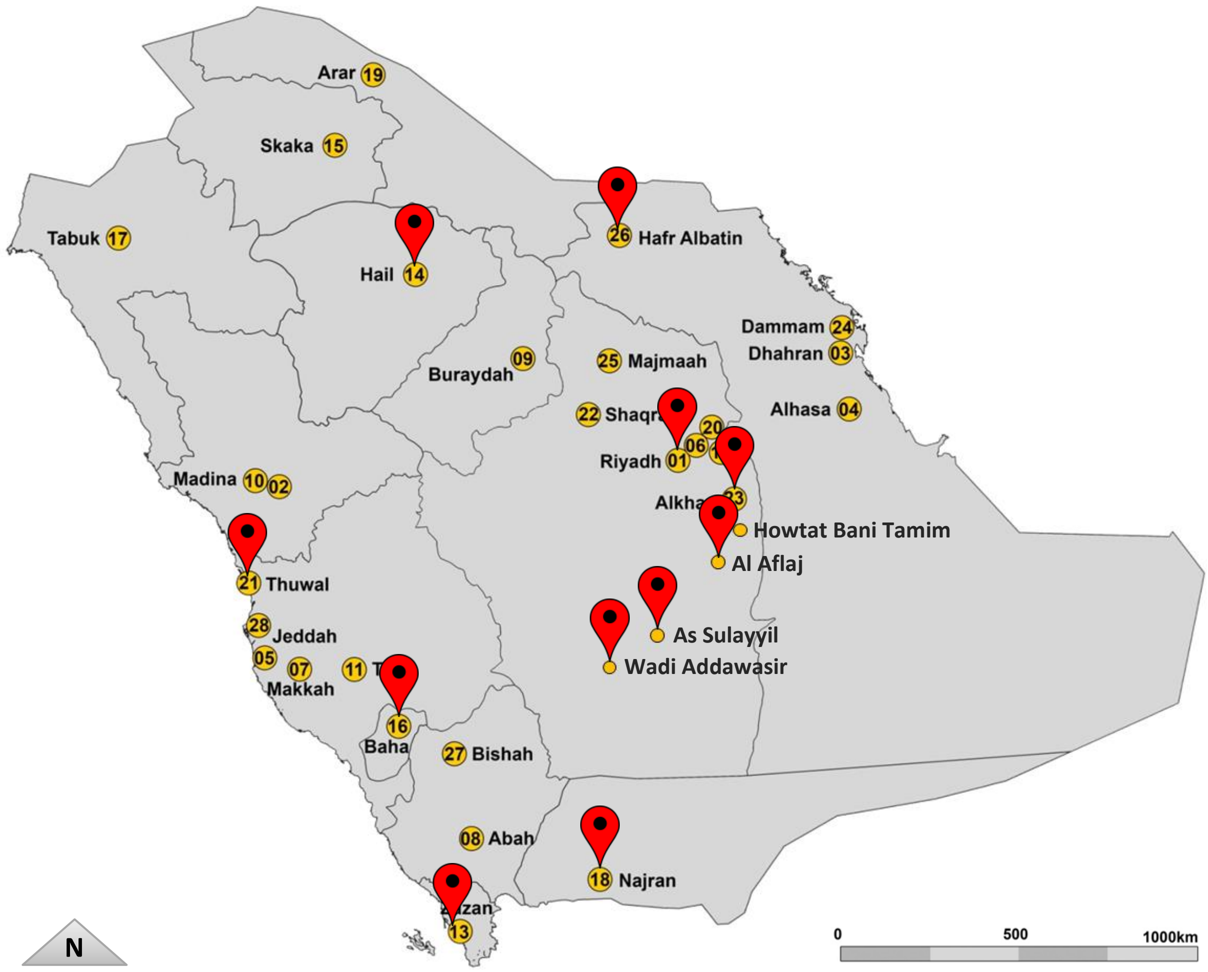


Figure 4.37: Locations of visited and observed campuses (Adapted from Ministry of Education 2012)

4.5 Sustainability aspects

In this section, the three sustainability aspects were assessed. These aspects are as follows:

- Management aspects
  (Vision, policy, planning, and commitments)
- Engagement aspects
  (Attitude, knowledge, and awareness of sustainability and willingness to change)
- Environment aspects
  (Location, physical accessibility, flexibility, climate considerations, and space utilisation)

Each one of these aspects has been explored and analysed in the following sections:

4.5.1. Management aspects

(Vision, policy, planning, and commitments)

4.5.1.1. Vision for sustainability

The first issue to explore is the vision of higher education institutions in Saudi Arabia. The investigation indicates that most universities share the same vision. The analysis shows that universities are unified in their vision to provide distinctive education that meets the needs of the society and labour market and hence contribute effectively to the sustainable development through applied research, optimal use of modern technologies, and active partnerships at different levels: locally, regionally, and internationally. Furthermore, it is clear that the vision of public universities in Saudi Arabia is not only to educate the population on the domestic front, but also to compete in the global arena through investing heavily in the higher education sector.

As for their campuses, the common vision of public Saudi universities is to create an environment that is appealing, smart, and sustainable. Most interviewees have confirmed this vision pointing out that their vision of sustainability for their campuses is to be attractive, fully equipped with cutting edge facilities, and environmentally friendly. The enormous investment is visible in the physical solutions that demonstrate the commitment to a shared vision of the future. The investment in the physical solutions has been justified as being one of the most important tools for the success of the university.

The aims of the Saudi Arabian institutions (in general) and the aims of the institutions for their campuses from a sustainability perspective (in particular) were examined. The analysis indicates that the majority of Saudi universities share almost the same goals of:

- Outstanding academic programs and leadership in research in order to actively participate in the Kingdom’s aim of achieving a ‘knowledge-based society’ and ‘knowledge-based economy’
- Physical assets: providing not only suitable purpose-built higher educational facilities for learning and research for each region and its provinces, but also much needed community services such as hospitals, housing, libraries, conference centres, museums, hotels, and sport facilities
- Human capital: investing in our human resources, which are regarded as a significant asset, without which the institution’s aims cannot be achieved
- Meeting the ever-increasing demand for university education.

As for the campus, the aims are:

- Having a campus that is attractive, well-eqipped, efficently operated, easily maintained, and environmentally friendly
- Executing construction projects of the university’s main campus and its satellite campuses (branches) in different provinces.

Having said that, very few universities have indicated clear and defined aims of sustainability for their university campuses. This is due to i) lack of interest, ii) scarcity in expertise, iii) differing priorities, and iiii) insufficient knowledge of climate change and sustainability. Some of these reasons were aknowledged in previous research such as Alshuwaikhat et al. (2016), Almufadi and Irfan (2016), and Alshuwaikhat et al. (2017a).

It can also be seen that each Saudi university recognises the fact that its campus is one of the most important tools to achieve the institution’s main aims. A project manager emphsises this saying “*Our campus will be used as one of the means to pursue our aim*”. Den Heijer (2011) emphasises that each university goal can be frustrated by the physical setting of the campus.

This indicates the significance of university facilitites, which can be moblised to help achieve the institutions' aims and objectives.

4.5.1.2. Policy for sustainability

Another aspect evaluated was the universities policy through which their vision and aim can be achieved. The analysis shows a number of policies adopted by some public universities to become more sustainable and hence carbon neutral. These policies, which can be found in campuses of new and well-established universities, are for example:

- indicating the aims and visions of the university for sustainability aspects, defined as clearly as possible in the project brief; known as the planning and design reference
- involving the end-users at early stage of the construction project in order to incorporate the ideas and expertise of users
- establishing a department, unit, or an office of sustainability to guarantee integrating policies of sustainability into the university's planning, construction, operation, and maintenance. For example, King Abdulaziz University (Jeddah) has established a unit called General Administration of Sustainability. The same goes for King Saud University, in which they established a department known as Sustainability and Environmental Development. Both of these sustainability offices are under the umbrella of the University Agency for Projects, which means that such offices may not cover other aspects of sustainability such as education, research, engagement and outreach.

Other technical policies include:

- rethinking the design of many university campuses through which a number of planning issues can be addressed, such as orienting some buildings, ensuring optimum use of spaces in college buildings, and reducing the parking zones and the hardscaping in general
- using the pre-cast concrete almost in all elements of the building, including, columns, beams, slabs, claddings, internal walls, and stairs to ensure quality, speed, and resilience
- investing in alternative ways of transportation such as bicycles, especially within the campus zones. For example, King Saud University is considering such a move to ease accessibility within its campus.

Overall, despite the fact that most public universities in Saudi Arabia show a common vision to create a learning environment that is appealing, smart, and sustainable, they indeed lack defined and comprehensive policies to achieve such vision.

4.5.1.3. Planning for sustainability

The analysis of the strategic plans of vast majority of public universities in Saudi Arabia indicates that there is no comprehensive plan to approach sustainability. What can be found are some modest programs that tend to be not from the university top management, but rather sponsored by individual departments. It seems that there is a lack of planning for sustainability at the institutional level. This means that a number of sustainability initiatives have been taken by individuals at some universities in the absence of the top-down inclusive sustainability approach, that deals with sustainability holistically.

The common vision for sustainability in Saudi Arabian campuses is facing a number of challenges that threatens its achievement. Lack of expertise, the number and size of the construction projects, the pace of executing these projects, the physical distance between these supervised construction projects, and the shortages in qualified management team, are all cases in point.

The analysis of the 27 interviews, about some of the recent sustainability developments in university campuses worldwide, confirms previous assumptions. The following sustainability developments were discussed with interviewees who were asked whether their institutions have taken part, been involved in, or at least have considered participating in the following:

- First is signing one (or maybe more) of the international declarations, charters, or partnerships, which are written agreements to a) inculcate environmental, social, economic, and educational sustainability in colleges and universities and b) advance all aspects of sustainability in higher education institutions. Declarations include, but are not limited to, Stockholm, Talloires, Halifax, Tokyo, and the UN. None of the Saudi public universities has signed such declarations or charters. Facility and project managers, together with the heads of design and study department believe that this is the rectorate's responsibility. Sustainability needs leadership; a top-down approach. They emphasise that sustainability requires a dedication from the people with the highest status in the university. Decision-makers have to be fully aware of the great benefits of sustainability and its implication for the campus and beyond.
- Second is having an 'Office of Sustainability' with specialised experts in sustainability aspects, given that sustainability has become a very hot topic worldwide. Such office does exist in only two well-established public universities, King Saud University and King Abdulaziz University. Of the 28 universities in the country, only two institutions have such offices, which means that public universities, both old and new, are falling behind in this regard, blaming limited resources and expertise and the young age of their institutions.
- Third is applying one of the Environmental Management Systems (EMS) such as the International Organisation for Standardisation (ISO 14001) Standard or the Environmental Management and Auditing System (EMAS) Regulation. Many of the well-established public universities and few recently established public universities have achieved the certification of such standards, which they both argue that these certifications show their attempts to advance some aspects of sustainability in their campuses.
- Fourth is participating in - or maybe holding - one of the specialised conferences that are organised annually to address sustainability in universities and discuss the latest developments in the field such as International Sustainable Campus Network (ISCN), Environmental Management for Sustainable Universities (EMSU) and Association for the Advancement of Sustainability in Higher Education (AASHE). A couple of interviewees indicate that they have participated in some sustainability conferences, but none of the above mentioned conferences. However, they point out that they have been to conferences on their expenditure, having tried to be sponsored by their universities and failed. This shows that sustainability might not be on the rectorates agenda for the time being, some interviewees argue.
- Fifth is using one of the sustainability assessment tools, frameworks, or systems such as Sustainability Assessment Questionnaire (SAQ), Sustainable University Model (SUM), Benchmarking Indicators Questions - Alternative University Appraisal (BIQ-AUA), Unit-based Sustainability Assessment Tool (USAT), and Adaptable Model for Assessing Sustainability in Higher Education (AMAS). None of the universities is either utilising one of the above mentioned tools or developing their own tailored tools. In many cases, the interviewees indicated a lack of knowledge of such instruments and systems.
- Sixth is applying for one of the sustainability ranking systems for university campuses such as the UI Green Matric, Green League, and Sustainability Tracking, Assessment

and Rating System (STARS). Figure 4.38 shows that there are two public universities, King Abdulaziz University and Princess Nourah University, which are ranked among the top 200 green campuses in the world (UI Green Matric 2015). However, other sustainable universities that can apply for such ranking systems include King Saud bin Abdulaziz University for Health Sciences and King Abdullah University for Science and Technology. The latter is known to be very sustainable; the first LEED-certified project in Saudi Arabia and the largest LEED-Platinum project in the world (U.S. Green Building Council 2016).

- Joining in one (or more) of the professional bodies or associations of campus facilities and college buildings such as Society of College and University Planners (SCUP) and Association of Higher Education Facilities Officers (APPA). None of the interviewees is a member of one of the mentioned professional bodies or associations. However, they all show more interest in joining such societies.
- Reinforcing the sustainability commitment on- and off-campus by i) bring in experts as guests speakers on sustainability, ii) arranging training sustainability courses and workshops, iii) celebrating the Earth Day (22 April), Sustainability Month (October), and so on. Very few interviewees have indicated that such events and activities take place in their campuses. Some interviewees have pointed at their rectorates for failing to draw some attentions to such events and activities on- and off-campuses.

To sum up, the overall status of planning for sustainability holistically in Saudi Arabian public universities is lacking. None of the public universities in Saudi Arabia have a sustainability plan, which addresses sustainability aspects. The reaction of Saudi universities towards the recent sustainability developments in university campuses worldwide is weak. In fact, the vast majority of Saudi public universities – both recently founded universities and well-established universities – are lagging behind in many sustainability respects. The interviewees have emphasised over and over again that sustainability needs a top-down management approach in order to advance it in campuses and beyond.

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Detail Ranking 2015

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Ranking	University	Country	Total Score	Setting and Infrastructure	Energy and Climate Change	Waste	Water	Transportation	Education
131	King Abdul Aziz University		5063	376	839	1575	1000	450	823
179	Princess Nourah University		4608	441	869	1425	925	834	114

Figure 4.38: Green universities in Saudi Arabia (UI Green Matric 2015)

4.5.1.4. Commitments to sustainability

Another issue examined was whether or not public universities are committed to climate change and sustainable development. In other words, what measures universities have taken or will take to promote aspects of sustainability and raise awareness of climate change. The analysis illustrates some of the commitments made by some Saudi universities. There are strategic and technical commitments. Strategic commitments include:

- raising awareness starting by educating the educators through setting up events, exhibitions, campaigns, and public lectures to equip faculty members with the necessary level of knowledge and tools. Despite the existence of such practices, it seems that not all public universities do indeed follow suit
- some public universities are committed to some of the green building schemes such as BREEAM (UK), LEED (US), GREEN STAR (AU), and DIGNB (GR). The analysis shows that the vast majority of Saudi public universities have no certified facilities by any global green-building schemes. However, some universities do indeed have some LEED certified buildings such as King Saud University (old public university), Princess Nora University (new public university), King Saud bin Abdulaziz University (new public university), King Abdullah University for Science and Technology (new private university). Some of the recently established universities are making a noticeable progress in this regards, through highlighting this issue clearly in the tendering document especially for proposed buildings. For example, figure 4.39 shows a part of the project brief of the Medical Zone at Jazan University, known as the Planning and Design Reference. It indicates some of the bidding requirements and conditions for green-building certification scheme. In such document, Jazan University asks a number of 'green' considerations for the design services including: using energy modelling software to stimulate the energy use of college buildings; Identifying sustainability initiatives and guidelines; developing preliminary environmental and green building strategies; and using applicable LEED checklists as the base for green design.

48	Produce Preliminary MEP systems and special support systems. With BIM, 3D sections to show the systems and identify any clashes I interferences with architectural and structural components.
49	Utilize acclaimed Energy Models and simulations software to steer the project towards sustainable design (i.e. Eco tech and IES)
50	Identify sustainability initiatives and guidelines.
51	Develop preliminary environmental and 'Green Building' strategies.
52	Utilize applicable LEED checklists as the basis for green design.

Figure 4.39: Some design requirements for the Medical Zone Project (Jazan University 2017)

Technical commitments made include:

- some of recently established public universities are committed to sustainability through commissioning well-known engineering consultancies. For example, Al Jouf University (AJU) has appointed a Spanish Engineering Consultancy, TYPSA, to provide technical support to manage the campus in as sustainable a way as possible
- automating buildings' systems including heating, ventilation, and air conditioning (HVAC), water, and lighting in both the existing and proposed building on campus to conserve energy and water use
- using renewable energy facilities such as the solar panels and wind turbine on campus and hence not depending totally on the conventional way of using fossil fuel to generate power for campus facilities

- ‘less is more’: some of recently established institutions are resizing some proposed college buildings to reduce any waste in spaces.

However, scanning some of the strategic plans of public universities indicates that very little can be found about a clear commitment for sustainability at the institution level. This does not come as a surprise since no public institution has a sustainability plan that addresses all aspects of sustainability; management, academia, engagement, environment, and innovation (Alghamdi et al. 2017). Over 60% of the interviewed campus managers and supervisors confirmed that there are no documented sustainability commitments in their universities. This can be true in the majority of Saudi public universities; both well-established and recently founded ones. ‘*Sustainability has not been taken seriously by universities yet... it takes a strong commitment from the university top management to approach sustainability comprehensively*’, a project manager says. The absence of commitment for sustainability comes as no surprise given the lack of comprehensive plan with defined policies for sustainability.

4.5.2. Engagement aspects

4.5.2.1. Attitude, knowledge, and awareness of sustainability and willingness to change
The analysis of the questionnaires indicates that little is known about the term ‘sustainable development’ among the majority of Saudi Arabian students in public universities. The questionnaire started with the most famous definition of Sustainable Development (SD) introduced by the World Commission (UN World Commission 1987). Figure 4.40 shows that only a quarter of the sample heard about the SD. This means that more than two-thirds of all the respondents did not have any prior knowledge about the SD. This indicates a massive obstacle facing the higher education system in Saudi Arabia in terms of advancing the knowledge of graduates to meet the challenging future of Saudi Arabia and its Vision 2030.

However, when zooming in and looking at the three categories of participants (students, academics, and supporting staff), it can be said that some groups do better than others. For instance, figure 4.36 demonstrations that over two-thirds of the academics had prior knowledge about the SD, whereas supporting staff and students had little knowledge about the SD, 32% and 20% respectively. Both of these groups, students and supporting staff, show an alarming rate of unawareness of one of the most important and hot topics worldwide.

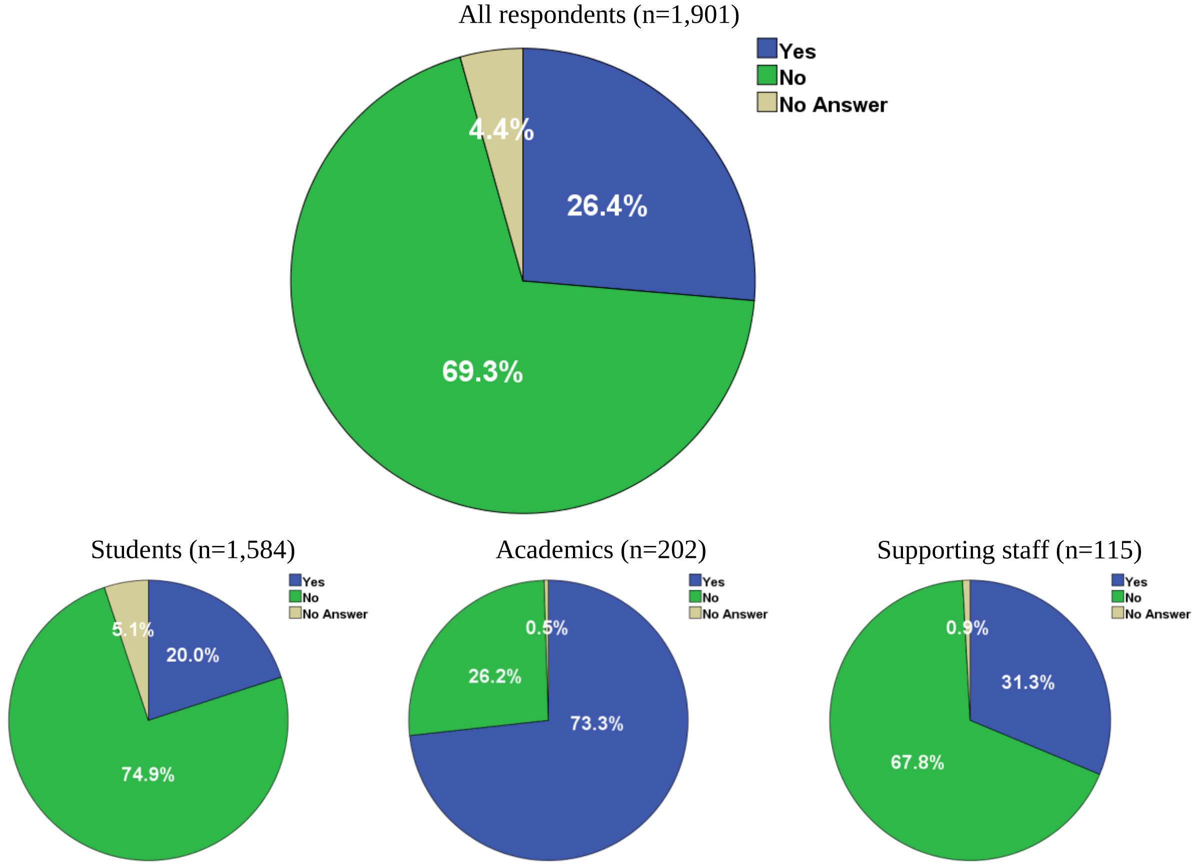


Figure 4.40: Percentage of knowledge about SD

Across tabulation test, known as Pearson's chi-square distribution, was carried out to highlight if there is an association between the knowledge level of sustainable development and the departments of those surveyed. If the result (the *p* value) is greater than 0.05, then there is no significant association between the two categories. Table 4.26 shows that the *p* value, which is 0.001, indicating that there is a relationship between knowledge level of sustainability and academic departments that those surveyed belong to. This means that there is a connection between the level of knowledge about the SD and the departments of those participated in the research.

Table 4.26: Testing the relationship between knowledge about the SD & departments of participants

	Value	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	380.853a	76	.001
Likelihood Ratio	361.082	76	.000
Linear-by-Linear Association	.800	1	.371
N of Valid Cases	1901		
a. 67 cells (57.3%) have expected count less than 5. The minimum expected count is .04.			

The second question raised in the questionnaire was to name the most important sustainability issues in Saudi Arabian universities. A definition was given before the question to briefly introduce 'sustainable university'. The definition was:

'when thinking about a 'sustainable university', its campus has to consider the implementation of sustainable practices (environmentally, economically,

socially and educationally) through its campus life cycle (planning, constructing, operating, maintaining, and retrofitting) through all management directions (top-down as well as bottom-up approaches) on all levels of campus (from classrooms to laboratories, transportation, procurement, housing, and other services) in many ways (e.g. energy saving, water conservation, air quality, social equity, waste reduction, walkability, well-being and health) or in many different shapes and forms (e.g. flexibility, multi-functionality, optimal space utilisation),'

Table 4.27 demonstrations the diversity of important issues pointed out by the participants in this research project. The table orders these issues according to their importance. The 10 most commonly mentioned issues include water and energy, buildings, healthy food, housing, labs and class-rooms, well-being, social aspects, flexibility, location and transportation, and air quality.

The top two issues were water and energy and buildings. It is understandable that most participants would refer to water and energy as key issues in sustainable development, given that such issues are crucial in an environment like Saudi Arabia, where 90% of the country is desert. Water, in particular, has been flagged up by many participants not only in this study, but also in others (Alhefnawy 2014). Alshuwaikhat et al. (2016, 10) believe that 'almost half of Saudi universities are running programs to reduce water consumption for irrigation purposes', which indicates an interest to address this important issue.

Buildings, on the other hand, are also seen by respondents as key given that buildings consume a lot of energy and generate a lot of waste. Buildings use about 40% of global energy, 25% of global water, 40% of global resources, and they emit approximately 33% of greenhouse gas emissions (UNEP 2016). Nevertheless, with these challenges come great opportunities. For example, energy consumption in buildings can be reduced by 30 to 80% using available technologies (UNEP 2016). Saudi universities can be greatly assisted if such technologies employed in their campuses. Yet, Alshuwaikhat et al. (2016, 10) argue that:

'Saudi universities are relatively less committed to common energy-saving practices such as energy-efficient lightning and air-conditioning systems, day-light saving practices, and setting energy usage standards for the construction of new buildings when compared with globally recognized universities. This indicates the need for on-campus sustainability initiatives such as improvements in automation and control systems technology for buildings, energy-efficient usage of computers and heating systems, and renewable energy initiatives. Such initiatives still need more recognition and promotion at the campus level to reduce the dependency on and promote savings of energy.'

Table 4.27: Sustainability issues in Saudi Arabian university campuses

No	Sustainability issues in Saudi Arabian university campuses	Number of respondents	Percentage of respondents
01	Water and energy	66	3.5
02	Buildings	58	3.1
03	Healthy food	32	1.7
04	Housing	32	1.7
05	Labs / class-rooms	31	1.6
06	Well being	30	1.6
07	Social aspects	20	1.1
08	Flexibility	21	1.1
09	Location / Transportation	21	1.1
10	Air Quality	20	1.1
11	All what have been mentioned in the definition	18	0.9
12	Shaded car parking	18	0.9
13	Infrastructure	15	0.8
14	Space Utilisation	15	0.8
15	Planning	13	0.7
16	Operation services	13	0.7
17	Lack of responsibility	12	0.6
18	Recycling	11	0.6
19	Maintenance	10	0.5
20	Raising awareness	8	0.4
21	Sustainability education & research	8	0.4
22	Landscaping	8	0.4
23	Management	5	0.3
24	Upgrading campus facilities	4	0.2
25	Procurement	3	0.2
26	Lack of smoking zones	1	0.1
27	Lack of sustainability aspects	1	0.1
	No Answer	1407	74
	Total	1901	100%

Figure 4.41 shows that over half of those surveyed indicated a concern about sustainability; either very passionate or considerably interested, 17.9% and 35.5% respectively. Merely about 6% indicate little interest in sustainability. However, the data illustrates that nearly 80% of academics are more interested in sustainability than students and supporting staff. Only half of students are concerned about sustainability. The same goes for the supporting staff. Alarmingly, 15% of students and 20% of supporting staff have shown either little or no interest at all in sustainability. The low level of interest in sustainability among students is also reported in other research Abubakar et al. (2016), who point out that, in general, students showed a lack of interest and willingness to take part in sustainable initiatives.

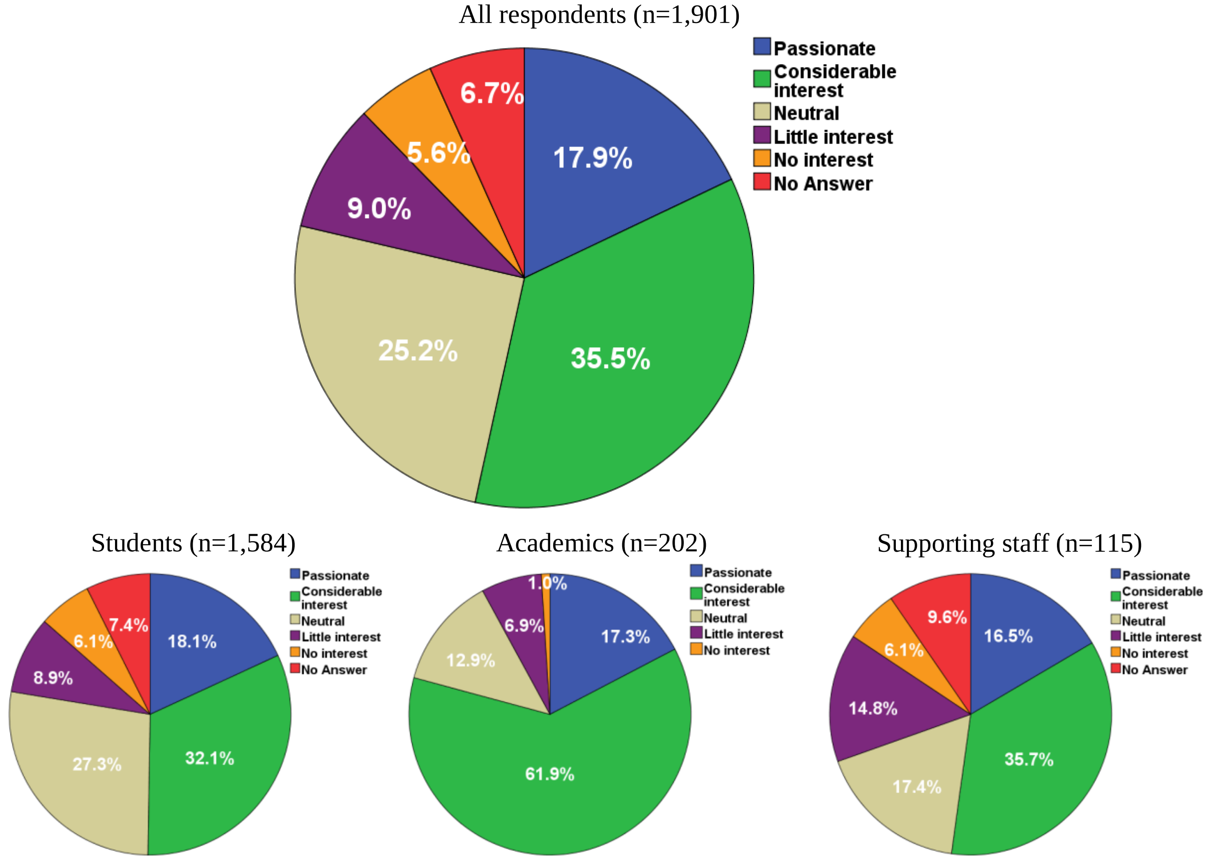


Figure 4.41: Level of interest in sustainability in Saudi universities

To check the association between the level of interest in sustainability and the academic departments of those surveyed, another cross tabulation test was undertaken. The analysis illustrated in table 4.28 demonstrations that the result, which is 0.001, indicates a significant relationship between the level of interest in sustainability and the departments of 1901 participants. Further research can be undertaken to establish such relationship.

Table 4.28: Examining the relationship between level of interest in sustainability & departments

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	272.580a	190	.001
Likelihood Ratio	282.247	190	.000
Linear-by-Linear Association	3.143	1	.076
N of Valid Cases	1901		
a. 144 cells (61.5%) have expected count less than 5. The minimum expected count is .06.			

Among the issues of sustainability awareness asked was the knowledge about whether or not their universities have any facility for renewable energy such as solar panels, wind turbines, hybrid power system (solar and wind), geothermal plant...etc. Figure 4.42 exhibitions that around 8% of those surveyed believe that there are facilities for renewable energy on their university campuses. However, nearly 88% of respondents said either no facilities or they do not know, 44% and 43.7% respectively.

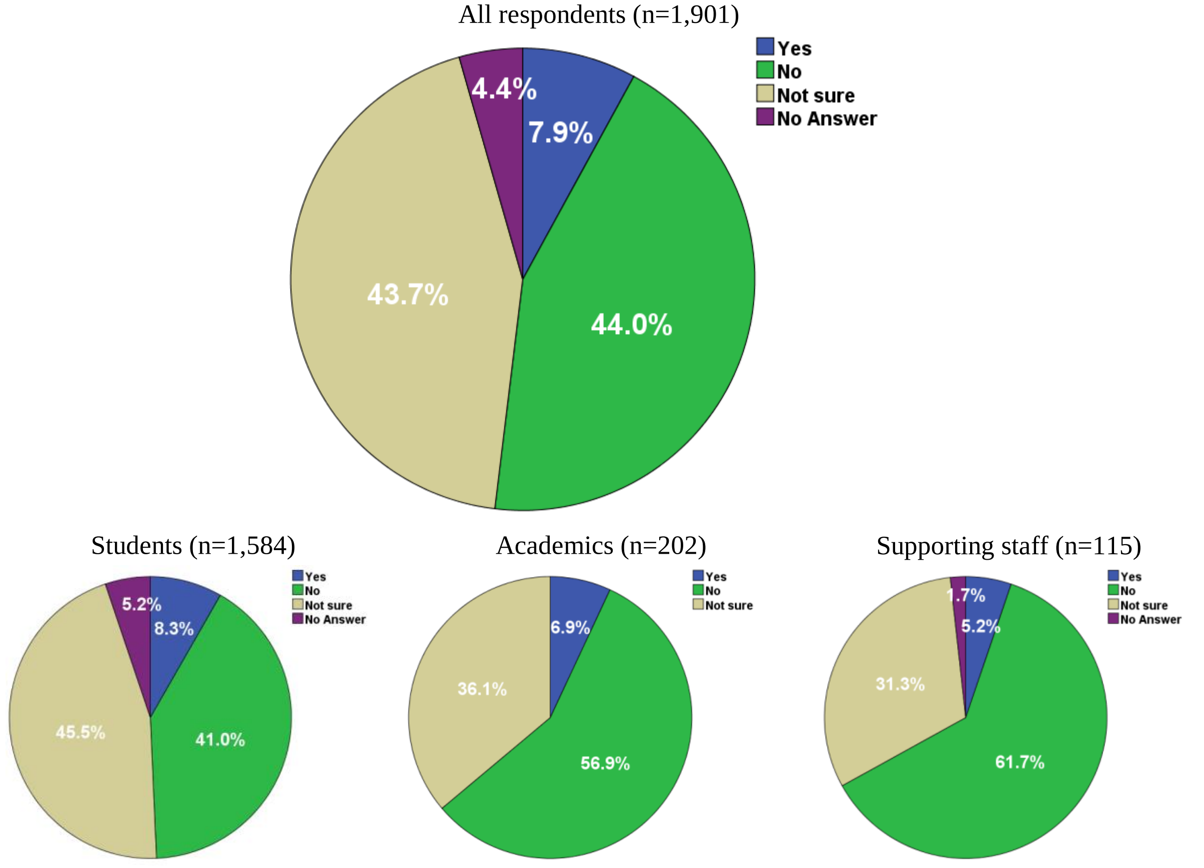


Figure 4.42: Knowledge about having facilities for renewable energy on campus

Furthermore, when exploring the responds of academics almost two-thirds pointed out that there are no facilities for renewable energy on their university campuses. Additionally, looking at the three groups (students, academics, and supporting staff), it can be said that few people in each group indicate that there are renewable energy sources on their campuses. This suggests that the majority of public universities in Saudi Arabia are lagging behind in this regard. This was confirmed by Alshuwaikhat et al. (2016, 10) who indicated that:

> *'Notwithstanding the abundance of energy resources Kingdom-wise, Saudi universities should adopt sustainable energy consumption on their campuses. Only 27.8% of university campuses of Saudi Arabia are striving for "Leadership in Energy and Environmental Design (LEED)" Certification for their campus buildings.'*

Of those 8% who claimed that there are facilities for renewable energy on their campuses, approximately 2% gave more explanation about these facilities. This can be shown in table 4.29, in which the facilities for renewable energy mentioned were solar panels (0.7%), wind turbines (0.6), and solar/wind hybrid system (0.6%). Fifth of the 202 respondents did not answer this query. This question was not applicable for the majority. This reflects the statistics in the abovementioned figure, in which around 88% of the respondents were either not sure if their campuses have such facilities or their campuses have no facilities.

Table 4.29: Examples of existing facilities for renewable energy

No	Facilities for renewable energy	Number of respondents	Percentage of respondents
01	Solar panels	14	0.7
02	Wind turbines	11	0.6
03	Hybrid Power System (Solar and Wind)	11	0.6
	Not Applicable	1674	88.1
	No Answer	191	10.0
	Total	1901	100%

Recycling and waste collections were also searched. Participants were asked whether they have separate collection bins for different types of waste such as paper, glass, plastic, organic...etc. Table 4.30 shows that less than one-third of public universities in Saudi Arabia have recycling bins. Almost 66% of respondents indicated that either their colleges do not have separate collection bins (53%) or they are not so sure about that (13%).

Table 4.30: Having separate collecting bins

No	Having separate collecting bins	Number of respondents	Percentage of respondents
01	Yes	590	31.0
02	No	1000	52.6
03	Not sure	250	13.2
	No Answer	61	3.2
	Total	1901	100%

Participants were also asked about their willingness to use the separate collection bins, if available. Figure 4.43 exhibits that the vast majority of those surveyed are willing to separate their own rubbish. Nevertheless, around 8% of participants were not prepared to separate the wastes. All those who are reluctant to separate the wastes did not justify why they are not willing to use the separate collection bins for different types of waste. Among the three groups, almost all the academics are willing to separate their rubbish. Alshuwaikhat et al. (2016, 10) argue that ‘nearly 30% of Saudi universities have been taking initiatives on waste recycling for paper, plastics, metals, food, etc.’, which shows that waste recycling management is still at early stage given that only one-third of higher education institutions have recycling programs.

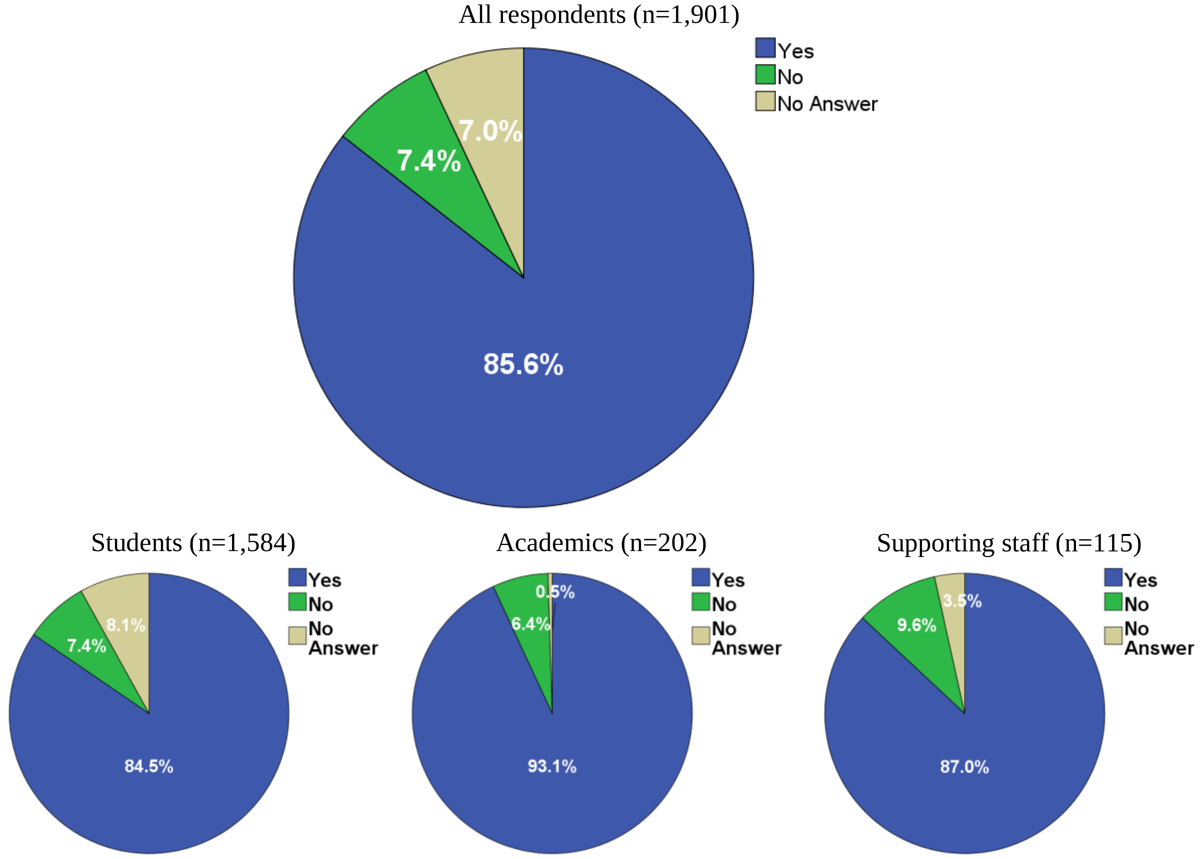


Figure 4.43: Willingness to use separate collection bins

Another explored aspect was about issues that act as barriers preventing people from living a more sustainable lifestyle at university and home. The analysis shown in table 4.31 suggests that there are three prominent barriers obstructing people from living sustainably: lack of support within communities (43%), lack of collective action to make a difference (39%), and unsure what should be done (32%). Other highlighted obstacles include lack of support at universities (28%) and sustainability is not a high priority (23%).

Table 4.31: Issues acting as barriers preventing living a more sustainable lifestyle

No	Issues	% of Cases
01	Lack of support within our community	42.8%
02	Lack of collective action to make a difference	39.5%
03	Unsure what we should be doing	31.9%
04	Lack of support at our university	28.3%
05	Not a high priority	23.3%
06	Too difficult	18.8%
07	Too time consuming	17.1%
08	Too costly	10.3%

Furthermore, some of the academics added more barriers than the provided list. They included lack of sustainability culture, society acceptance to sustainability, and also lack of commitment from decision makers at all levels in both public and private sectors.

Some behavioural attributes of sustainability are listed in an attempt to acquire an overall image of participants' behaviour. This question was answered by the majority of participants, which indicates that there are some sustainable behaviours and activities being adopted by the majority in Saudi Arabian public universities. Table 4.32 gives more detailed overview of some sustainable examples. Based on the percentage of cases of sustainable behaviours, the outcome can be clustered into three groups:

- The most popular sustainable behaviours in public universities in the Kingdom, that were ticked by about two-thirds of the participants, are i) Donating unwanted possessions such as clothes, furniture, kitchen appliances, and electronics...etc. and ii) Engaging in energy reduction practices such as turn off heat/A.C./ lights, high efficiency lightbulbs...etc.
- Well over one-third of participants marked off a couple of behaviours such as i) Recycling which was defined as treating or processing used or waste materials so as to make suitable for reuse, ii) refilling water bottles, and iii) purchasing sustainable products.
- Other sustainable behaviours, which were selected by about a quarter of participants, include i) Having conversations outside the class with faculty, staff, or friends about sustainability issues, ii) Participating in student organisations focused on sustainability, and iii) Attending lectures focused on sustainability.

Table 4.32: Sustainable behaviours

No	Sustainable behaviours	% of Cases
01	Donate unwanted possessions	65.2%
02	Engage in energy reduction practices	64.4%
03	Recycle	41.1%
04	Refill water bottles	39%
05	Purchase sustainable products	33.7%
06	Have conversations outside of class with faculty, staff, or friends about sustainability issues	26.8%
07	Participate in student organizations focused on sustainability	23.2%
08	Attend lectures focused on sustainability	23.1%
09	Attend a program/event related to sustainability	22.8%
10	Perform research on a sustainability topic	20.7%
11	Take a module/course on sustainability subjects from your program of study	20.3%

To sum up, the findings show that the majority of students in public universities in the Kingdom have little knowledge about sustainable development. 70 percent of unawareness of one of the most important and hot topics worldwide is indeed alarming. One of the reasons might be because there is no public university in the country that assesses its students about their knowledge and awareness of sustainability on a regular basis. It seems that there is a lack of policies to integrate sustainability into the existing education courses. This was highlighted by previous studies such Alhefnawy (2014), Abubakar et al. (2016), and Alshuwaikhat et al. (2016). Students showed a lack of interest and willingness to take part in some sustainable initiatives on-campus. The majority of Saudi Arabian policy- and decision-makers have inadequate knowledge and awareness about the recent sustainability developments in university campuses worldwide especially in Europe and North America.

4.5.3. Environment aspects

Location, physical accessibility, climate considerations, flexibility, and space utilisation

4.5.3.1. Location

The investigation shows that the geographical locations of public higher education institutions in Saudi Arabia are an issue. The 20 recently established universities in the Kingdom have been located in provinces that have had no history of hosting such institutions. This has many profound positive aspects to every province and its cities and towns, economically, socially, and beyond. However, this research has found that some of these campuses have been located a) in challenging sites and b) far away from their main cities and towns. Some selected sites have difficult topographies including rocky mountain (e.g. Al Baha University), and hilly (e.g. As Sulayyil Campus), sandy (e.g. Najran University), or low-line ground (e.g. Prince Sattam bin Abdulaziz University).

On one hand, the analysis of the interviews suggests that the decision and the process of selecting these sites were taken in a very short span of time. Such process tends to take long in order to explore all available options for the university main campus and its branches. The Ministry of Education along with the authority of each local municipality were the parties involved in taking such strategic decisions. Whether the selected sites for the recently founded university campuses were the right decision or not, only ongoing research and time will tell. However, this research has identified that there are four main reasons for selecting these locations as follows:

- First, many university campuses were intentionally located in remote sites ‘to avoid the conflict and distractions presented by cities’ (Haar 2011, xx). Historically, and especially in the United States of America, a number of campuses located in the countryside believing that ‘the academic ideal has been profoundly suburbanised, where a rural setting is part of the definition of academic excellence’ (Bender 1988, v). Thus, the Saudi campuses might follow the same traditional principle.
- Second, and perhaps more acceptable reason, it was because of the size needed to accommodate all the institution’s facilities and services, a decision made based mainly on size. As expected, there is not enough space within the city tissue to house a large scale development with the proposed size.
- Third, it might be also because these municipalities have no master plan for their cities that takes a university campus into account.
- Four, it might be because of the need to establish a new and large development outside the city that characterised as ‘big and far’ (Alonso 1968); aiming at a regional balance or a de-concentration by making the campus as an attractive starting point for such new development (growth-pole) (Parr 1999).

It is acknowledged that the process of selecting the location is not an easy task. It was seen by many decision makers in public universities as one of the most difficult decisions to take, given the strategic role it plays. The common practice is to locate the main campus in or near the capital of each province. However, this cannot be always the case for several reasons among which is the consideration of other populated cities. For example, Al Jouf University main campus has been located between the biggest two cities in the province of Al Jouf; Sakaka and Dumah Al Jandal, seen in figure 4.44. The main campus is 30 kilometres away from Sakaka and 24 kilometres away from Dumah Al Jandal. This means that almost all students and staff have to commute to the campus, given its geographical location between these cities.

Figure 4.44: The location of Al Jouf University (Adapted from Google Maps 2017)

On the other hand, the analysis of the questionnaires supports the assumption that the locations of new campuses were not suitable. Figure 4.45 shows that around two-thirds of participants indicated that their campuses are located far away from their cities. The long distances between university campuses and their cities were highlighted by all groups; students, academics, and staff, 62%, 59%, and 74% respectively. This indicates that a large number of university campuses, especially new ones, are located far away from their own cities. This can be regarded as one of the most challenging issues facing public universities particularly new campuses. Locating a university away from its city or its towns will have huge consequences now and in the future.

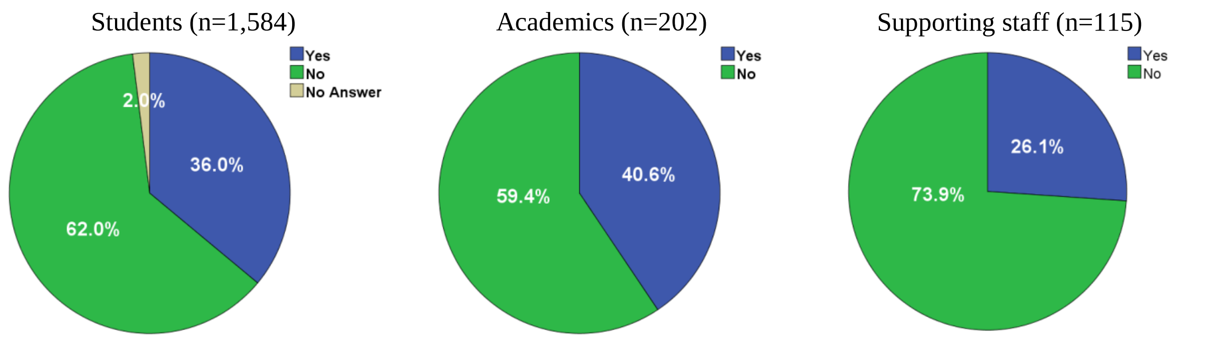


Figure 4.45: Is the university in close proximity to your place of living?

The distance of a university's location from its city can be explained in table 4.33. From the point of view of participants, there are a number of campuses that can be categorised as very far. These campuses are Najran, Hafr Albatin, Hail, Albaha, and Jazan with majority of their participants confirming this result, 80%, 78%, 71%, 69%, and 67% respectively. Those five universities abovementioned are recently established and hence have new campuses.

Table 4.33: Is the university in close proximity to your place of living?

No	Name of the institution (Code)	Is the campus in close proximity to your place of living?			Total
		Yes (%)	No (%)	No answer (%)	
01	King Saud (KSU)	153 (46%)	179 (53%)	3 (1%)	335
02	Islamic of Madinah (IUM)	45 (62%)	28 (38%)	0 (0%)	73
03	King Abdulaziz (KAU)	38 (58%)	27 (42%)	0 (0%)	65
04	Jazan (JNU)	78 (26%)	200 (67%)	18 (7%)	296
05	Hail (UH)	90 (27%)	234 (71%)	3 (12%)	327
06	Al Baha (ABU)	51 (28%)	122 (69%)	4 (3%)	177
07	Najran (NU)	27 (18%)	116 (80%)	2 (2%)	145
08	Prince Sattam bin Abdualaziz (PSAU)	163 (54%)	138 (46%)	0 (0%)	301
09	Hafr Al Batin (HAU)	38 (21%)	143 (78%)	1 (1%)	182
	Total	683	1187	32	1901

Participants were also asked about whether or not they live in the university campus, the vast majority of them indicated that they live off-campus. Figure 4.46 shows that only 6% live on-campus, while 90% live away from the university campus. This comes as no surprise given the fact that 70% of the universities in Saudi Arabia are recently established and hence their campuses are still under construction. It is also because, in some new universities, there is a delay in providing some housing units with essential services such as water, electricity and telephone lines for both students and staff housings.

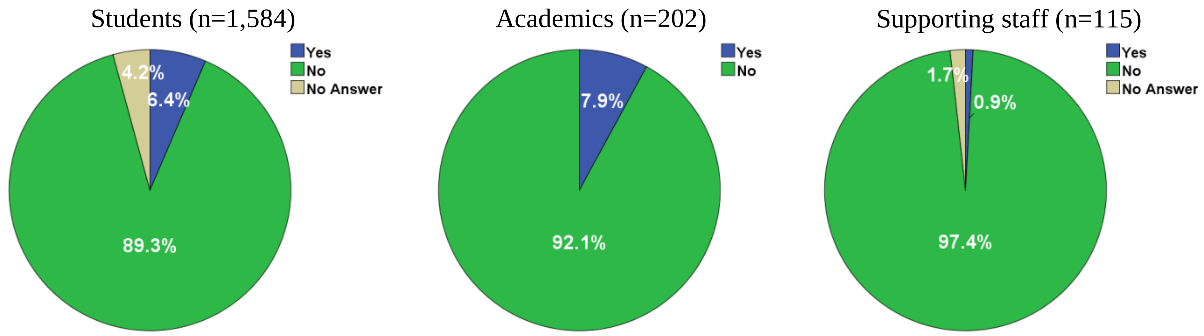


Figure 4.46: Percentages of people living in on-campus housing

The following question was about whether or not participants prefer to live on-campus instead of off-campus and why. Figure 4.47 illustrates that only one-third of the participants do prefer to live on-campus. The analysis shows that there is a variation among the groups. On one hand, only one-third of students prefer that, while almost a half of supporting staff prefer living on-campus. On the other hand, two-thirds of academics prefer to live on-campus. The reasons given by those academics that do prefer to live on-campus tend to be:

- Because of the close distance between work and place of living; hence the traveling distance will be shorter and thus no means of transport are needed
- It is easily accessible and traffic jam will be avoided and hence more time, effort, energy, and commuting expenses will be saved
- The staff housing on-campus is safe as well as convenient and that will help in the research and educational process (increasing productivity)
- It is also because of the variety of housing types and sizes available on-campus

- Finally, most academics feel satisfied and live in harmony with other families on campus.

However, the main reasons for living off-campus were:
- Housing is not constructed or not ready to be occupied yet
- Lack of basic supporting facilities and services such as schools, bookshops, clinic, supermarket, restaurants, places of worship, some of which are still under construction
- Scarcity of variety in types of housing provided to both students and staff in some university campuses
- The long distance from the city centre
- Other reasons include social reasons, difficulties in finding suitable housing unit to live in and finally some tightened rules and regulations when living on-campus

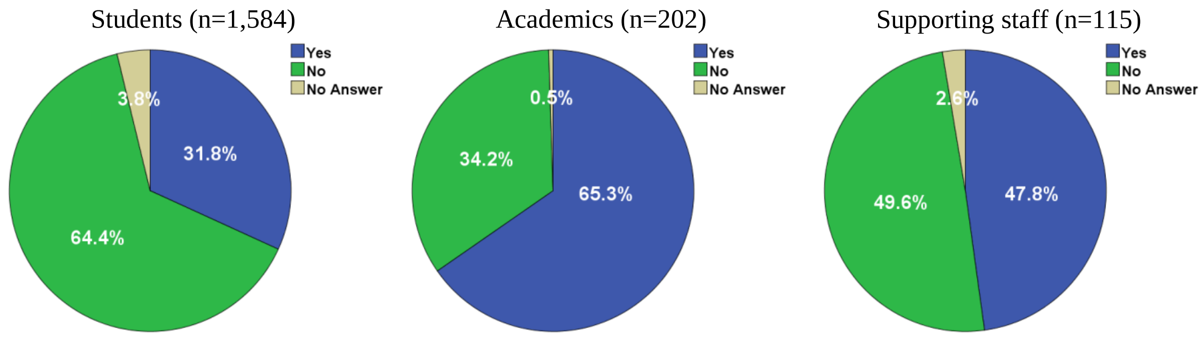


Figure 4.47: Preference of living on campus instead of off campus

The findings of observing the selected campuses have indicated a number of infrastructure issues and challenges. Figure 4.48 presents some of the infrastructure projects including road network, electrical grids, water supply, sewers, and telecommunications.

The first photo shows one of the gates of University of Hail, in the northern part of the Saudi Arabia. All new campuses of recently established universities have exactly the same gates and fence walls. The campuses are guarded and these gates, although symbolic, can be regarded as a check point controlling the access to the campus in which each and every user or visitor has to go through. The gates and the fence wall were one of the first infrastructure projects built in all campuses not only to be as an access control, but also to express ownership and territoriality.

The second photo displays the campus road network and the fence wall of Prince Sattam University, in the central part of the Kingdom. Although the ornamental fence is aesthetically pleasing to the eye, maintains visibility, and is not easily breached or vandalized, it costs dearly to maintain (Hanover Research 2013). The road network, including roundabouts, pavements, planting, and lighting systems, are among the first infrastructure projects to be constructed in every new campus.

The third photo presents the national electrical network and the power substation of University of Hafr Al Batin, in the eastern part of the country. Given the fact that most of the campuses of new universities have been remotely located from their cities, basic infrastructure such as the power lines have to be extended to reach these new campuses. Additionally, because of the size of new universities and the number of facilities each campus has, a substation has been built in each campus. The electrical substations are either to generate, transmit, distribute, or to transform voltage to university's needs. This is an unavoidable scenario, given the fact that a large development such as university campus has been located far from existing infrastructure. This in turn needs an extra budget that universities have to take into account.

One of the gates of University of Hail, northern part of the Kingdom of Saudi Arabia (KSA)

Campus ring road and fence wall of Prince Sattam University, central part of the KSA

Electrical grids and the power sub-station of University of Hafr Al Batin, eastern part of the KSA

Water supply by a large vehicle such as trucks in Najran University, southern part of the KSA

Septic tanks are emptied by vacuum track in Al Baha University, southern part of the KSA

Figure 4.48: Infrastructure projects in some of the new Saudi public universities

The fourth photo illustrates the water being supplied by large vehicles such as this truck in Najran University, in the southern part of Saudi Arabia. This is just an example of how the water is being obtained for the vast majority of new universities. Until the campus water tanks are built, water storage tanks for firefighting are used instead. Water in a desert country is a major challenge. What makes the situation even more difficult is the location of new campuses, which is distant from their cities and hence far away from the already existing water supply network. New universities, therefore, are struggling to secure water supply to their academic buildings, housing zones, hospitals, and the rest of the campus facilities.

The fifth and final photo demonstrates how campus septic tanks are emptied using vacuum tracks in Al Baha University, in the southwest of the Kingdom. Although there will be a wastewater treatment plant in each campus, until then vacuum tracks will be seen in the new university campuses. This is just another consequential result of the problem of site selection.

4.5.3.2. Physical accessibility

The physical accessibility is an issue to be addressed especially in countries that can be described as car-oriented societies such as Saudi Arabia. Transportation is one of the problems that has no simple, quick, or cheap fix. The geographical locations of campuses along with the availability of alternative transportation modes are two important issues to explore. The 20 recently established universities have been located in provinces that have had no history of hosting any higher education institution. Table 4.34 illustrates the distance between the main campus of the each public university in Saudi Arabia and the centre of the main city in each province. The centres of big cities were used as a reference given the expected high population density. Google Maps (2017) were employed to measure the distance in kilometres.

The table shows that the overall average of distances is 22 kilometres, which seems relatively reasonable. However, it can be noticed that there is a difference between old and new universities in terms of the average distance. The average of distance of well-established universities, which are the oldest eight institutions, is 15 kilometres, while the average of the 20 recently established universities is 25 kilometres. This indicates that 70% of users of campuses in Saudi Arabia commute for longer distances. The table shows that there are four campuses that are located in remote sites of their cities. These institutions are the University of Jeddah and Najran University, 55 kilometres and 50 kilometres respectively. Other universities that also share the same location and accessibility issue with a distance of 35 kilometres are Northern Boarder University and Al Baha University.

Table 4.34: How far the main campuses of the 28 public universities are from the centre of the main city

No	University (City)	Distance in km (Google Maps 2017) 0.........10.........20.........30.........40.........50........60
01	King Saud (Riyadh)	18 km
02	Islamic of Medina (Medina)	10 km
03	King Fahd for Petroleum & Minerals (Dhahran)	08 km
04	King Faisal (Al Hofuf)	10 km
05	King Abdulaziz (Jeddah)	10 km
06	Imam Muhammad Ibn Saud Islamic (Riyadh)	28 km
07	Umm Al Qura (Makkah)	20 km
08	King Khalid (Abha)	12 km
09	Qassim (Buraydah)	30 km
10	Taibah (Medina)	12 km
11	Taif (Taif)	25 km
12	King Saud bin Abdulaziz for Health Sci. (Riyadh)	30 km
13	Jazan (Jazan)	10 km
14	Hail (Hail)	20 km
15	Al Jouf (Sakaka)	30 km
16	Al Baha (Al Baha)	35 km
17	Tabuk (Tabuk)	15 km
18	Najran (Najran)	50 km
19	Northern Border (Arar)	35 km
20	Princess Nora bint Abdulrahman (Riyadh)	33 km
21	Shaqra (Shaqra)	15 km
22	Prince Sattam bin Abdulaziz (Al Kharj)	10 km
23	Imam Abdulrahman Al Faisal (Dammam)	20 km
24	Majmaah (Al Majmaah)	10 km
25	Saudi Electronic (Riyadh)	25 km
26	Hafr Al Batin (Hafr Al Batin)	22 km
27	Bisha (Bisha)	05 km
28	Jeddah (Jeddah)	55 km

However, not every campus user lives in the main city or in the city centre. Hillman and Weichman (2016, 2) indicate that in the United States of America 'place still matters, in fact, the majority – 57.4 percent – of incoming freshmen attending public four-year colleges enrol within 50 miles [80 kilometres] from their permanent home'. The statistical analysis of distance between campuses and place of living in Saudi Arabia, shown in table 4.35, suggests that of the 1901 participants, around 68% answered the question of providing the actual distance in kilometre. The analysis demonstrates that on average, Saudi students, academics, and supporting staff travel some 44 kilometres distance between their place of living and their university campuses almost on a regular basis. People from universities such as King Saud University and Prince Sattam University are well-connected to their cities with very short distances, with minimum distance of one kilometre for some individuals. That is either because the location of their campuses are within or in close proximity from their cities or they are fortunate to live in on-campus housing. The maximum distance shown in the analysis is 300 kilometres, which has been pointed out by four participants from Jazan University, Al

Baha University, and Prince Sattam University. The analysis also shows that there are 46 participants who indicated that they commute between 150 and 300 kilometres to their campuses.

Table 4.35: Statistical analysis of distance in kilometres

How far in kilometres approximately?		
N	Valid	1290
	Missing	611
Mean		43.4
Median		30.0
Std. Deviation		42.0
Minimum		1
Maximum		300

Participants in the questionnaire were also asked about the used modes of transportation. Figure 4.49 displays the types of transport the 1,901 participants use. The analysis shows that the vast majority of participants use their own cars to come to the university campus. That is obvious given that the Kingdom is a car-oriented country. It is also reported in other research such as Abubakar et al. (2016, 10) who highlighted the issue of transportation when assessing sustainability in Imam Abdulrahman Al Faisal (formerly known as University of Dammam):

> *'43.4% of the students indicated that there is no sustainable transportation program on the university campus, as they commute to the university and move around the campus using their private automobiles.'*

Other mode of transportations mentioned by participants was taking a taxi. This was reported by only 2% of the participants. The majority of them were either academics or students; both tend to be new to the university or not owning a car yet.

However, the data analysis reveals promising trends for more sustainable modes of transportation. Carpooling, for instance, is used by 10% of commuters in public universities. Sharing a car is popular among all three groups; students, academics, and supporting staff. The other relatively common modes include using the campus fleets and or just walking, 3.5% and 3% respective. Although the figure shows that few people come to the university on foot, those who come walking most likely live in on-campus housing. It is very rare to go to the campus on foot. The distance is one obvious reason, but also it is because walking is not common in Saudi Arabia for various reasons such as the weather, culture, and cheap fuel price, to name but a few. The surprising result was cycling, which is the mode of transport used by mainly students in well-established universities such as King Saud University (Riyadh) and Islamic University of Medina (Medina).

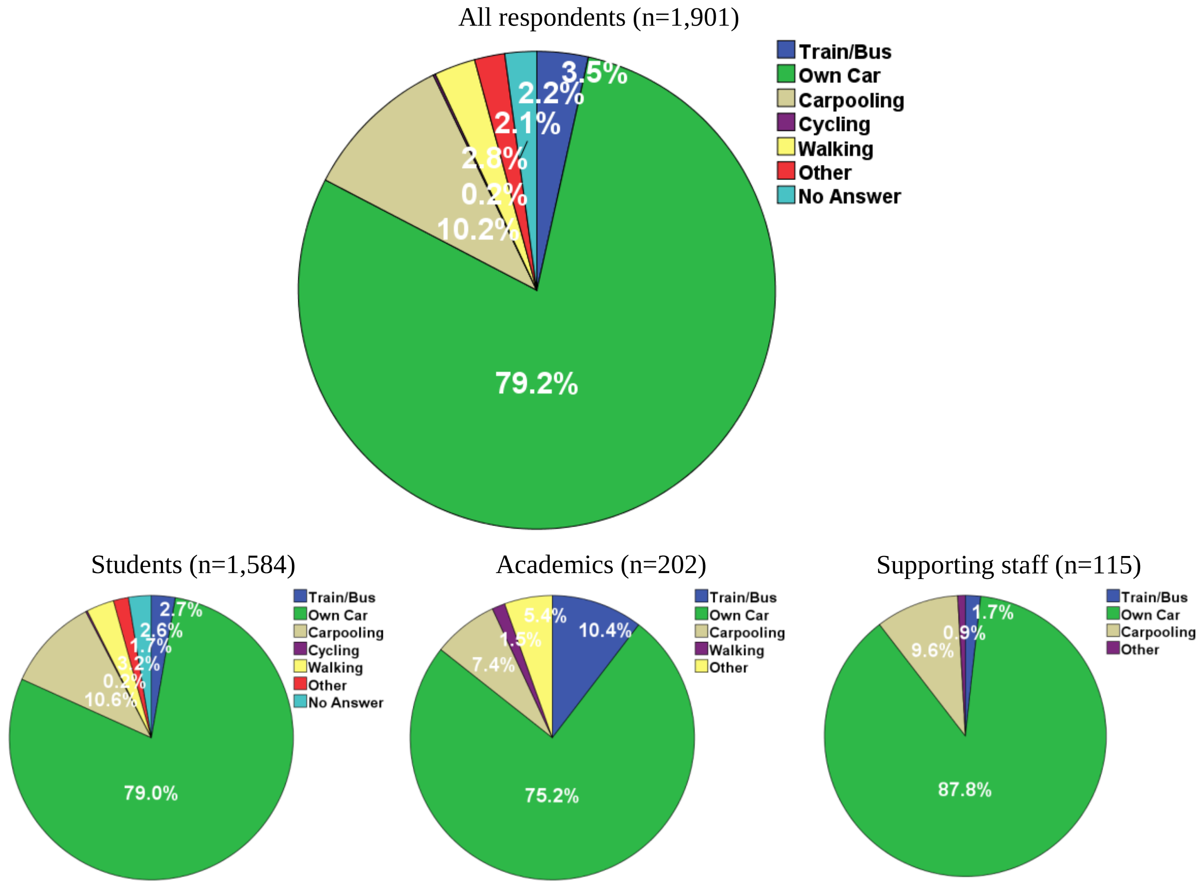


Figure 4.49: The used modes of transportation

The analysis also indicates that the majority of public universities in the Kingdom have contracted private companies to transport their female students to their main campuses and also branches. Some universities have female student housing such as King Saud University, King Abdulaziz University, Umm Al Qura University, and Princess Nourah bint Abdulrahman University, Al Baha University, and Jazan University. Some universities have a fleet of busses transporting users within the campus such as King Saud University, King Fahd University for Petroleum and Minerals, and King Abdulaziz University. King Abdullah University of Science and Technology (KAUST 2017) provides 'alternative fuel vehicles and shuttle buses for campus and community use' and 'bicycles are widely used with bicycle racks widely available'. Some public universities offer more sustainable alternative transportation modes. For example, in its 6-million square metres campus in Riyadh, King Saud University for Health Sciences provide electric buses serving more than 10 thousand students, see figure 4.50. Another example is women only institution Princess Nourah bint Abdulrahman University, which provides driverless metro serving over 40 thousand female students in 8-million square metres campus. Figure 4.51 shows one of the 14 metro stations operated by around 60 female engineers and technicians, most of whom are Saudis (Al-Jazirah 2017).

Figure 4.50: Electric buses in King Saud University for Health Sciences in Riyadh (ABB 2017)

Figure 4.51: Driverless metro in Princess Nourah bint Abdulrahman University (Hitachi Rail 2017)

The question of how long the commuting time to the university is was raised. The analysis in figure 4.52 exhibits that one-third of the participants spend from 10 to 20 minutes to go to their colleges. However, two-thirds of those who took part in the research pointed out that they take between 30 minutes to one hour driving to their university campuses almost on a daily basis. This highlights the issue of long distances between campuses and their cities, which has been confirmed in previous figures and tables.

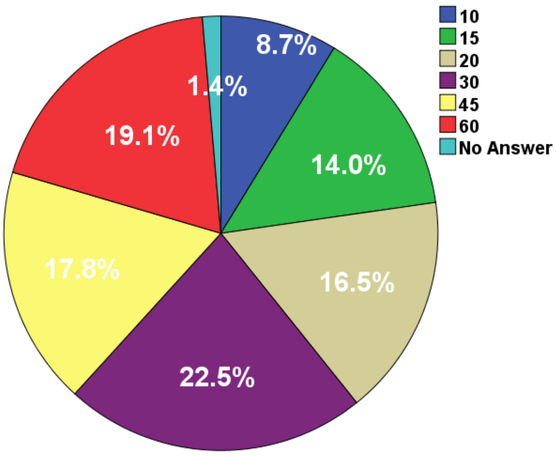


Figure 4.52: Commuting time spent from home to university

Participants were also asked about the number of car parking spaces on their campuses. Figure 4.53 shows that only one-quarter of the participants believed that car parking spaces in their university campuses are about right. However, there are over 40% of people in public universities who pointed out that the spaces for car parking are too little. In contrast, there are around 40% who stated that there are too many car spaces in their campuses. Scanning the campus master plans indicates that campuses have a large size of car parking lots. Plenty of spaces undoubtedly encourage people to use their own cars instead of other more sustainable means of transport.

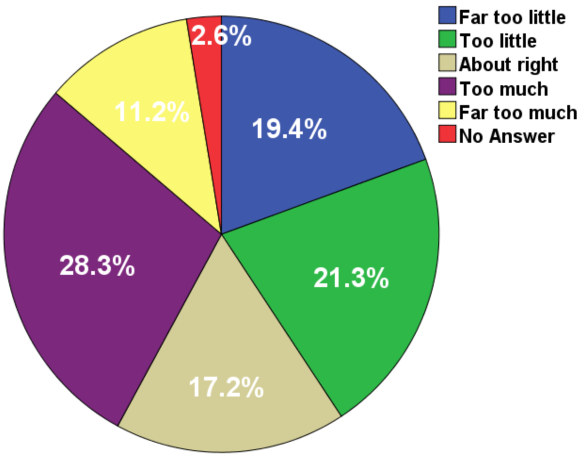


Figure 4.53: Assessing the number of car parking spaces on campus

Another explored aspect was the willingness to use public transportation, university fleet, or to share a car. Figure 4.54 shows that well over half of the participants are prepared to do so. Around 40% is not willing to use public transportation, university buses, or carpooling. Those who are not willing suggested that they have for example busy schedules, social reasons including taking family members with them using their own cars, or public transportation does not exist yet in most cities in the Kingdom. Furthermore, other claimed reasons include convenience, independence, and privacy. However, among the three surveyed groups (students, academics, and supporting staff), three-quarters of the academics pointed out their willingness to use public transportation, whereas just over half of the students are willing and the same goes for the supporting staff.

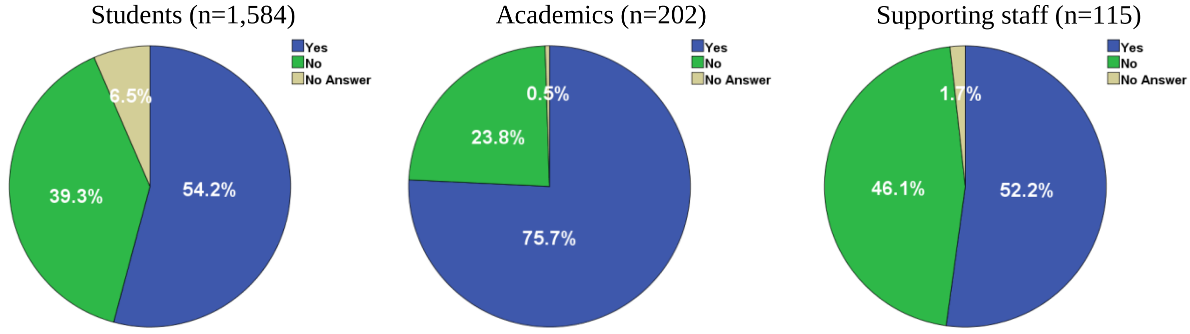


Figure 4.54: Willingness to use public transportation, university fleet or share a car

Participants were asked whether or not their universities have developed actions to reduce the need to travel using for example the tele-education, tele-working, or flexible schedules-working hours etc. Figure 4.55 demonstrates that almost half of the participants indicated that their universities have no actions in place to reduce the need to travel to the university. However, only 20% indicated that such practices do exist in their universities.

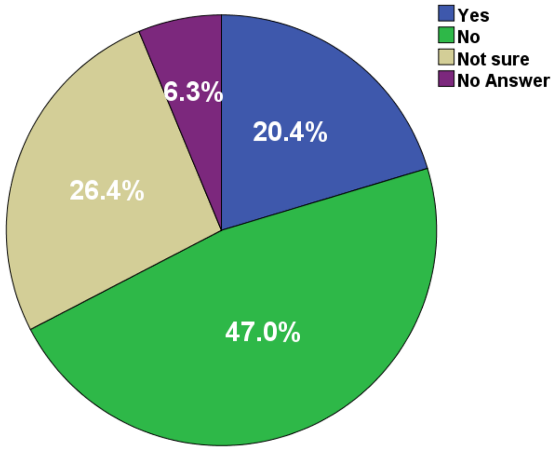


Figure 4.55: Current practices and actions to reduce the need to go to university

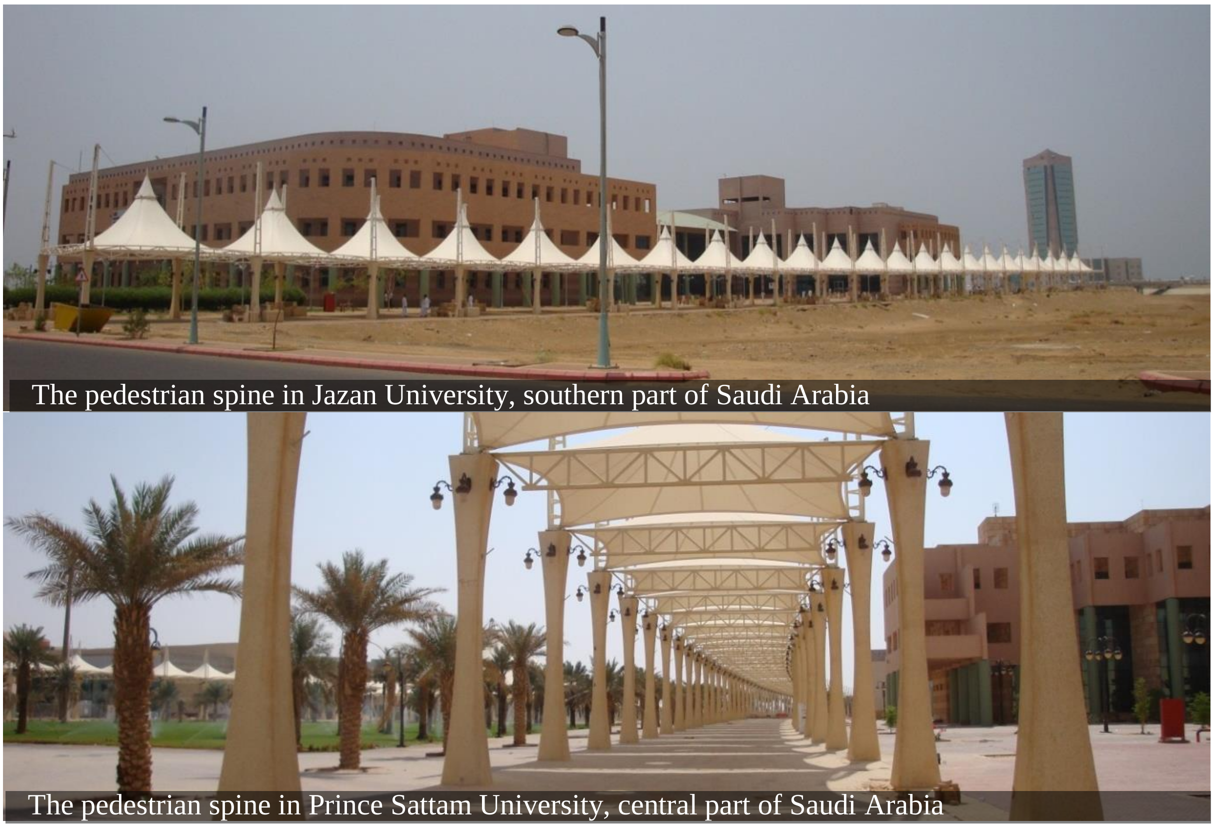
4.5.3.3. Climate considerations

Although the general character of the climate in Saudi Arabia is a desert, the country has a variety of climates given its semi-continent size. For instance, the west side of the Kingdom is characterised as tropical arid climate (mild temperature in winters), while the southwest side of the country is characterised as temperate climate (moderate temperature given the highlands). As a result, these different climates give an indication that they have to be taken into account when planning and designing for large projects such as university campuses.

The analysis of the 20 recently established university campuses have been located all over the country. This means that there should be a consideration for the climate of each province. However, examining the master plans of new campuses as well as the college buildings indicates that little attention has been paid to the climate considerations. The design was standardised and the same prototypes of college buildings can be seen in different provinces for different campuses.

The analysis shows that the concept of compactness, which is to occupy as little space as possible, was not realised. In fact campuses and college buildings are believed to be large in size. This negatively impacts the density, outdoor walking distance, and the amount of exterior envelope exposed to the blustering sun of Saudi Arabia. This goes against the traditional urban design in Saudi Arabia where compacting the development is one of the key passive strategies employed. Such strategy has a huge impact on the performance of buildings, users, and beyond. For example, given the size of the new campuses, walkability is seen by campus users as an issue. However, the architectural firm points out that ‘*we thought about creating walkable environment, safe, car-free, and hence carbon-free*’. Figure 4.56 shows two examples of pedestrian spines from two campuses; Jazan University and Prince Sattam University. The spine was designed to easily connect the campus’s zones. It considers not only linking colleges together, but also other zones in the campuses such as housing.

The analysis indicates that compactness, natural light, natural ventilation, and shading are all basic elements of planning and design, which have not been given enough attention in the new campuses. The analysis also shows that failing to properly address the issue of compactness leads to a low campus density. The latter has a positive impact on the infrastructure, mobility, land utilisation, operation, and safety on campus. It enriches the sense of community on campus as well as it stimulates collaboration and innovation through encouraging ‘encounters between different users or user groups, aligning with organisational goals to work on cross-disciplinary products... increasing occupancy and frequency rates in combination with reducing the footprint per user’ (Den Heijer 2011, 98).



The pedestrian spine in Jazan University, southern part of Saudi Arabia

The pedestrian spine in Prince Sattam University, central part of Saudi Arabia

Figure 4.56: Examples of pedestrian spine from two different campuses in Saudi Arabia

Another issue with the standardisation of not only the physical facilities, but also the landscaping objects. The analysis shows that plants and landscaping objects were also standardised in almost all the new campuses. A facility manager points out that

> *'The Ministry seems to standardise even the landscape plants including the palm trees. We understand that the main reason for such decision may be because the palm tree is a symbol of the country (the national emblem). However, using palm trees in all campuses in different parts of the country is proven to be a problematic for several reasons. First, in some northern parts of the country, such as Hafr Al Batin, palm tree is not favoured, because it does not produce fruit. Hence, there is no real benefit of it except as a symbolic object. Second, according to the Ministry's landscape contract, the palm tree must be 6-meter high. However, this would be possible in some parts, but not in every part of the country. That is because of the strong wind in city like Hafr Al Batin, which causes a huge damage to trees such as palm.'*

Figure 4.57 shows a comparison of planting palm trees in two different campuses. The top photo illustrates the state of palm trees in University of Hafr Al Batin in the eastern part of the country (where planting such trees are not appropriate), while the photo in the bottom presents palm trees in Prince Sattam University in the central part of the country (where planting such tree is suitable).

Planting palm trees in the campus of University of Hafr Al Batin, eastern part of the Kingdom

Planting palm trees in the campus of Prince Sattam University, central part of the Kingdom

Figure 4.57: A comparison of planting palm trees in two different campuses in Saudi Arabia

College buildings: The analysis shows that the design was standardised and the same prototypes of colleges were used in different campuses in different universities. Standardisation does not take into account the differences in a) size of student body, b) education programs, c) attitudes to campus housing, d) importance of having a unique image and identity, e) climate (air temperature, humidity, wind, dust storm, rain...etc.), f) landscaping, and g) building materials' specifications, to name but a few.

The findings indicate that the size of college buildings is larger than necessary. Many of the college buildings in new campuses are housing more than one college. This can be seen in for example, Najran University, Al Baha University, University of Hafr Al Batin, University of Hail, and Prince Sattam University. An observation in these university campuses illustrates that the issue of standardisation has created costly and wastefully spaces. It seems that the size of the university campus and college buildings in terms of square meter per user has been properly planned.

The analysis of the master plans of recently established universities shows poor orientation of the campus buildings. Universities can save substantial amount of energy through orientation, appropriate shades, windows, and vents in order to take advantage of natural ventilation, solar energy, and daylight. Figure 4.58 presents two examples of not only poor orientation of college buildings, but also the excessive use of glassing in the façades.

Eastern façade of Community College at University of Hafr Al Batin, eastern part of Saudi Arabia

South façade of College of Engineering at Najran University, southern part of Saudi Arabia

Figure 4.58: Examples of glassed façades from two different campuses

With regards to the energy efficiency, a few numbers of recently established universities have invested in green strategies to increase energy efficiency. For example, Najran University has installed motion sensors to control the light and the air condition in the college buildings. The analysis of observing campuses suggest that currently there is no big investment by universities in generating on-site renewable energy using wind, solar, biofuels, and other alternatives.

4.5.3.4. Flexibility

This research explores some of the properties of flexibility. That is only in terms of building elements, furniture, and time. The latter refers to strategies that can be employed by higher education institutions such as online education, flexible work schedules, and remote work arrangements. The investigation shows that not only the Kingdom has an online university known as Saudi Electronic University, but also many of its public universities offer distance education and distance learning. Many of the public universities have deanships of e-learning and distance education with the aim of advancing both online teaching and learning through state-of-the-art-technology platforms including smart classrooms and virtual labs. However, options such as flexible work schedules and remote work including tele-work, tele-commute, or work-from-home offered by institutions cannot be found in public universities in Saudi Arabia.

The analysis of the questionnaires suggests that over a half of the academics has a flexible schedule and are willing to deliver lectures in the evening (between 17:00 and 21:00), whereas around a quarter of students and supporting staff favour the evening period instead, as can be seen in figure 4.59. This is advantageous when thinking about optimising the utilisation of college buildings. Around a quarter of students and supporting staff favour the evening classes instead of the morning sessions.

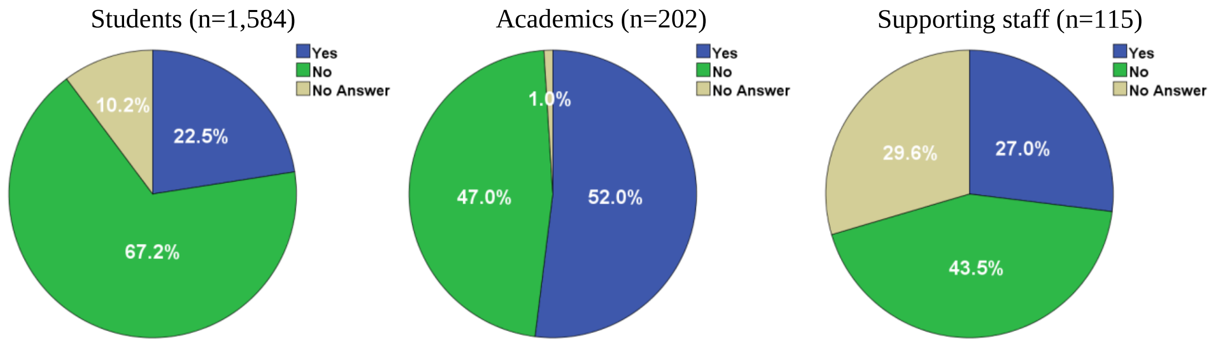


Figure 4.59: Willingness to attend university in the evening (between 17:00 and 21:00)

Figure 4.60 shows the number of people who actually prefer to attend university in the evening sessions (between 17:00 and 21:00) rather than the daytime working hours (between 09:00 and 17:00). The result indicates that only 12% prefer to go to the university in the evening. Even with this small percentage, the utilisation of the building can be optimised. It is noticeable that around a quarter of the 1,290 respondents did not answer this question. The 12% is promising, but had the 22% of participants answered this question, the percentage might have increased even further.

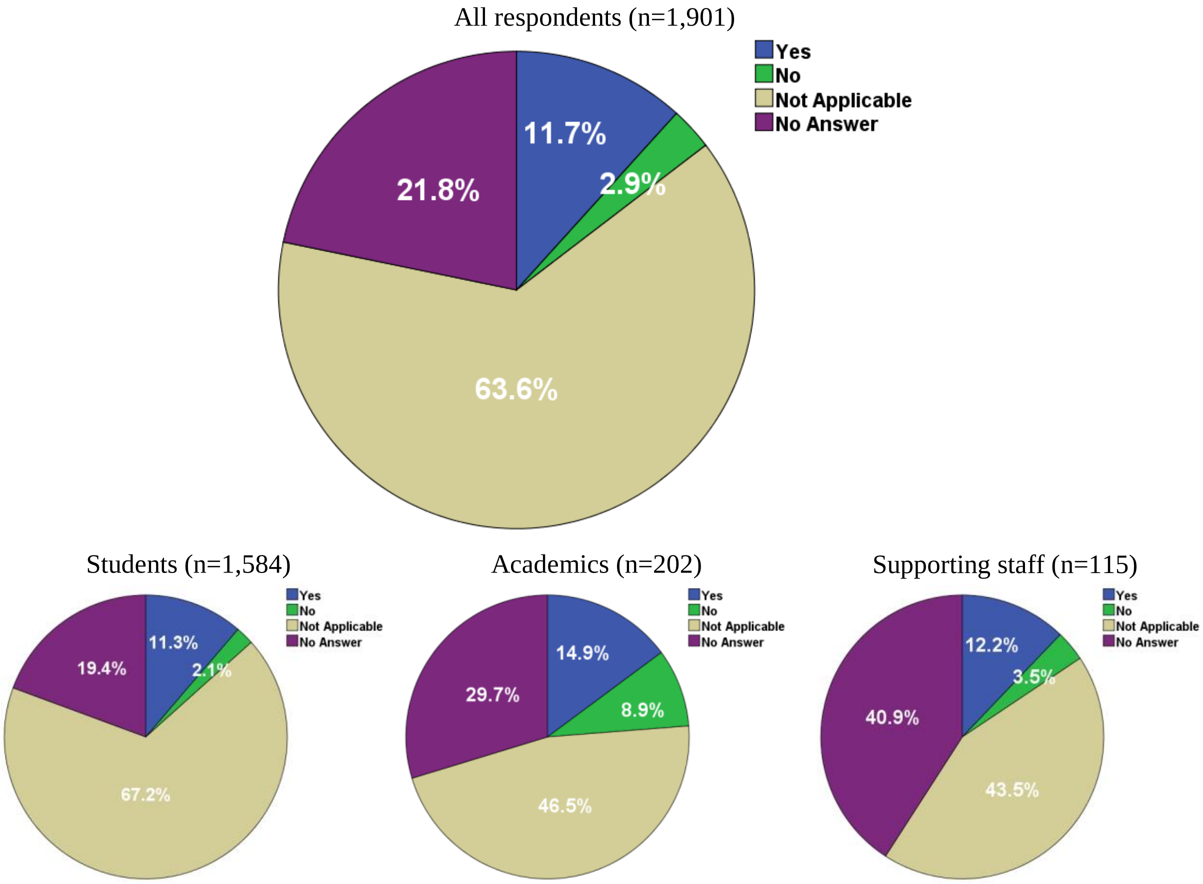


Figure 4.60: Prefer to attend university in the evening (between 17:00 and 21:00)

Another aspect of flexibility explored is physical flexibility. It was defined by Monahan (2002, 1) as ‘the adjustability of a space to the practices of individuals, such as meeting the special sensory and/or mobility needs of students. Movable furniture and walls, or re-configurable buildings, rooms, and passageways all represent this type of physical flexibility.’ The findings of this research indicate that physical flexibility in the layout of college buildings in campuses of recently founded universities has been highlighted as an issue. Table 4.36 illustrates that about two-thirds of the participants indicated that the spaces in their college buildings can be used for multiple purposes. Furthermore, one-third pointed out that spaces can easily adopt new functions. However, only a quarter of the respondents believed that the spaces of college buildings can be expanded and/or contracted. The question to raise here is to what extent the internal layouts can be responsive to the immediate as well as the long-term change. A flexible layout that is easy and quickly reconfigure must be comprised of mobile components such as partitions, furniture, and equipment. Monahan (2002, 02) emphasises this saying:

> *'Highly modifiable spaces invite imaginative experimentation to coordinate space and subject matter with the specific learning needs of different student populations. The design of such spaces requires much forethought, because these spaces must take into account many structural dependencies such as ceiling configuration for lighting and air circulation, floor materials for ease of partition movement, and so on'.*

Table 4.36: Space flexibility

Space flexibility properties	Number of responses	Percentage of responses	Percentage of cases
Opportunities to use spaces for multiple purposes	890	52.0%	65.4%
Easiness of adapting spaces for new functions	457	26.7%	33.6%
Easiness of expansion and/or contraction of educational space	366	21.4%	26.9%
Total	1,713	100.0%	125.9%

King Saud University (KSU) can be considered as one of the most flexible campuses in Saudi Arabia. Campus buildings were smartly planned in an integrated way which allows for great physical flexibility. The interior elements (floors, walls, and ceiling) are integrated with the building systems (lighting, air conditioning, fire systems...etc.) using a design module of 1.2 by 1.2 meter. Such choice of measurement helps enormously in the building layout in which it works in line with the structural module of 9.6 by 9.6 meters. The 9.6 meters structural module can be divided into 8 units of 1.2 meter. Additionally, this systematic module can give a variety of different sizes of space and hence different layouts. For example, 9.6÷4=2.4 meters width are usually for corridors, 9.6÷3=3.2 meters width are typically for offices, 9.6÷2=4.8 meters width normally for middle size classrooms, and 9.6 meter by 9.6 meters are for big classrooms, studios, or workshops. This principle of standardised module has been used in the buildings of the entire KSU campus. Another interesting example of achieving flexibility is through the materials used. KSU campus uses a metal floor-to-ceiling partition system for the interior walling in all the campus buildings as shown in figure 4.61. These partitions, as well as ceiling panels, can be easily removed, unlike the internal walls in all recently established universities where materials such as concrete blocks or gypsum boards were used. Although the initial costs of both the partitions and the ceiling panels are high, they are both made of maintenance-free materials. As a result, it seems that flexibility has been addressed sufficiently in campuses of well-established universities such as KSU, while in the campuses of recently founded universities it has not been given enough attention.

Figure 4.61: The metal floor-to-ceiling partition system in King Saud University (KSU)

The third aspect of flexibility is furniture in the college buildings. Flexible furniture in any classroom in colleges can be easily reorganised in any of these multiple configurations: linear (lecture, presentation, and video), horizontal (class discussion), cluster (small group discussion and activities), and network (decentralised instruction). Figure 4.62 shows that almost half of the 1901 participants indicated that the furniture of their colleges is flexible. In contrast, only 20% of respondents stated that the furniture cannot be easily reorganised for different configurations.

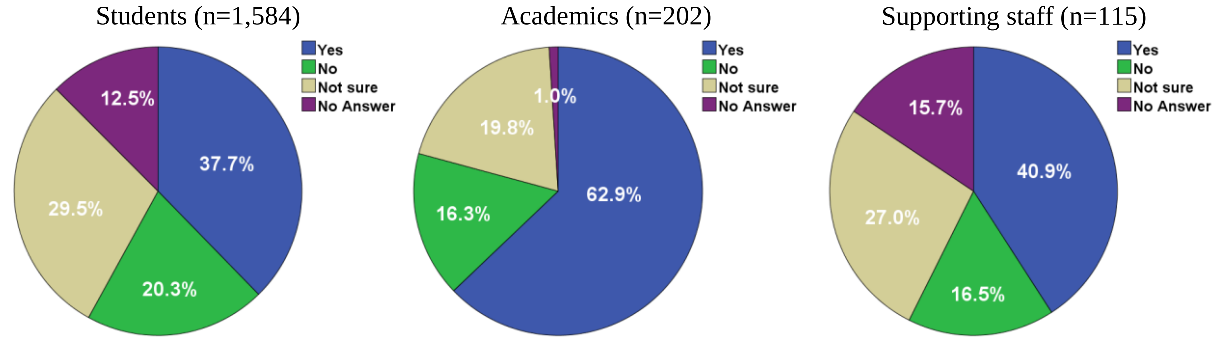


Figure 4.62: Flexible furniture

4.5.3.5. Space utilisation

Two techniques were employed in order to collect data to explore the utilisation level in public university campuses in Saudi Arabia. The primary technique was the examination of the space usage of five college buildings in five different universities. The second instrument employed was a questionnaire in which 1,901 campus users including students, faculty members, and supporting staff were asked about their experience of space use in their college buildings.

Given that the majority of higher education institutions tend to focus on the general purpose teaching space, this study has followed suit. Therefore, this research concentrates on general teaching rooms which include mainly classrooms, few teaching laboratories, studios, and computer rooms. Other rooms such as specialist teaching space (theatres/auditoriums), research space (research laboratories), offices (for both academic and staff), and supporting space (libraries, meeting rooms, exhibition areas, conference rooms, staff rooms, and leisure rooms) are not included in this examination.

As for how space utilisation rate is calculated, this research uses the scheduled activities and the planned group sizes to calculate the predicted utilisation rates. This means that this study uses data from the timetables of the five existing college buildings in order to assume how teaching space is utilised in Saudi Arabian campuses. Digital copies of the timetables have been requested from the Registration Departments at each college. Microsoft Excel program was used for data entry and analysis.

The research collected its data during the second semester of the academic year 2015-2016 and hence the results of this research represent the utilisation rates of that period. This research uses the standard working hours of 40 hours per week for its analysis (eight hours a day; 09:00 - 17:00). However, since universities in Saudi Arabia have different timetables, hence no ‘typical day’, a comparison between different working hours per day and their impact on the utilisation rates has been carried out to identify the utilisation levels in every case. Note that the working week in Saudi Arabia starts on Sunday and ends on Thursday.

Therefore, the sample in this research consists of five college buildings from five different universities; four buildings were from recently founded universities, while one building was from a well-established university. Table 4.37 illustrates the five cases and some basic information for each case. The choice of these five cases was purely based on the availability of information and also permission to access these premises. These cases are:

- 1st Case: College of Languages and Translation at King Saud University (KSU) that founded in 1957, and is in the centre of the country (Appendix D.1).
- 2nd Case: College of Science at University of Hail (UofH) that founded in 2005, and is in the north of the country (Appendix D.2).
- 3rd Case: College of Engineering at University of Najran (UofN) that founded in 2006 and is in the south of the country (Appendix D.3).
- 4th Case: College of Science and Humanities at Prince Sattam bin Abdulaziz University (PSAU) that founded in 2006, and is in the centre of the country (Appendix D.4).
- 5th Case: Community College at University of Hafr Albatin (UHB) that founded in 2006 and is in the east of the country (Appendix D.5).

Table 4.37: The research sample for space utilisation study

1st Case	2nd Case	3rd Case	4th Case	5th Case
				
College of Languages and Translation	College of Science	College of Engineering	College of Science and Humanities	Community College
King Saud University	University of Hail	University of Najran	Prince Sattam bin Abdulaziz University	University of Hafr Albatin
(KSU)	(UofH)	(UofN)	(PSAU)	(UHB)

In order to assess the space at 'a time of peak load', 30 of the busiest rooms were selected in each college building. These rooms were selected based on their high frequency and occupancy rates. The total number of rooms analysed in this research were 150 rooms. Figure 4.63 displays the frequency, occupancy, and utilisation rates of the five college buildings. The figure shows each college individually, in which there were two colleges with very low utilisation rates (UofN 7% and UHB 7%), two colleges with fair level of utilisation (KSU 25% and UofH 32%), and one college with relatively high rate of utilisation (PSAU 36%). The poor utilisation rates are caused by very low frequency and occupancy rates. It has to be highlighted though that these rates represent the 30 busiest rooms in each college building. Therefore, this indicates a serious utilisation issue, given that the predicted or timetabled rates tend to be higher than the actual use of space.

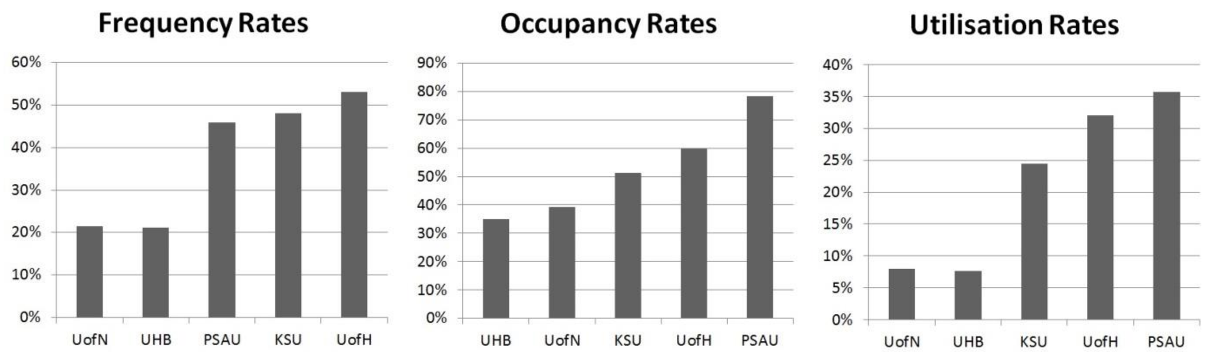


Figure 4.63: Frequency, occupancy, and utilisation rates of the five college buildings

This research uses the standard working hours of 40 per week for its main analysis (eight hours a day; 09:00 - 17:00). Table 4.38 shows the frequency, occupancy, and space utilisation rates of all college buildings combined when working hours are between 09:00 and 17:00 (8 hours per day - 40 hours per week). It illustrates that the average rate of utilisation of all college buildings is low (22%). However, given that every institution has a different timetable (no fixed working hours per day), a comparison between different working hours per day and their impact on the utilisation rates was carried out to identify the utilisation levels in every case. Tables 4.39 and 4.40 present the frequency, occupancy, and space utilisation rates of all college buildings combined when working hours are between 08:00 and

17:00 (9 hours per day - 45 hours per week) and when working hours are between 08:00 and 20:00 (12 hours per day - 60 hours per week). In all seniors, the utilisation rates are very low, except in the old college where working hours are 45 per week. These low utilisation rates are alarmingly low, since the analysed rooms were supposed to be the busiest in each building.

Table 4.38: Space utilisation rates of buildings - working hours are between 09:00 and 17:00

	Frequency %	Occupancy %	Utilisation %
Average rates of recently founded colleges	35%	53%	21%
Average rates of old college	48%	51%	24%
Average rates of all	38%	53%	22%

Table 4.39: Space utilisation rates of buildings - working hours are between 08:00 and 17:00

	Frequency %	Occupancy %	Utilisation %
Average rates of recently founded colleges	37%	53%	22%
Average rates of old college	50%	53%	27%
Average rates of all	39%	53%	23%

Table 4.40: Space utilisation rates of buildings - working hours are between 08:00 and 20:00

	Frequency %	Occupancy %	Utilisation %
Average rates of recently founded colleges	26%	52%	15%
Average rates of old college	35%	53%	19%
Average rates of all	28%	52%	16%

Another serious issue is the space area per an equivalent full-time student unit (EFTSU). The analysis of space per user in the five college buildings (see Appendix D) shows that the average area per student is 1.8 m2 per student. This excludes specialised teaching rooms such as science laboratories, computer rooms, and studios, which all have different size requirements. The standard for general teaching room suggests 1.0 m2 per workplace (UGC 1987). Therefore, space planning in terms of space per user has to be addressed, given that the average area of teaching space in Saudi Arabia tends to be higher than the norm.

The space planning issue, above mentioned, has led to a mismatch between the planned capacity and the scheduled capacity. The planned capacity is what the designers/architects have suggested for each space, whereas the scheduled capacity is what the college registrars have actually scheduled in each space (the scheduled group size). The average difference between the available capacity and the scheduled capacity is 5.2 people. This demonstrates another issue with facility management practices particularly in the allocation of teaching space. It has to be emphasised that there is a difference between the scheduled capacity and the actual attendees (or the real-time use). The latter provides very accurate occupancy rate and hence utilisation rate.

Further facility management issue discovered is the allocation of teaching rooms per department per subject. The analysis shows that only 44% of the total 150 rooms surveyed were commonly used by different departments for different subjects. To increase the utilisation rate of teaching space and counteract the ‘territorial culture’, more rooms should be accessible to all departments. This can be achieved when classrooms are managed centrally in order to maximise the frequency in using the space.

The frequency rate per timeslot indicates the number of times the room is being used during the day. Table 4.41 shows a heat map that represents how the frequency rates of 150 rooms surveyed differ during the week. The highest frequency rates were coloured with dark green, whereas the lowest frequency rates were coloured with dark red. The last column shows the average frequency rate per day. It indicates that the busiest days in all college buildings were Sundays. Tuesdays were not too far behind Sundays. By contrast, Thursdays had the lowest average frequency rate. The table also shows that in general, morning timeslots were busier than the afternoon timeslots. The timeslot 10:00 to 11:00 had the highest frequency rates in almost all days. However, the timeslot 12:00 to 13:00 was the least, given that in most universities this is the lunch hour. Overall, the last timeslots of the days were less busy.

Table 4.41: A heat map representing the frequency rates of 150 rooms surveyed

	09:00 to 10:00	10:00 to 11:00	11:00 to 12:00	12:00 to 13:00	13:00 to 14:00	14:00 to 15:00	15:00 to 16:00	16:00 to 17:00		Average
Sunday	55%	61%	64%	16%	41%	35%	31%	24%		41%
Monday	51%	61%	53%	16%	37%	38%	31%	23%		39%
Tuesday	55%	63%	53%	16%	42%	38%	31%	22%		40%
Wednesday	47%	55%	47%	19%	41%	40%	29%	23%		38%
Thursday	52%	49%	40%	12%	39%	30%	21%	15%		32%

Figure 4.64 is another representation of how the frequency rate changes during the weeks of the semester. It represents the fluctuation of the frequency rates identifying the peaks and troughs patterns. This shows how the use of teaching rooms changes throughout the week. The ideal situation would be a complete flat line (represented in dark green), which means that almost every room in the college building is being used for the same amount of time during the semester. These peaks and troughs result in having to supply more rooms than what is actually needed.

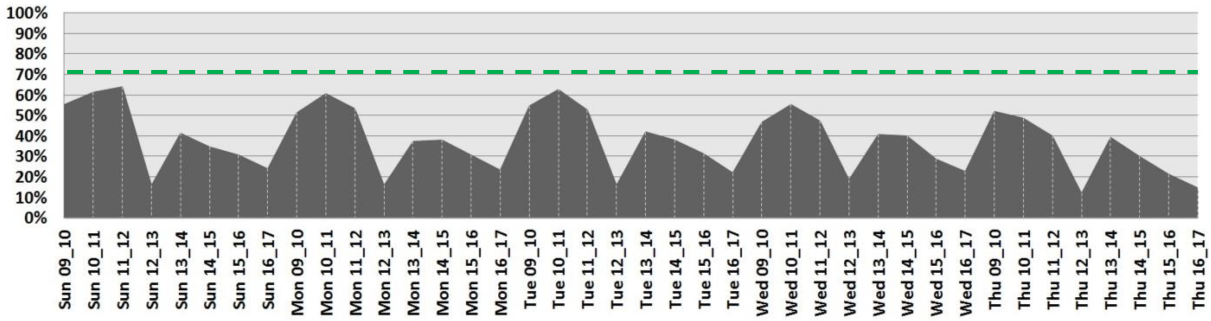


Figure 4.64: The frequency rate per timeslot

The occupancy rate per timeslot indicates the size of the group to be occupying a room during every timeslot. Table 4.42 displays a heat map that shows how the occupancy rates of rooms surveyed vary during the week. The highest occupancy rates were coloured with dark green, while the lowest occupancy rates were coloured with dark red. The last column demonstrates the average occupancy rate per day. It shows that Sundays were the busiest days in all five college buildings, followed by Wednesdays, 49% and 45% respectively. In contrast, Tuesdays had the lowest average occupancy rate with 45%. The table also presents that generally, the size of the student groups in the morning timeslots were bigger than in the afternoon timeslots. The timeslot 09:00 to 10:00 had the highest occupancy rates in almost all days. Nonetheless, the timeslot 16:00 to 17:00 had the lowest occupancy rates.

Table 4.42: A heat map representing the occupancy rates of 150 rooms surveyed

	09:00 to 10:00	10:00 to 11:00	11:00 to 12:00	12:00 to 13:00	13:00 to 14:00	14:00 to 15:00	15:00 to 16:00	16:00 to 17:00		Average
Sunday	55%	51%	51%	59%	48%	44%	45%	37%		49%
Monday	57%	52%	54%	43%	46%	43%	41%	34%		46%
Tuesday	52%	50%	52%	53%	45%	45%	37%	28%		45%
Wednesday	58%	55%	52%	49%	44%	39%	43%	37%		47%
Thursday	53%	55%	55%	56%	44%	40%	35%	33%		46%

Figure 4.65 is another demonstration of how the occupancy rate changes throughout the weeks of the semester. It shows a flux of the occupancy rates which identifies highs and lows patterns. This shows how the size of the group changes during the course of the week. The ideal situation would be a complete flat line (represented in dark green line), where the average rate of occupancy is around 70% or above.

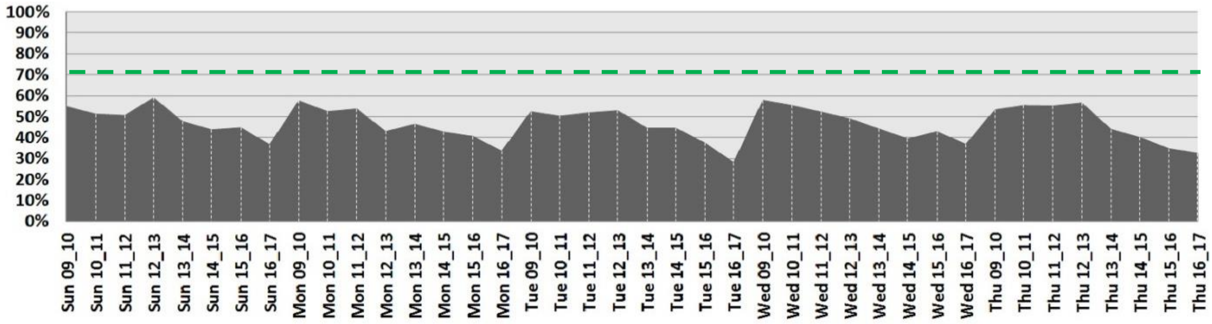


Figure 4.65: The occupancy rate per timeslot

Another explored issue is the room requirement. This represents how many rooms of certain capacities the institution actually needs, presuming ideal situations with optimal space utilisation rate. Table 4.43 illustrates the capacity band (number of students), room requirement (how many rooms are used by each band), currently available (how many rooms are actually available), and difference (how the room requirement compares to what is currently available for each group size). The 'difference' column, in other words, explains the difference between the supply and the current need. It can be clearly noticed that there is a large oversupply of middle- and big-sized rooms. For example, in the surveyed five college buildings, there are 11 rooms with capacities of 60 to 70 students which have very few reservations. The same is true for rooms with capacities of 20 to 30, 30 to 40, 40 to 50, and 50 to 60 students. In contrast, small-sized rooms were noticeably undersupplied. The table also shows that there was no room available that suits a small capacity of one to ten students. This indicates that most of the rooms in these colleges were either middle sized or large. The absence of small-sized rooms means that small groups of students have no option but to use middle sized rooms or large rooms. Consequently, space is wasted and vacancy rate increases due to poor planning. This leads to a huge energy bill to pay in order to operate and maintain these middle sized and large underutilised spaces.

Table 4.43: Room requirement

No.	Capacity Band	Room Requirement	Currently available	Difference
01	01 to 10	19.075	0	-19.075
02	11 to 20	15.45	14	-1.45
03	21 to 30	10.175	34	23.825
04	31 to 40	9.25	62	52.75
05	41 to 50	2.45	21	18.55
06	51 to 60	0.325	4	3.675
07	61 to 70	0.1	11	10.9
08	71 to 80	0	0	0
09	81 to 90	0	4	4
10	91 to 100	0	0	0
11	> 100	0	0	0

User satisfaction about the utilisation of college building is also examined. Finding the balance between satisfaction and high utilisation rate in college buildings is challenging. SMG (2006, 06) states that '[high] rates of utilisation do not necessarily mean that space is being managed effectively. Staff and students may complain about lack of space, overcrowding, and the adverse effect on academic activity, recruitment, and retention.' Therefore, given the importance of user satisfaction in college buildings, a questionnaire was distributed with the purpose of exploring:

- The level of feeling experienced about the utilisation in these five college buildings, and
- The extent to which users are flexible with the working hours particularly in the evening.

A core issue raised in the questionnaire was the size of rooms in college buildings compared to the number of students. Figure 4.66 reveals that over a quarter of participants claimed that their classrooms are either very congested (9%) or crowded (19%). On the other hand, 15% of the participants indicated that there are plenty of seats available in their teaching rooms, while 24% of them pointed out that their teaching rooms are not crowded. Over a quarter of respondents stated that their teaching rooms are half filled. When combining all these percentages (15%, 24%, and 26%), the result indicates that 65% of teaching rooms in the five college buildings were half filled or have plenty of seats available.

Another question asked was about the satisfaction of users about the overall size of teaching rooms in their college buildings. Figure 4.67 exhibits that more than a half of the participants were pleased with the overall size of teaching rooms in their college buildings, either very satisfied (16%) or satisfied with the size (39%). Nevertheless, nearly 17% of respondents indicated their dissatisfaction, with 7% of respondents stating that they were very dissatisfied about the size of classrooms.

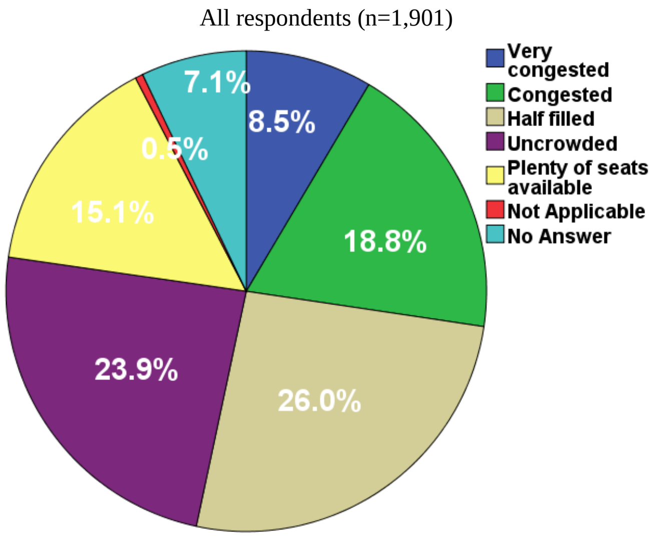


Figure 4.66: Assessing the size of classrooms compared with the number of students

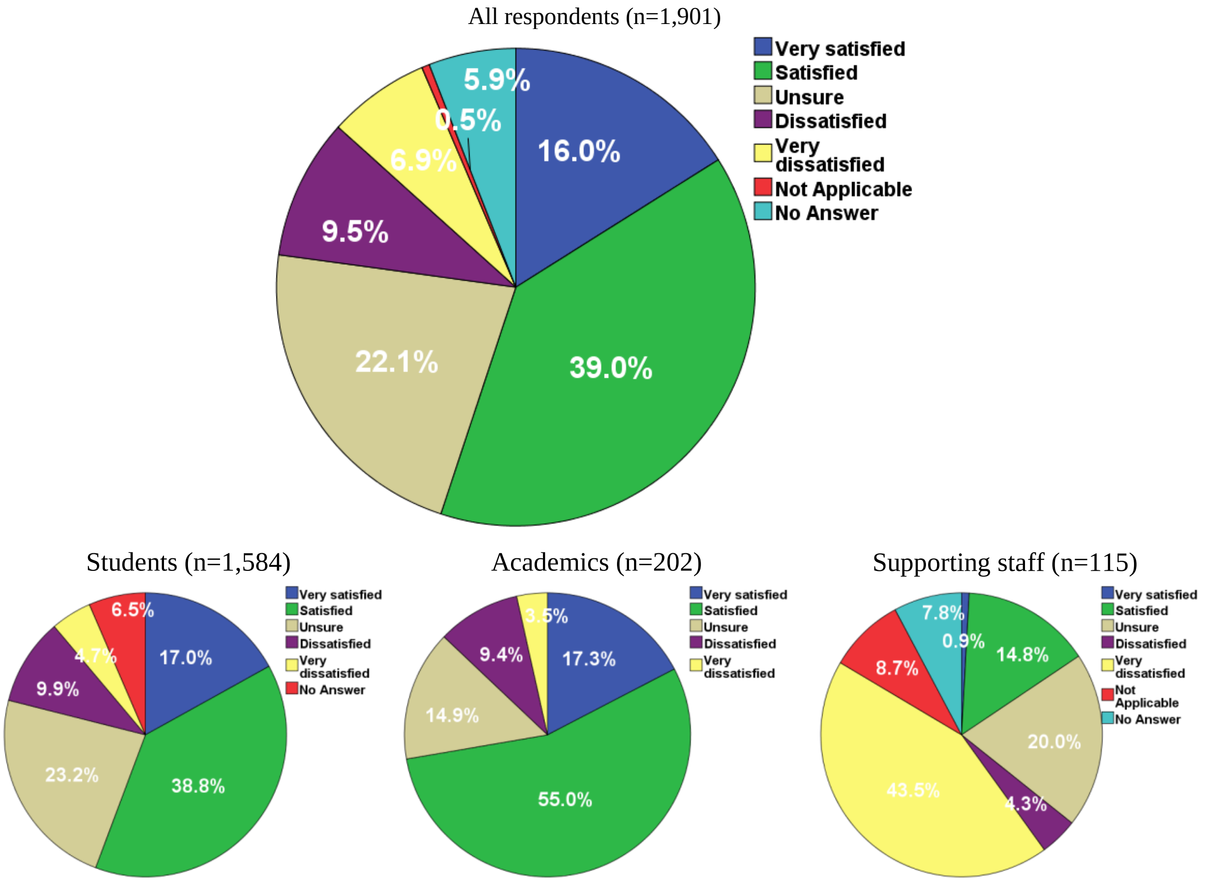


Figure 4.67: Measuring user satisfaction about the overall size of classrooms

4.6 Conclusions

The main aim of this chapter was to highlight how sustainable Saudi Arabian public university campuses are. This chapter also aims at documenting the great developments in the higher education sector in the Kingdom, where two-third of its campuses is still under construction.

The sub-question research to be answered in this chapter is '*What are the main issues of sustainability in university campuses in Saudi Arabia?'*

As a developing country, Saudi Arabia is investing massively in sectors such as health, education, infrastructure, among others. Education, in particular, has received a special focus in which on average 25% of the national budgets are spent on in recent years. The country adopted a long-term strategic plan to advance its higher education system, known as The Horizon 2030. This plan can be considered as part of a national vision known as Saudi Vision 2030. One angle of the strategic plan is to expand higher education. Therefore, 20 new universities were established only in the last decade. In order to accommodate these public institutions, campuses have been built in phases. This research assessed some planning aspects in public universities with a focus on the new university campuses constructed in the first phase. These evaluated aspects include the management aspects (vision, policy, planning, and commitments), the engagement aspects (attitude, knowledge, awareness and willingness to change), and the environment aspects (location, physical accessibility, climate considerations, flexibility, and space utilisation). The methods used in assessing these aspects were a desk study (include reviewing literature, documents, and architectural drawings) and a field study (include conducting 27 interviews, analysing 1,901 questionnaires, and undertaking 12-site observations).

The overall analysis suggests that Saudi university campuses are lagging far behind the rest of their counterparts in Europe and North America in sustainability aspects. The following points briefly summarise the main findings from examining and analysing the Saudi Arabian public university campuses:

Management aspects (vision, policy, planning, and commitments)

The findings show that the vast majority of Saudi public universities have no clear sustainability aim and plan for their campuses. In spite of the fact that these universities show a common vision to create a learning environment that is appealing, smart, and sustainable, they lack defined policies to achieve such vision.

Most universities have no documented sustainability commitments for their campuses. Public universities in the Kingdom have neither developed tools to measure their advancement in sustainability nor adopted existing tools. There is a noticeable absence of leadership in relation to sustainability as well as a comprehensive sustainability approach in higher education institutions in the country.

In general, most university projects lack enough emphasis on sustainability in the project brief. Additionally, the time spent on developing the brief is not enough and that effects the consideration to incorporate some of basic passive environmental sustainability elements (e.g. orientation and building placement, campus compactness, building size...etc.).

At the national level, there is a lack of strategic planning for higher education facilities in terms of supply and demand. Feasibility study has not been undertaken for these massive developments (e.g. 20 new large-sized campuses). There is a lack of supply and demand policy to manage physical spaces in higher education institutions at the national level in Saudi Arabia. This accompanied by the absence of a long-term detailed study of the youth population, which the UN recent projections suggest that there is a serious fluctuation and long-term decline in such segment of the society.

Although standardising both the college buildings and the landscaping objects has helped the Ministry of Education, who managed the planning and construction of new university campuses, to speed up the process of constructing the new campuses, it did not consider key aspects for each institution. Standardising did not take into account the differences in a) size of student body, b) education programs, c) attitudes to campus housing, d) importance of having a unique image and identity, e) climate (air temperature, humidity, wind, dust storm, rain...etc.), f) landscaping, and g) building materials' specifications, to name but a few.

Engagement aspects (attitude, knowledge, awareness and willingness to change)
The findings show that the majority of students in public universities in Saudi Arabia have little knowledge about the sustainable development. This rate of unawareness of one of the most important and hot topics worldwide is alarming. No public university assesses its students about their knowledge and awareness of sustainability on a regular basis. There is a lack of policies to integrate sustainability into the existing education courses.

Students showed a lack of interest and willingness to take part in some sustainable initiatives on-campus. Most of the Saudi Arabian policy- and decision-makers have inadequate knowledge and awareness about the recent sustainability developments in university campuses.

Environment aspects (location, physical accessibility, climate considerations, flexibility, and space utilisation)
The findings show that the location of and the physical accessibility to public university campuses in Saudi Arabia have been emphasised by many interviewees as particularly difficult issues. The remote locations, the absence of public transportation, incompleted infrastructure projects, and the challenging topography of some sites are some cases in point. A large number of Saudi university campuses, especially new ones, are located far away from their own cities. The vast majority of surveyed people indicated that they live off-campus and few of them prefer to live on-campus. This is not only because of the long distance between the campus and the city centre, but also because of the lack of basic supporting facilities and services such as school, bookshop, clinic, supermarket, restaurants, places of worship, some of which are still under construction.

On average, Saudi students, academics, and supporting staff commute some 44 kilometres distance between their place of living and their university campuses. Two-thirds of people indicated that they take between 30 minutes to one hour driving to their university campuses almost on a daily basis. The vast majority of surveyed people use their own cars to come to the university campus. That is obvious given that the Kingdom is a car-oriented country.

As for the climate considerations, the findings show that analysing the master plans of new campuses as well as the college buildings show that the issue of compactness has not been considered. Compactness has a number of advantages especially for the Saudi context given the extreme climate. The idea to occupy as little space as possible was not realised. In fact campuses and college buildings are large in size. This negatively impacts the density, outdoor walking distance, and the amount of exterior envelope to be exposed to the sun, among others. There are issues with the environmental quality including the orientation of buildings, shading and day-light, passive ventilation strategies, and other energy free facilities (e.g. solar panels and wind turbines).

Regarding flexibility (time, space, and furniture), the findings show that over a half of the academics have a flexible schedule and are willing to deliver lectures in the evening (between 5 pm and 9 pm), whereas around a quarter of students and supporting staff favour the evening period instead of morning. Two-thirds of participants indicated that the spaces in their college buildings can be used for multiple purposes, whereas one-third pointed out that spaces can easily adopt new functions. Only a quarter of surveyed people believed that the spaces of college buildings can be expanded and/or contracted. Physical flexibility in the layout of college buildings in campuses of recently founded universities has been highlighted as an issue. This limits the prospect for adjustment in college buildings now and in the future. Over one-third of surveyed people pointed out that the furniture is flexible.

In terms of space utilisation of facilities in campuses, the findings show that the surveyed people indicated that more than two-thirds of classrooms in Saudi campuses are either half-filled or even have plenty of seats available. More than a half of people are pleased with the overall size of classrooms in their college buildings. The assessment of space utilisation in some college buildings in public universities suggests low rate of utilisation of 23%. The average rate of space utilisation of new college buildings is 22%, whereas average of old colleges is 27%. It is noticeable that almost all public sectors in the Kingdom, including higher education, are not familiar with space utilisation studies. The lack of expertise and knowledge are just two reasons for not undertaking such study.

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Chapter 5

Best Practices in Sustainable Campuses

5.1 Introduction

In the previous chapter, the main sustainability challenges in Saudi Arabian higher education institutions have been established. These issues include sustainability management, engagement, and environment in public universities.

The aim of this chapter, however, is to explore best practices in sustainable campuses worldwide. This is to draw some lessons to help advancing sustainability aspects in Saudi Arabian universities. This chapter, therefore, answers the following sub-research question: *What lessons can the Kingdom learn about sustainable campuses in different parts of the world?*

In order to achieve the goals of this chapter, a research has been undertaken starting by selecting two benchmarking cases which were chosen based on developed selection criteria. These cases are Arizona State University (ASU Tempe Campus) and University of South Florida (USF Tampa Campus). Using the same three sustainability aspects and the ten indicators, this chapter draws key lessons from these leading universities.

This chapter is composed of seven sections. The second section presents how the two cases were chosen using the developed selection criteria. The next section shows the sample and the data-collection techniques used. Section four analyses the two cases; ASU Tempe campus and USF Tampa campus. Section six highlights the main lessons learnt from the two leading universities. This chapter ends with some conclusions and with the answer of the raised sub-research question.

5.2 Selection criteria for best practices in sustainable campuses

In this section, the aim is to highlight how cases are selected and on what basis. Given that there are many qualified cases worldwide, a scan of the candidate cases was conducted. The aim of the ‘screening procedure’ is to ensure identifying the appropriate cases before the formal data collection (Yin 2014, 95). The use of these criteria helps maintain the sampling relevance, feasibility, and research ethic (Miles et al. 2014). Therefore, a set of defined selection criteria was proposed. The purpose of these selection criteria is to reduce the number of cases. The criteria used through which cases were selected are specifically developed, in order to confirm that the selected cases are relevant to the Saudi cases. Consequently, the selected cases are believed to be addressing many of the sustainability issues in Saudi Arabian campuses including location, mobility, climate, and type and size of the cases.

The processes of selecting the cases were operationalised as follows:

- The first criterion was using the two renowned ranking tables: the 2016 STARS Index (STARS Index 2016) and the 2015 UI Green Metric (UI Green Metric 2015). Acting as a point of departure, these tables were employed to help start the search for best practices in sustainable campuses. On one hand, the 2016 STARS Index is based on assessing five areas: academic, engagement, operations, planning and administration, and innovation. It has 74 indicators to measure sustainability aspects in universities. The STARS Index has listed 296 universities in its 2016 ranking. On the other hand, the 2015 UI Green Metric covers six areas: setting and infrastructure, energy and climate change, water, waste, transportation, and education. It has 54 indicators to gauge sustainability aspects in higher education institutions. The UI Green Metric has listed 407 universities in its 2015 ranking table. The total number of cases reviewed in both tables was 703 universities, although there are a number of cases that can be found in both tables.

- Second, to narrow down the scope of searching further, another selection criterion was introduced in which cases that have small-sized campuses were eliminated. Having processed the cases using this criterion, the total cases remained were 95 universities.
- Third, another criterion was mobilised to limit the search even further. Universities that are or used to be mainly car-based oriented. Automobile should be the main mode of transportation to, from, or within the university campus. With this criterion, the total cases remained were 54 universities.
- Fourth, cases have to be principally funded by the state and hence all non-public universities left out. Additionally, cases have to be classified as comprehensive research universities and therefore other types of institutions are excluded. Having filtered the cases using this criterion, the total cases remained were 34 universities.
- Fifth, cases should have student dormitories and staff housing on their campuses. The capacity for accommodating students is about 10% or even more. Including this criterion, the total number of cases remained were 23 universities.
- Sixth, although there are a number of cases worldwide, the challenging task is the availability of information and a reasonable amount of literature in the English language. With this criterion, the total cases remained were 11 universities.
- Seventh, cases are preferred to be rural campuses or at the edge of their cities. This means that urban campuses were not favoured, given that such campuses have an ongoing relationship with its surrounding environment (Haar 2011). However, since the majority of university campuses tend to be typically in and/or form a part of their cities where they were founded, this criterion has been proven to be difficult to satisfy. This is because of the factor of the institution’s age. This means that the urbanisation of their cities have grown over the years to surround them. Although the locations of some campuses were in remote sites, now, however, they are no longer separated from their cities and they (the city and its campus) have become one with no clear boundary. Therefore, this criterion has not been considered in the processes of selecting cases.
- Eighth, the last criterion to use in narrowing down the scope of search was that cases should be in hot and/or humid weather conditions. Having adopted this criterion, the total cases remained were two universities; namely Arizona State University (Tempe campus) and University of South Florida (Tampa campus).

Overall, the process mentioned above shows eight steps of operationalising the selection criteria. It involves prioritising a number of criteria (such as type, size, mobility, and weather conditions), so that it ensures, to a large extent, the relevancy to the Saudi conditions.

5.3 Data analysis and interpretation

This section highlights the research sample and the data-collection techniques used. This research sets out to investigate three sustainability aspects through ten indicators as follows: Management aspects (Vision, policy, planning, and commitments), engagement aspects (Attitude, knowledge, and awareness of sustainability), and environment aspects (Location, physical accessibility, flexibility, climate considerations, and space utilisation). In order to examine these aspects and these indicators, a number of techniques were employed. This includes the following methods:

- Desk research (e.g. scholarly literature review such as articles, books, thesis...etc. and professional documents review such as university strategic plans, university master plans, sustainability plans, and sustainability reports)
- Fieldwork research (e.g. interviews, questionnaires, and observations). Although this was the case with Saudi Arabian campuses, visiting the two cases in the United States

- namely ASU Tempe Campus and USF Tampa Campus - was not possible given the inability to acquire a visiting Visa. Instead, only face-to-face interviews were conducted through some telecommunications application software (e.g. Skype and Facetime). The analytical framework used to evaluate sustainability aspects in Saudi Arabian campuses was also employed in the assessing the same aspects in the American cases.

5.3.1. Scholarly literature and professional documents review

A number of scholarly literature and professional references have been reviewed for the purpose of analysing certain issues of interest to the research such as planning, design, capacity, commitment, policies, and so on. These sources are publically accessible, mostly up-to-date, and to a large extent sufficient in answering most of the questions raised, since they cover most aspects. For Arizona State University, the main references were as follows:

- ASU Webpage (ASU 2017)
- ASU STARS Reporting (2015) (275 pages)
- ASU Student Sustainability Literacy Survey (2015) (64 pages)
- ASU Master Plan (2011) (235 pages)
- ASU Sustainability Plan (2011) (46 pages)

As for the University of South Florida, the main references were as follows:

- USF Webpage (USF 2017)
- USF System Facts (2016) (19 pages)
- USF STARS Reporting (2015) (287 pages)
- USF Tampa Campus Master Plan (2015) (216 pages)
- USF Sustainability Initiative Report (2009) (24 pages)
- USF Sustainability Report (2007) (214 pages)

One of the most important references is the sustainability plan. Such a plan was submitted to both the Association for the Advancement of Sustainability in Higher Education (AASHE 2017) (Known as STARS Reporting) and The American College and University Presidents' Climate Commitment (ACUPCC 2017). These plan covers sustainability aspects such as academic, engagement, operations, planning and administration, and innovation. However, given the focus of this research, certain sustainability aspects were examined including (management, engagement, and environment).

5.3.2. Interviews

There were seven people interviewed online from the United States, which is about 40% of the 18 officials planned to be interviewed. Those officials are involved in campus planning, campus management, sustainability practices and operations. Table 5.1 presents the positions and numbers of interviewees and their organisations. It shows that some interviewees hold executive positions. The vast majority of them have 30 years of experience on average. This means that they have the knowledge, skills, and abilities to support their institutions in pursuing their sustainability agenda. Some interviewees, however, work to translate sustainability policy into actions on the ground (tactical and operational levels).

Table 5.1: Numbers and positions of interviewees

No	Position	University	No. of interviewees
01	Sustainability Director	ASU & USF	2
02	Sustainability Assistant Director	ASU & USF	2
03	Sustainability Expert (Practices and Operations)	ASU & USF	2
04	Campus Manager (Space Resource Management)	ASU	1
	Total		7

The main purpose of interviewing such experts was to further understand how all efforts come together to achieve the institution's sustainability goals. The other objective was to look for an answer to the remaining questions including, but not limited to:

- Overestimated and/or underestimated issues while working on sustainability aspects
- Main sustainability hindrances (organisational, technical, or maybe both)
- What really works and what does not and why

5.3.3. Questionnaires

The aim of the distributed questionnaires is to measure different variables about knowledge on fundamental sustainability terms and issues including, but are not limited to, attitude, awareness, and behaviour of campus users. However, this research did not distribute questionnaires in the two American universities. Instead, it reported the results obtained from previous questionnaires namely:

- ASU Student Sustainability Literacy Survey (2015), which reports the findings of the survey from Arizona State University
- Alvarado (2013), which reports the findings of the survey, explored the environmental literacy among students of University of South Florida.

5.4 Study of cases

The selected cases were Arizona State University (ASU) and University of South Florida (USF), shown in figure 5.1. Having selected the two cases, the following sections present the cases and their analysis.

This analysis consists of the sustainability aspects below, which were investigated in the two cases: ASU and USF. These aspects and their indicators are as follows:

- Management aspects
  (Vision, policy, planning, and commitments)
- Engagement aspects
  (Attitude, knowledge and awareness of sustainability)
- Environment aspects
  (Location, physical accessibility, flexibility, climate considerations, and space utilisation)

Figure 5.1: The two selected cases in the United States of America (Template Gallery 2017)

5.4.1. Arizona State University (ASU)

5.4.1.1. Background information

The Arizona State University (ASU) is a public higher education institution that was established in 1885. The university was ranked No. 1 among the 'Most Innovative Schools' in America by U.S. News and World Report (2016). Known to be the largest research university in the United States, ASU total enrolled in 2016 was over 98 thousand students most of whom were in Tempe campus (ASU 2017). Table 5.2 presents some statistics about the University including numbers of colleges, departments, students, and staff. It can be seen that regardless of the category, these numbers are enormous. The question of why is answered in the ASU Master Plan (2011, 44) in which the University indicates five strategic goals and among which is to 'Become a National Comprehensive University' and to have 'Schools in Every Field'.

Table 5.2: Facts and figures about Arizona State University (ASU STARS Reporting 2015, 10)

No	Category	Data
01	Number of academic divisions	22 Divisions/Faculties
02	Number of academic departments	83 Departments/Schools
03	Full-time equivalent enrolment	68,374 Students (2015)
04	Full-time equivalent of employees	8,358 Employees (2015)
05	Full-time equivalent of distance education students	6,230 Students (2015)
06	Total number of undergraduate students	59,382 Students (2015)
07	Total number of graduate students	13,996 Students (2015)
08	Number of employees	8,907 Employees (2015)
09	Number of residential students	11,712 Students (2015)

Arizona State University has five campuses throughout metropolitan Phoenix, Arizona, shown in figure 5.2. Besides the physical campuses, ASU has a virtual campus, known as SkySong Innovation Center, which offers online and extended education. Phoenix is the capital of Arizona with a population of 1.5 million residents (Suburban Stats 2016).

Climate

Phoenix's climate is a desert climate; warm and dry most of the year (Climate-Data 2017). The city is characterised as one of the sunniest cities in the US (Stanley 2017), with extreme heat than any other US city (Weatherbee 2012).

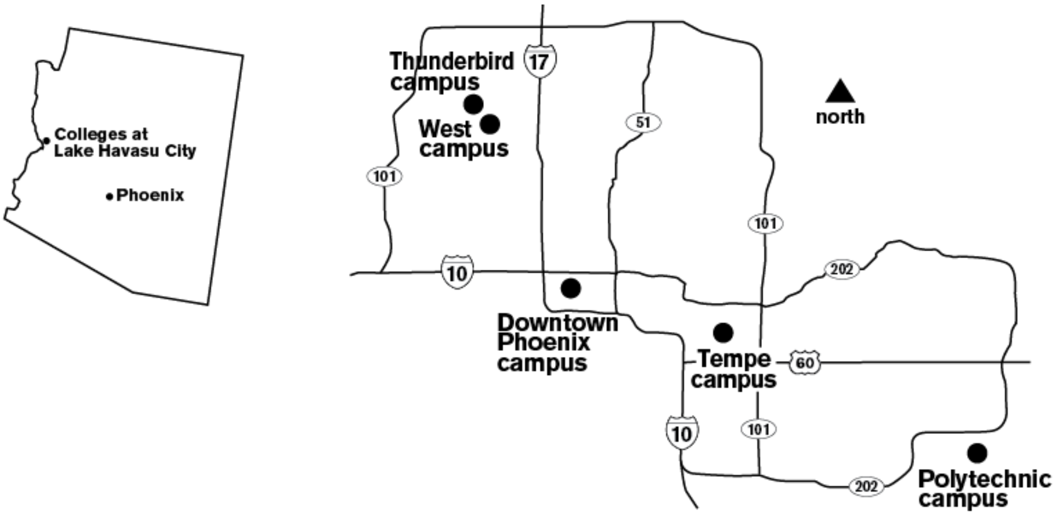

Figure 5.2: The five main campuses of ASU (ASU Locations 2017)

Table 5.3 shows some facts and figures about the ASU campuses. It highlights the total area of campuses, gross floor area of buildings, and other floor areas of different functions. The data in this table is a direct result of the numbers in the previous table; large student body and many schools need large size campuses.

Table 5.3: Facts and figures about the ASU campuses (ASU STARS Reporting 2015, 7)

No	Category	Data
01	Total campuses area	6.3 Square kilometres (1,544 Acres)
02	Total gross floor area of building space	1,681,134 Gross Square Metres (18 m. Gross Square Feet)
03	Gross floor area of laboratory space	73,314 Square Metres (789,150 Square Feet)
04	Gross floor area of healthcare space	2,223 Square Metres (23,938 Square Feet)
05	Gross floor area of residential space	225,567 Square Metres (2,427,987 Square Feet)

University campus

The Tempe campus is the main subject of the investigation in this study. This is because it is the original campus, the largest campus of ASU, home to many colleges and schools for undergraduate and graduate students, and has many educational, research, and athletic facilities. Table 5.4 illustrates some key information about ASU Tempe campus. It shows the type and size of the campus, number of buildings, total gross floor area, campus population, enrolment, staff, and student housing. The campus is characterised as an urban campus, next to the centre of Tempe town. The size of the campus is about 2.6 square kilometres (642 acres). It is home to almost 290 buildings. The total gross floor area of buildings' spaces is 1.4

million square meters (as of 2011). This means that the floor area ratio, the ratio of building's total floor area to the size of the campus land, is 53%. The enrolment in 2016 was 51,869 full-time equivalent students (ASU 2017). There were over 10 thousand students living on campus, which means that Tempe campus accommodates almost 20% of its students on campus. In order to help the Tempe campus becoming a more residential campus than a commuter campus, ASU has a housing target to accommodate '25% of its student body on-campus' by 2020 (ASU Master Plan 2011, 12). The Tempe campus is the most densely populated of the five ASU campuses (0.025 people per km^2) (core campus density is 0.046 people per m^2).

Table 5.4: Facts and figures about ASU Tempe campus (ASU Master Plan 2011, 10; ASU 2017)

No	Category	Data
01	Campus type	Urban
02	Campus size (campus acreage)	2.6 Square kilometres (642 Acres)
03	Number of buildings	288 buildings
04	Gross floor area of building space	1.4 million square meters (15.9 million square feet) (2011)
05	Campus population	65,341 people
06	Total enrolment	51,869 students (Full-Time Equivalent) (2016)
07	Faculty members	2,317 members (full- and part-time members) (2015)
08	Employees	11,155 staff (regular full- and part-time employees) (2015)
09	Number of beds (Student dormitories)	10,432 beds (2011)

Figure 5.3 exemplifies the master plan of ASU Tempe campus. It shows that the campus is divided into zones and each zone has distinctive related programs or uses. The main zones are as follows:

- Central zones consist of Faculties of Art, Performing Arts, Design, Engineering, Life Sciences, and Business. It also accommodates other functions such as the library, Memorial Auditorium, Art and Music Centres, Discovery Hall, Student Service, Bookstore, Student recreation complex and others.
- Northern zone is residential housing
- Far northern zone is the University athletic facilities (Sun Devil Stadium, Wells Fargo Arena, and the University golf course).
- Eastern zone bioscience research facilities.
- Southern zone is the residential housing.

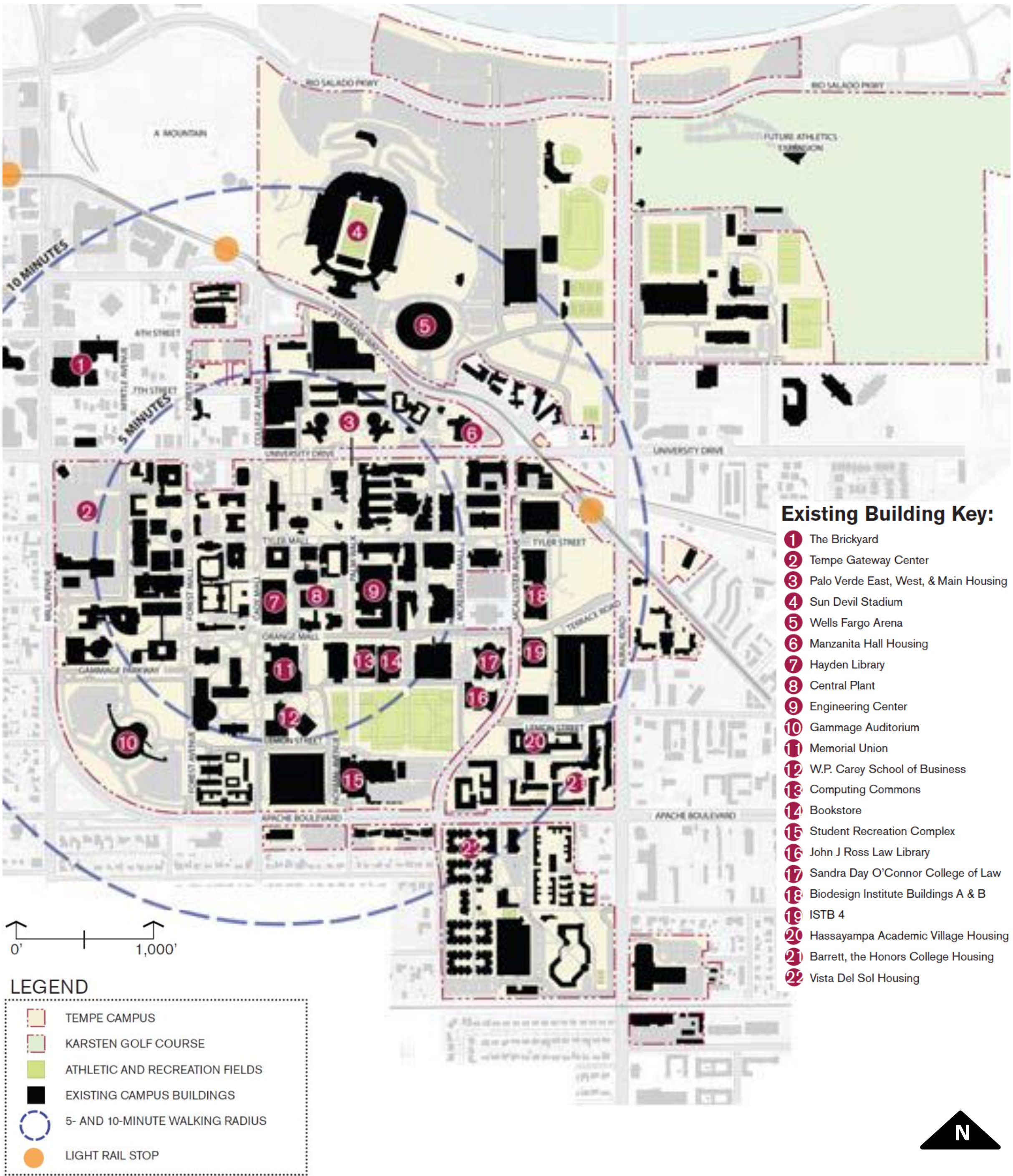

Figure 5.3: Master Plan of ASU Tempe campus (ASU Master Plan 2011, 58)

Given that the Tempe campus is part of Tempe town, the street network passes through the campus. However, these streets have been redesigned to become ‘open air pedestrian malls that handle a significant amount of foot traffic, bicycles, carts, and maintenance vehicles’ (ASU Master Plan 2011, 59).

Another observation on the master plan is the concentration of buildings in the central zone of the campus. The compactness gives a number of advantages including easing the walkability, encouraging sociability, and increasing density and hence changes of encountering and exchanging ideas stimulating innovation (Curvelo Magdaniel 2016).

Recent enrolment figures suggest that there are 51,869 Full-Time Equivalent students enrolled in 2016 in the Tempe campus (ASU 2017). However, the University aims to increase the enrolment in Tempe campus from 50 thousand students to 60 thousand students by 2020. An increase of student body by 10,000 students means an increase of 16% of the enrolment. In order to accommodate such a figure, the campus is expanding its physical facilities by adding over 300 thousand square meters. Other strategies to absorb such a number include 'increasing efficiency, more online learning, and different models of teaching' (ASU Master Plan 2011, 61). Table 5.5 presents the projection of space needed by 2020. It shows that interestingly, the residential space will be growing as much as the academic, research, and support space on Tempe campus.

Table 5.5: Tempe campus future space needs (Adapted from ASU Master Plan 2011, 61)

No	Future Space Needs	Total	Academic/Research/Support	Residential
01	Existing Campus 2011	1,479,833 M^2 (15,928,800 GSF)	824,990 M^2 (8,880,120 GSF)	323,710 M^2 (3,484,390 GSF)
02	Future Need 2020	313,086 M^2 (3,370,040 GSF)	156,065 M^2 (1,679,880 GSF)	157,021 M^2 (1,690,160 GSF)
	Total	1,792,920 M^2 (19,298,840 GSF)	981,056 M^2 (10,560,000 GSF)	480,731 M^2 (5,174,550 GSF)

Gross Square meters (M^2)
Gross Square Feet (GSF)

Having briefly looked at the ASU in general and Tempe campus in particular, the following sections evaluate ASU's sustainability plans and practices. This research focuses on certain areas of sustainability including:

- Management aspects
  (Vision, policy, planning, and commitments)
- Engagement aspects
  (Attitude, knowledge, and awareness of sustainability)
- Environment aspects
  (Location and physical accessibility, flexibility, climate considerations, and space utilisation)

5.4.1.2. Management aspects

(Vision, policy, planning, and commitments)

In its webpage, the School of Sustainability at Arizona State University (ASU) defines sustainability as:

> *'Improving ecological integrity, human well-being, and social justice for present and future generations is the grand challenge of sustainability. Sustainability is the "reframing" of the debate over human-environment relationship critical to ensuring quality of life for future generations – whether the human life-support system on earth can continue indefinitely, or whether it is changing the world in radical ways that will lead to new, undesirable states for people and the planet'* (ASU School of Sustainability 2017).

5.4.1.2.1. Vision for sustainability

Arizona State University has a vision that indicates its dream for the institution among its peers in the US and beyond. The vision is ‘New American University: Toward 2025 and Beyond’ (ASU 2017). It is ‘ASU’s reconceptualisation of 21st century higher education’ (ASU NAU 2017). Through this vision, ASU demonstrates a new model for the US public research universities. It points out that:

> *‘More than a decade ago, ASU set forth a new and ambitious trajectory to become a comprehensive knowledge enterprise dedicated to the simultaneous pursuit of excellence, broad access to quality education, and meaningful societal impact. From that point forward, and founded on a vision for a new “gold standard”, all of its energy, creativity and manpower have been brought to bear on the design of a uniquely adaptive and Transdisciplinary University committed to producing master learners’* (ASU NAU 2017).

Sustainability is seen by ASU as a substantially important factor of the transformation of ASU into the New American University. Therefore, the University vision for sustainability indicates the fact that they want:

> *‘To be the worldwide leader in sustainability higher education operations. As an organisation, we are among the acknowledged world leaders in sustainability education, research and, operational practices for higher education. It is our vision that the operations and practices on all of the Arizona State University campuses will be the standard for sustainability practices in higher education’* (ASU Sustainability Plan 2011, 7).

ASU has also a sustainability vision for their university campuses. The vision covers a whole spectrum of sustainability aspects in which it (ASU Sustainability Plan 2011, 7) aims to:

> *‘To create an environment of sustainable operation and practices that aligns with and support Arizona State University’s education, research, and student life programs, seeking to minimise the institution’s impact on the planet, while maximising the positive impact on the world and its inhabitants, and setting strong examples for others to follow.’*

The University has aspiring strategic aims vary from local, regional, national to international levels. These goals, which are to be achieved by 2020, state that ASU is to:

- ‘Demonstrate leadership in academic excellence and accessibility’
- ‘Establish national standing in academic quality and impact of colleges and schools in every field’
- ‘Establish ASU as a leading global centre for interdisciplinary research, discovery and development by 2025’
- ‘Enhance our local impact and social embeddedness’ (ASU NAU 2017).

On the other hand, the ASU has four overarching sustainability goals to be achieved in short-, mid-, or long-terms. Each goal is in line with the ASU’s strategic goals mentioned above. The four major goals are:

1. ‘Carbon neutrality (Achieve carbon neutrality for Scope 1, 2 and non-transportation Scope 3 emissions by 2025; carbon neutral for Scope 3 transportation emissions by 2035)’
2. ‘Zero waste (To facilitate implementation, sub-goals for solid and water waste are addressed separately. Eliminate 90 percent of campus solid waste from the landfill by 2015. Reduce water consumption by 50 percent and eliminate 100 percent of campus water effluent by 2020)’

3. 'Active engagement (Achieve 60 percent documented engagement by members of the campus community by 2015)'
4. 'Principled practice (Integrate sustainability practice principles in 80 percent of campus operations and functions)' (ASU Sustainability Plan 2011, 9).

5.4.1.2.2. Policy for sustainability

In order to realise the four sustainability goals, ASU has developed a number of strategies. These strategies, mentioned in the ASU Sustainability Plan (2011, 11-19), have been listed below under each goal as follow:

1. 'Carbon neutrality
    - Energy consumption and efficiency (Reduce university energy consumption by 35% per square foot by 2025)
    - On-Site Renewable Energy (Generate 35% of university energy requirements from on-site renewable energy facilities 2025)
    - Off-Site Renewable Energy (Purchase 65% of university energy requirements from off-site renewable energy facilities by 2025)
    - Transportation (Replace all university owned vehicles with alternative fuel vehicles by 2018. Mitigate 100% of transportation emissions related to university fleet by 2020. Mitigate 100% of transportation emissions – commuter, air/business travel and shuttle vendor partnerships by 2035)
    - Campus Operations (Eliminate 100% agriculture related emissions by 2025. Eliminate 100 percent refrigerant related emissions by 2025. Eliminate 90 percent solid waste related emissions through aversion and diversion practices by 2035)'
2. 'Zero waste (solid waste and water waste)
    - For solid waste: Aversion (Reduce university's solid waste footprint by 30% through aversion by 2015)
    - For solid waste: Diversion (Reduce university's solid waste footprint by 60% through diversion by 2015)
    - For water waste: Water Conservation and Efficiency (Reduce landscaping water consumption by 30% by 2020. Reduce building water consumption by 30% by 2020)
    - For water waste: Water Capture and Reuse (Develop long-term plan for water capture and reuse. Reduce building water consumption by 30% by 2012)'
3. 'Active engagement
    - Faculty, Staff, and Student Engagement (60% of faculty, staff and students to engage as active change agents in supporting the university's sustainability practices vision by 2015)
    - Increase Community Awareness (Establish integrated family of programs to communicate sustainability information/practices/opportunities internal and external to the ASU community by 2012)
    - Staff Literacy/Training (100% of ASU staff to participate in staff sustainability literacy program by 2015. 10% of ASU staff to complete specialty (job specific) training by 2015)
    - Staff Performance Appraisals (75% of ASU staff to achieve a sustainability rating of average or above in their performance evaluation by 2012)
    - Increase Community Recognition (Establish sustainability recognition programs for members of ASU community by 2011)'
4. 'Principled practice

- Practices Mandates: Construction (100% of new university construction and renovation contracts to be in compliance with ASU Sustainable Design Guidelines and ASU Green Construction Guidelines by 2014)
- Practices Mandates: Procurement (100% of new university contracts to be in compliance with ASU Green Procurement Guidelines by 2013)
- Practices Mandates: Events (100% of university sponsored events (including athletics) to be in compliance with ASU Green Event Guidelines by 2018)
- Practices Mandates: Offices (100% of university departments to be in compliance with ASU Green Office Guidelines by 2035)
- Practices Mandates: Labs (100% of university departments to be in compliance with ASU Green Labs Guidelines by 2035)
- Practices Mandates: Publications (100% of university publications to be in compliance with ASU Green Publication Guidelines by 2018)
- Products (100% of products used by vendors and service providers on campus (food, cleaning, etc.) to comply with ASU Green Procurement Mandates by 2014. 100% of electronics to be EPEAT Gold, ENERGY STAR® products or those certified by the Federal Energy Management Program as energy efficient by 2015. 80% of durable and consumable goods used on campus by university employees and service providers to be comprised of recyclable, renewable, fair trade, sustainably farmed or local material by 2020. 90% of trademarked wear include organic, recycled, fair trade or other eco-friendly contents by 2020)
- Operations (100% of service providers and vendors to follow ASU sustainability practice principles in their own operations by 2015. ASU sustainability practice principles integrated into 80 percent of all campus operations by 2018)
- Quality of Life (Provide ASU employees with a safe and healthy working environment. Provide ASU students with a safe and healthy learning, living (residents) and playing (sports, activities) environment)’

5.4.1.2.3. Planning for sustainability

To realise the abovementioned overarching sustainability goals, the following approach is used:

- First, ‘determine the critical components that contribute to whatever we are trying to reduce or eliminate (e.g., carbon emissions, solid waste, waste water).’
- Second, ‘establish metrics baseline before implementing any change.’
- Third, ‘[prioritise] the components from [the] largest impact to [the] smallest impact.’
- Fourth, ‘create projects to address each component and execute them.’
- Fifth, ‘measure and report changes annually based on the project outcomes.’ (ASU Sustainability Plan 2011, 9)

Other planning measures taken to green Tempe campus are:

- Increasing the enrolment in Tempe campus to 60 thousand students by 2020. The University, therefore, has many strategies to accommodate such number. It is not only expanding its physical facilities by adding over 300 thousand square meters, but also looking for other possibilities such as increasing the density. There are a number of buildings in the core if the campus that characterised by 'low-scale’ and ‘1- and 2-story buildings', which are seen to be as 'an inefficient use of land' (Ibid, 70). Such buildings are considered for redevelopment to higher densities and include a mix of academic, faculty office, and/or research uses, with informal gathering spaces' (Ibid, 70). Other strategies to accommodate such a number include ‘increasing efficiency, more online learning, and different models of teaching’ (ASU Master Plan 2011, 61).

- Accommodating more students on campus. The aim is to house up to 25% of students on campus by 2020 (Ibid, 12). The great benefit of such plan is to assist converting the campus from a commuter campus into a more residential campus.
- Although the campus population is growing, the aim is to decrease the number of car parking spaces. The campus offers over 18 thousand car spaces, serving approximately 65 thousand users on-campus, which means that nearly every 4 people share one space. Improving mobility is a priority and the campus is connected to its urban surroundings through a transportation network including a light metro line and buses. Other measures deployed including e.g. promote vanpooling and carpooling with some incentives.
- Taking advantages of the existing physical facilities by ‘[finding] ways to activate building edges and expose more of the programs and student initiatives to pedestrian passers-by would go a long way to enlivening campus’ (Ibid, 60).
- Providing, expanding, or renovating some of the campus facilities for ‘new research, support, and collaborative learning space on campus’, which include ‘bio-design research institute, large lecture theatre, computer and tutorial labs, a new Engineering Centre, a new School of Construction Management, bookstore expansion, possible hotel/conference centre, redeveloping the athletics facilities, on-campus housing, dining, and related amenities’ (Ibid, 62). These developments - which include constructing new facilities, expanding some buildings, modernising some premises, and repurposing others - indicate that there is a huge investment in the physical aspect of Tempe campus.
- The Tempe campus is lacking open spaces. Therefore, a Framework Plan has been developed to address the fact that the campus ‘is built out to near-capacity and lacks significant open space’ (Ibid, 66). The main purpose of this framework is to 'guide the location of future development to appropriate sites on campus' and to 'ensure that successful campus spaces, open space areas, storm water management, and pedestrian and vehicular circulation corridors are preserved as the spatial organisation for future growth' (Ibid, 67).
- Activating the campus core. The centre of the Tempe campus can be a livelier environment when most developing strategies are completed, including ‘residential units in upper floors, with a base function of academic classrooms or office use’ (Ibid, 77). These developments are to be accompanied by indoor recreational and fitness centre, mainly for students.

Interviewees from ASU highlighted an interesting way of approaching sustainability and getting university users involved. The approach shows the steps that were taken by ASU in order to implement the institution’s sustainability policies. A director points out that:

> *‘We started working on sustainability by taking advantage of the low-hanging fruits... that is targeting the most easily achieved tasks... we also started with rewarding not forcing, which helped us tremendously in getting people aligned with our sustainability mission. Once most people are on board, we then inforce implementation gradually to cut off the bottom-dwellers... we then warn and penalise those who are not in line.’*

5.4.1.2.4. Commitments to sustainability

ASU is known to be one of the sustainability leading institutions in the US and in the world. There are a number of initiatives, programs, and practices that show how committed the

University is to advance its sustainability effort. For example, the following list illustrates some cases in point:

- The University has established the first School of Sustainability in the US in 2006, which offers undergraduate and graduate sustainability programs.
- The University has more than 400 sustainability experts in a variety of fields and disciplines.
- The University mobilises its campus as a living lab through which it is ranked No. 1 in the US in generating renewable energy through on-site solar panels and wind turbines. According to the book *Arizona State University Achievements 2002-2014*, 'ASU's Tempe campus hosts the largest solar energy capacity on a single U.S. university campus. [Solarisation] is funded entirely by a public/private university partnership' (ASU Achievements 2014, 59). A sustainability expert emphases this as exceptionally important especially with the financial constraints that most public universities face. However, the expert advises with such type of contract indicating that '*such contract may challenge us as a university since these companies are for profit... so conflict of interest may arise when trying to implement some of the university's sustainability initiatives*'.
- The University internally developed a tool that shows energy consumption of buildings in all campuses, as shown in figure 5.4. Campus Metabolism is 'an interactive web tool that displays real time energy use on campus' (ASU Sustainability Plan 2011, 42). Such tool monitors the University buildings including research and academic buildings, residence halls, and several activities related buildings (ASU Campus Metabolism 2017). This smart tool gives a general as well as a detailed illustration on energy consumption per campus as well as per building, as shown in figure 5.5. It shows data on each building including its characteristics, energy sources, greenhouse gas emissions, historical consumption data (hourly, monthly, and yearly), and peak consumption. These data can be exported and downloaded for study and research purposes. The tool also displays a map of the campus that demonstrates data for each building.
- The University established *The Sustainability Review (TSR)*, which is an online journal that is edited and published by ASU's graduate students and hosted by the University's School of Sustainability. Part scholarly journal, part popular magazine, this journal 'communicates sustainability challenges, developments, and opportunities through reporting, analysis, opinion, and art/visual media' (ASU STARS Reporting 2015, 63).
- ASU Global Institute of Sustainability provides an online mailing news list on a weekly basis, named Sustainability Digest. It announces sustainability seminars, meetings, colloquiums, lectures, brown bags, announcements of interest, and job opportunities to the Institute community.

Figure 5.4: Web tool showing real time energy use in all campuses (ASU Campus Metabolism 2017)

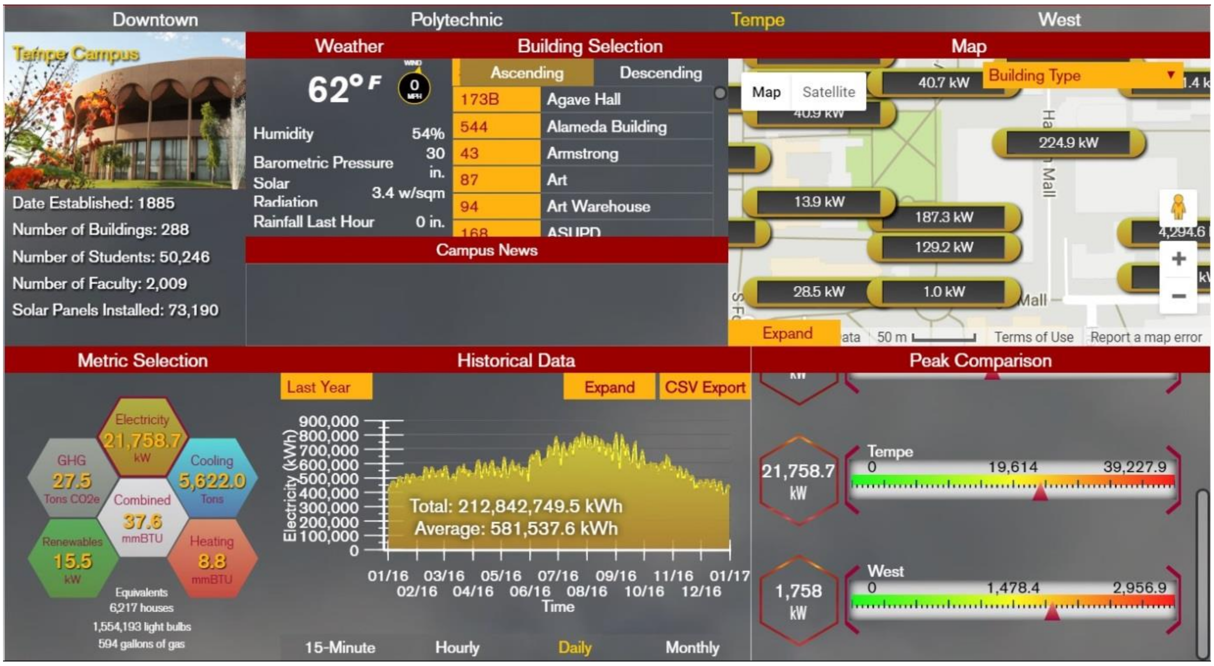

Figure 5.5: Web tool showing real time energy use in Tempe only (ASU Campus Metabolism 2017)

There are many stakeholders involved in implementing sustainability on campus. This, therefore, requires a certain organisational structure in the university in order to effectively institutionalise sustainability. The analysis of the interviews indicated that the following structure of planning and implementing sustainability practices and operations in ASU:

- Institution of Sustainability (Office of Sustainability). The main responsibility is coordinating the sustainability efforts between all parties involved. It also deals with some of the technical issues such as gathering data, analysing, and reporting. The institution is basically looking at the business side of sustainability.

- School of Sustainability. This is like any other school in the university. It offers a variety of sustainability topics and subjects for under- and post-graduate levels. Therefore, the main responsibility is education, research, and outreach activities.
- Facilities Development and Management. This is like any other department in the university. The main responsibility is to looking after the university's physical assets; facilities, grounds, and infrastructure including the planning, management, operations, and maintenance. This department is basically addressing the operation side of sustainability.
- University Business Services. This is another department involved in supporting sustainability logistically. For example, this department deals with issues such as procurement, finance, transportation, food, and security.

5.4.1.3. Engagement aspects

5.4.1.3.1. Attitude, knowledge, and awareness of sustainability

The University mission to sustainability engages all ASU's stakeholders. In their Sustainability Plan (ASU Sustainability Plan 2011, 7), it states clearly that:

> *'ASU's students, staff, faculty, and administration are committed to moving toward a more sustainable world in which the economy, the environment, and social institutions prosper simultaneously and symbiotically'.*

In an effort to advance knowledge and awareness of sustainability among the University students, the institution undertakes an investigation on an annual basis. According to the recent one, the ASU Student Sustainability Literacy Survey (2015), the surveys distributed to 40,390 students and the total number of completed surveys was 2,791, with a response percentage of 6.9%. The aim is to 'asses how knowledgeable Arizona State University students are related to sustainability topics, and how this knowledge changes as they progress in their studies over time' (2015, 3). The following points sum up the main results of the survey (Ibid, 4):

- 'The majority of respondents (61.7%) indicated they have considerable interest in or a passion for sustainability. In looking at the academic level of respondents, the percentage of students who said they have an interest in sustainability increased each year from freshmen up through graduate-level students.'
- 'Interest in sustainability is evenly divided along gender lines, with a similar percentage of male and female respondents saying they have considerable interest in or a passion for sustainability.'
- 'As a group, respondents indicated that the top three sustainability issues they place the most importance on are 1) recycling, 2) water conservation and 3) energy conservation. This ranking did not change from one academic level to the next. There were some differences when the question was stratified by gender and college affiliation; however these were small variations in ranking the issues. Respondents in the School of Sustainability ranked water and energy conservation the highest, followed by minimizing waste in landfills. They placed recycling near the bottom of the list in importance.'
- 'In looking at the questions which were used to test the respondents' knowledge of sustainability issues, when stratified by academic level, the percentage of correct answers generally increased from freshman to graduate-level students.'

Additionally, the institution is committed to educate the students at all levels about sustainability. The total number of courses offered by the institution is 5,252 courses for undergraduate and 2,703 courses for graduate (ASU STARS Reporting 2015, 14). However, the University offers a number of sustainability courses for undergraduates and graduates, 119 and 105 respectively. Besides, there are other courses that include sustainability in their curriculums for both undergraduate (287 courses) and graduate (204 courses). This means that not only the ASU School of Sustainability offers Bachelor, Master's, and Doctor of Philosophy (PhD) in sustainability aspects, but also other faculties and departments offer such modules or units of study that are related to sustainability. The University gives incentives for departments to incorporate sustainability into already existing courses or to develop new sustainability courses. Such incentives vary from funding, to certification, to release time, and to personal trainings.

Beside these formal educational courses, the University offers some sustainability-focused educational programs. These programs tend to be short and focused. It might be held on campus, off-campus, or abroad. ASU has offered, organised, and sponsored many programs of this kind on-campus. Overseas sustainability programs, in the form of mainly summer school, were held in many countries around the world including United Kingdom, Spain, Morocco, Ecuador, and United Arab Emirates.

Faculty members, employees, and administration staff are also involved actively in sustainability movement in the ASU. Training programs for the University's staff are offered regularly. According to ASU STARS Reporting (2015, 84), it is stated that 'Throughout the year, staff of all four campuses have the ability to receive one on one training about Green Office, Green Lab, Green Event and Green Shop practices. All staff can also participate in the on-line Sustainability Literacy Training. They receive a certificate of completion after the training for all of the training opportunities listed above'. Staff are incentivised and rewarded for their participation and determination. ASU's President awards faculty members for their effort to develop sustainability courses with the "President's Award for Sustainability" (ASU STARS Reporting 2015, 35).

5.4.1.4. Environment aspects

Location and physical accessibility, climate considerations, flexibility, and space utilisation

5.4.1.4.1. Location and physical accessibility

ASU Tempe campus is an urban campus that is in very close proximity with the centre of Tempe town. In spite of the fact that it is located next to the downtown of Tempe, it is about 20 kilometres away from Phoenix, the capital of Arizona State. The campus is connected to the capital through a transportation network including light metro and buses. Table 5.6 shows how accessible Tempe campus is. It highlights the commuting comparison between driving and public transportation. It demonstrates that commuting to and from the campus using private modes of transport such as cars seems faster in both cases: from the centre of Phoenix and the airport.

Another aspect of looking at mobility is car parking spaces. Tempe campus can offer over 18 thousand car parking spaces, serving approximately 65 thousand users on-campus. This means that nearly every 4 people share one parking space. According to the Space Planning Guidelines (AAPPA 2002, 6) '[a] broad ratio for the provision of car parking on a campus is in the order of 1 bay for each 4 to 5 EFTSU, [Equivalent Full Time Student Unit]'. However, this ration can vary from campus to campus and there are several factors influencing this proportion such as 'locality (city, metropolitan, and country), available public transport, other parking options off campus, student demographics, and available space on campus' (Ibid, 6).

What is missing from these factors is whether or not students are housed on campus and hence the need for car parking spaces might be far less than they otherwise would. Therefore, the 1:4 ratio can be yet seen as high, given that the University aims to accommodate '25% of its student body on-campus' by 2020 (ASU Master Plan 2011, 12).

Table 5.6: Accessibility in Tempe campus

No	Category	Data
01	Campus distance from the city centre of Phoenix	Driving: 19 km (12 miles) (17 minutes) | Public Transport: 18 km (11 miles) (24 minutes) (Google Maps 2017)*
02	Campus distance from the Airport	Driving: 9 km (5.6 miles) (8 minutes) | Public Transport: 9 km (5.6 miles) (12 minutes) (Google Maps 2017)*
03	Car parking	18,118 parking spaces (ASU Master Plan 2011, 10)
	* Note that the time for commuting between the campus and both the city centre of Phoenix and the airport is changing slightly from time to time and it depends on various issues such as congestion, accidents, street maintenance...etc.	

Tempe campus has two light metro stops that ease its accessibility. Figure 5.6 shows that most of the campus buildings can be reached within a five-minute walk from either metro station. However, the University is planning to develop the areas around the two stops in order to promote ridership. It states that 'Higher density mixed use development that includes academic, research, office, and/or residential uses should also include retail and commercial uses on the primary pedestrian routes to and from the stations' (ASU Master Plan 2011, 78).

ASU provides reduced price transit passes to its students, faculty, and staff (known as U-Pass) in which it gives them 'unlimited access to all four campuses and greater Phoenix on Valley Metro bus routes and the METRO light rail' (ASU STARS Reporting 2015, 177). However, students, faculty, and staff can use the free campus shuttle 'from the Tempe campus to each of the other Arizona State University campuses and a free on-campus shuttle service at the Tempe campus' (Ibid, 177). Other sustainable transportation modes include car/vanpool program and ride sharing program where the University take the responsibility to manage, promote, and facilitate such initiatives. Furthermore, ASU shows commitment to sustainable transportation as can be seen in the following initiatives:

- Partnering with private company to provide electric vehicle recharging stations around the campus.
- Introducing telecommuting program for the University employees that is regulated and guided to ensure that offices have sufficient coverage.
- Instituting a condensed work week option for employees where two typical schedules are available for employees to choose: 'Four-day/40-hour work week and Nine-day/80-hour, two-week work week' (Ibid, 178).
- Providing incentives to encourage staff and employees to live close to the campus. The University offers generous subsidy as an incentive to promote living in close proximity to its campuses.
- Using the campus as a 'living lab' for sustainable transportation through which students from the School of Sustainability undertook research to help develop 'a B99 (99% used vegetable oil made into diesel fuel) fuel tank and dispensing system on the Tempe campus' (Ibid, 39).

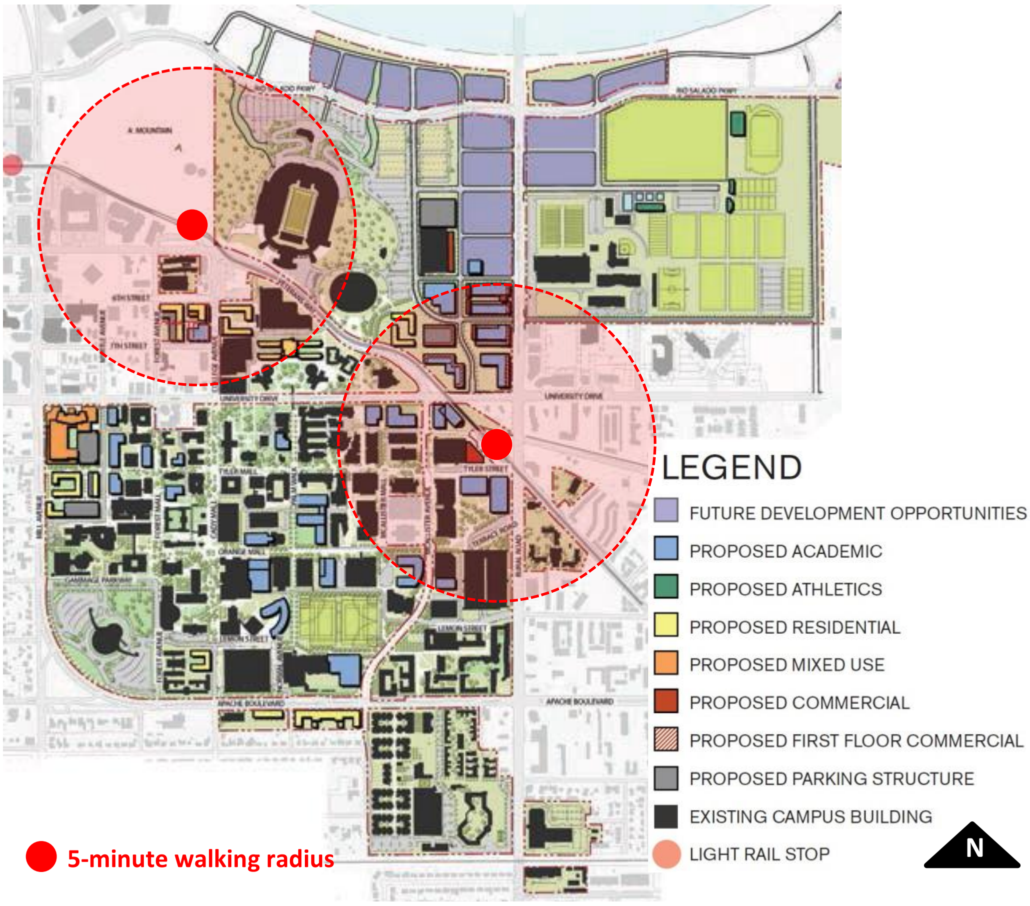

Figure 5.6: Light Rail stops serving the Tempe Campus (ASU Master Plan 2011, 78)

Managing accessibility on Tempe campus is a daunting challenge given the large population of the campus. Yet, the future projection suggests a growing to over 70 thousand by 2020. The movement involves ‘pedestrians and wheeled transportation: large and small delivery trucks, ASU fleet pickup trucks and sedans, service and delivery vans, ASU golf carts, bicycles, skateboards, longboards, and rollerblades’ (ASU Master Plan 2011, 80). Figure 5.8 illustrates how accessibility is managed in Tempe campus. It shows the four major vehicle roads (in blue) surrounding the campus, forming the primary boundaries of it. The service roads (in orange) connect the campus and its core with these four major vehicle roads. Car parking, surface lots and structures/garages, are mostly positioned at the edges of the campus. The core of the campus has been mainly designated to the pedestrians. There are four famous pedestrian routes (in green) used extensively by pedestrians namely Palm Walk, Orange Mall, Tyler Mall, and Cady Mall. The University shows its commitment for more sustainable modes of transportation such as bicycles. There are routes (in red) designed especially for carts and bikes. Other facilities to support biking include a network of routes, several bike lockers around the campus, shower facilities in some buildings, bicycle sharing program known as The Bike Co-op. ASU Tempe achieved Gold Level status as a Bicycle Friendly University in October 2014 (ASU STARS Reporting 2015, 176-177).

Another planning observation is the design of Tempe campus. Figure 5.7 also shows a careful consideration for the campus grid. Buildings ‘respect the established campus grid and reinforce the orthogonal mall structure, with designed moments for quads, courtyards, and other gathering spaces’ (ASU Master Plan 2011, 91). It also indicates that when measuring the distance between the four major roads forming the boundaries of the campus, it can be seen that the dimensions are 1,240 meter by 778 meter (a 12-minute walk and a 7-minute walk, respectively). This indicates that walkability in the campus is carefully considered and planned. What makes the campus more walker-friendly is the four major arteries in the core of Tempe campus: the four malls, see examples in figure 5.8.

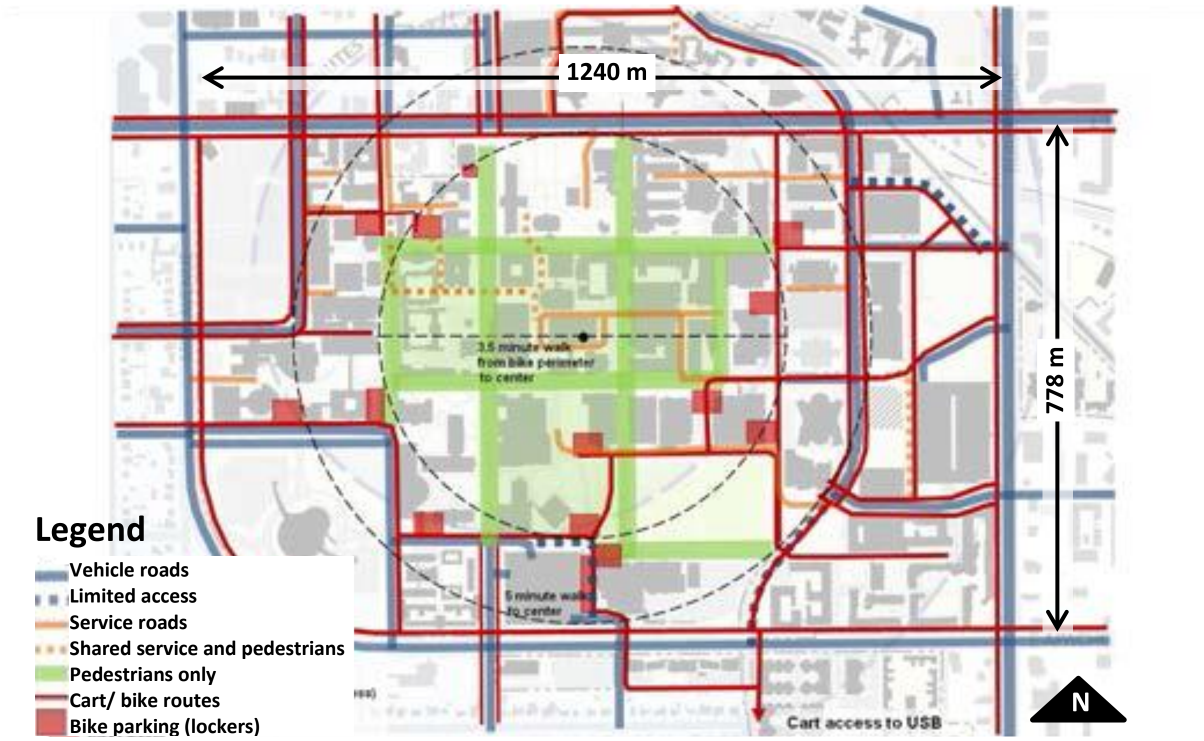

Figure 5.7: Accessibility management in Tempe campus (ASU Master Plan 2011, 88)

Figure 5.8: Examples of routes for walking/biking in Tempe campus (ASU Master Plan 2011, 6)

5.4.1.4.2. Climate considerations

State of Arizona is characterised by a desert climate; intense heat and drought in the summer, while moderate to mild in winter. Therefore, the planning and design of the built environment in such region should react to such challenge. In response to the desert climate, planners and designers in ASU have introduced some measures to mitigate the impact of such climate as well as take advantage of it. In this section, two aspects were explored in Tempe campus; the architectural elements and the landscape.

ASU has developed architectural measures for each campus in order to integrate sustainable design principles to help improve the environmental aspects of sustainability. To start with, ASU has initiated a policy for building size. It aims to 'minimise the overall building size (square footage and footprint), while meeting the building program requirements. The goal is the efficient use of space to reduce overall resource consumption; including embodied energy, operational energy, and building materials' (ASU STARS Reporting 2015, 183). Additionally, the University states clearly that 'all new construction and major renovation work should comply with the Arizona State University Sustainable Design Guidelines and Comprehensive Design Guidelines' (ASU Master Plan 2011, 28). The following points, mentioned in ASU Master Plan (Ibid, 48), sum up these measures:

- 'Plan for healthy, sustainable, mixed use, live/learn/work/play environments in context with the desert southwest'
- 'Enhance and restore ecosystems and habitat, not just reduce impacts'
- 'Use land and resources sparingly: increase overall campus density to minimise environmental impact and maximise efficient use of energy, water, transportation, site, and materials'
- 'Increase surface area dedicated to generating on-site renewable energy (solar, biofuels, and other alternatives)'
- 'Repair/renovate existing infrastructure and innovate with new technology for more efficiency'
- 'Re-purpose, renovate, and recycle existing campus facilities to the greatest extent possible'
- 'Renovate existing campus buildings for better energy and water efficiency and quality of life'
- 'Design new construction to exceed a LEED Silver standard, updating design and construction standards to keep current with best practices'
- 'Utilise building greywater systems to reduce potable water needs for buildings and landscape'
- 'Capture and store rainwater for building and landscape use'
- 'Combine green roof design with solar panels to capture energy, absorb storm water, and reduce heat island effects'
- 'Where demolition is necessary, recycle and/ or re-use construction debris as construction material for new facilities'
- 'Orient development in response to the desert environment'
- 'Create Transit Oriented Campuses (more density and mixed use near LRT stations) at Tempe and DPC [Downtown Phoenix], and bring alternative fuel- based regional transportation to West and Polytechnic campuses'
- 'Increase students living on campus or within an easy walk/bike commute'
- 'Redevelop or design new communities to attract faculty and staff to live close to campus'

- ‘Make campuses safer and more attractive to both pedestrian and bicycle commuter traffic’
- ‘Create cooling microclimates through shading, water and air circulation for outdoor spaces’
- ‘Increase use of desert appropriate landscape plants and materials’
- ‘Use the campuses as living laboratories, making processes and recognition visible’.

ASU is known to have a very comprehensive renewable energy program, which has given the University the title of ‘the largest solar energy capacity on a single U.S. university campus’ (ASU Achievements 2014, 59). Table 5.7 shows an overview of ASU energy profile particularly the energy sources. It indicates that around 20% of the energy use is sourced by clean energy (Solar photovoltaic 10% and other renewable energy sources 7.13%). This free and clean energy is generated by a huge investment in renewable energy facilities in which over 70 thousand solar panels and six small-sized wind turbines are installed. The advantage of the wind turbines is the fact that they can generate power during the day as well as night, unlike the solar panels. Solar panels have been installed on the roof of the majority of Tempe campus buildings and on the roof of the car parking structures as well as on the surface lots, not only shading and hence reducing the heat island effects, but also capturing energy. The six wind turbines in Tempe campus have been mounted on the roof of the Global Institute of Sustainability building, not only as a source of clean energy, but also as a strong message for commitment to environmental sustainability. These wind turbines have a social impact on the campus community and beyond. According to ASU Sustainability News (2008), it is stated that:

> *‘More impressive than the power the turbines generate, however, is the discussions they stimulate. From their prominent rooftop location, the iconic turbines are visible from Cady Mall and University Drive where students, alumni, parents, and visitors from across the country and around the globe have a chance to see and think about them. "The real value of the turbines comes when they prompt a student to say ‘I should study wind power,' or an alumnus to think ‘My company could convert to renewable energy,'" said Jonathan Fink, the Julie Ann Wrigley Director of the Global Institute of Sustainability and University Sustainability Officer.’*

Table 5.7: ASU energy profile

No	Category	Data
01	Electricity use by source	Coal 25.50%, Natural gas 32.78%, Nuclear 21.60%, Solar photovoltaic 10%, & Other renewable sources 7.13% (ASU STARS Reporting 2015, 8)
02	Energy used for heating buildings, by source	Natural gas 100% (ASU STARS Reporting 2015, 8)
03	Renewable energy facilities - Number of solar panels installed - Number of wind turbines installed	 73,190 solar panels (ASU Solar 2017) 6 wind turbines (ASU Renewable Energy 2017)

ASU has been working to green its facilities to achieve the Leadership in Energy and Environmental Design certification (LEED) since 2006. The University ‘has completed 28 certified LEED projects which are comprised of 47 buildings (3 Platinum, 27 Gold, 16 Silver, and 1 Certified)’. The total LEED building gross square meters are 401,922 (4,326,254 gross square feet). This means that almost 17% of the total gross square meters are certified (ASU LEED Certifications 2017).

ASU has also established landscape measures to incorporate sustainable design principles to assist advancing the environmental sustainability in each campus. This is to enhance the outdoor spaces and to create a sense of place and an identity to the institution. The ultimate aim of the landscaping is to 'establish the ASU campuses as venues for living laboratories of sustainable landscape practices that focus on the reduction of energy and resource consumption' (ASU Master Plan 2011, 34). The following points, stated in ASU Master Plan (Ibid, 34 and 36), summarise these measures:

- 'Specify low water use and low maintenance plants. Allow room in the design for plants to reach their mature size without extensive pruning or removals'
- 'Locate trees to provide shade and provide natural cooling for buildings'
- 'Practice/develop techniques for improved tree growth, with use of structural soil and tree planters in or near hardscape edges'
- 'Where possible, specify vertical landscape systems to create "green facades" for cooling buildings and reducing mechanical costs'
- 'Design landscape and hardscape spaces to accommodate bicycle dismount zones with ample storage and social programs such as bicycle co-ops and rental programs'
- 'Investigate techniques for water harvesting, such as collecting condensate from HVAC systems, reusing rainwater runoff, and recycling greywater'
- 'Design landscape and hardscape areas to reinforce and improve campus wayfinding'
- 'Provide adequate wayfinding at gateways, malls, and pedestrian and vehicular nodes'
- 'Design flexible and comfortable spaces to allow for small and large group assembly and encourage social interaction'
- 'Provide ample shade with fixed and flexible seating arrangements'
- 'Establish a consistent ground plane palette of paving materials for all pedestrian routes and streetscape corridors'
- 'Establish a simple and consistent palette of trees and select understory plantings for all pedestrian and streetscape corridors.'

5.4.1.4.3. Flexibility

This research explores some of the properties of flexibility. That is in terms of time, building, and furniture.

ASU offers online education to students at both levels; under- and port-graduate. This is seen by some as a type of education that is convenient given its flexibility. The University offers online programs in 16 different fields of study such as art, design, education, business, language, engineering, health, technology, and sustainability. As for staff and employees, ASU allows 'flexibility in work schedules' (ASU STARS Reporting 2015, 159). The University introduced a condensed work week option for employees where two typical schedules are available for employees to choose: 'Four-day/40-hour work week and Nine-day/80-hour, two-week work week' (Ibid, 178).

In this research, flexibility in buildings is defined as the easiness of expanding or contracting the space and the easiness of adapting new functions or allowing for multiple purposes. In this study, the two main definitions adopted for the physical flexibility were:

- *'... flexibility refers to the ability of built space to accommodate for unforeseeable changes such as demographic shifts, community needs, or policy mandates'* (Moore and Lackney 1994) and
- *'... physical flexibility refers to the adjustability of a space to the practices of individuals, such as meeting the special sensory and/or mobility needs of students. Movable furniture and walls,*

> *or re-configurable buildings, rooms, and passageways all represent this type of physical flexibility'* (Monahan 2002).

Flexibility in buildings has been emphasised clearly by the ASU documents. It highlights the importance of flexibility in terms of building age-lasting layout, furniture, and materials. According to ASU STARS Reporting (2015, 183), it is stated that:

> *'Design for Future Use: Plan for a "100-year Building" through flexibility of use and future reuse. Design interior spaces that are flexible and allow for changes in use. Use standard furniture wherever possible. Minimise use of custom millwork, custom building systems (door frames, doors, interior windows etc.) to maximise reuse in the future. For retrofits, analyse current space requirements for space efficiency, function, and use proximity. Design in accordance with cradle to cradle principles to the full extent practical'.*

To make campus facilities more flexible and hence allowing for alternative use in the future, ASU encourages the following measures:

- 'utilising established construction methods'
- 'standardised components'
- 'minimising custom systems where possible' (ASU Master Plan 2011, 90).

As for the furniture, ASU recommends flexible furniture which can 'provide flexibility in gathering spaces and allow for different types of functions by incorporating different types of seating, such as tables with chairs, permanent benches, and moveable furniture' (ASU Master Plan 2011, 108).

5.4.1.4.4. Space utilisation

Given the importance of real estate of any university, some institutions tend to establish a unit that manages spaces in the campus. Under the ASU Office of University Architect, there is a Planning and Space Management section that responsible for space management including space provision, space utilisation, and space operation and maintenance.

Underutilised spaces are one of the difficult tasks that facility managers have to deal with. It is stated in ASU Master Plan (2011, 59) that:

> *'The single biggest challenge for the Tempe campus is finding sites for new construction or replacement of outdated facilities on a landlocked campus... The compactness and walkability of central campus creates the demand for more research, academic, and residential facilities in close proximity; however, there are no remaining buildable sites in the core...... Underutilised or very low density, single-story buildings in the core exacerbates the problem. Therefore, it is necessary for all new development to be very efficient in its use of space'.*

In order to optimise the use of the existing facilities on campus, ASU has adopted a policy of sharing the university facilities with the surrounding community. Figure 5.9 illustrates a diagram that simplifies such strategy. ASU policy, mentioned in ASU Master Plan (2011, 91), points out that:

> *'It is also important to recognize the limited supply of land available to the campus, and to efficiently utilize sites with compact footprints allowing for maximum future development. Along edges where the University abuts commercial or business uses building design should have sufficient flexibility to accommodate an interweaving of program, blurring the boundary between institutional and on institutional uses... This could manifest as*

multi-function zones that have the potential to be incubator office, retail, cafe or exhibition, suiting both student and private entrepreneurs'.

Figure 5.9: ASU's policy for sharing facilities with the community (ASU Master Plan 2011, 91)

5.4.2. University of South Florida (USF)

5.4.2.1. Background information

The University of South Florida (USF) is a metropolitan public research institution founded in 1956. Although the institution is relatively young in age compared to Arizona State University, USF is among one of the top five fastest-growing research universities in the US (USF Strategic Plan 2013, 6). In 2015, USF is ranked among the top universities in the US for social mobility (recruiting and graduating low-income students), research (producing cutting-edge scholarship and PhDs), and service (encouraging students to give something back to their country) (Washington Monthly 2015). According to the Academic Ranking of World Universities (ARWU 2016), USF ranks among the top 300 of the best colleges and universities in the world and among the top 100 in the US. USF is considered one the biggest universities in the US in which it enrolled almost 50 thousand students in 2015 (USF System Facts 2016, 9). Table 5.8 shows some facts and figures about how large the University really is. The table includes the numbers of academic divisions, departments, enrolments, and staff.

Table 5.8: Facts and figures about the University of South Florida (USF STARS Reporting 2015, 9)

No	Category	Data
01	Number of academic divisions	47 Divisions/Faculties
02	Number of academic departments	37 Departments/Schools
03	Full-time equivalent enrolment	42,065 Students (2015)
04	Full-time equivalent of employees	9,206 Employees (2015)
05	Full-time equivalent of distance education students	100 Students (2015)
06	Total number of undergraduate students	30,317 Students (2015)
07	Total number of graduate students	9,905 Students (2015)
08	Number of employees	9,206 Employees (2015)
09	Number of residential students	5,673 Students (2015)

Figure 5.10 presents the locations of the University in the State of Florida. USF consists of three member institutions, which are separately accredited by the Southern Association of Colleges and Schools Commission on Colleges (SACSCOC 2017):

- USFT (Tampa campus) (Main campus)
- USFSP (St. Petersburg campus)
- USFSM (Sarasota-Manatee campus)

The three campuses are located in the densely populated cities of Florida. For example, USFT campus is in Tampa city with a population of 335,709 inhabitants, USFSP campus is in St.

Petersburg city with a population of 244,769 inhabitants, and USFSM campus is in Sarasota city with a population of 51,917 inhabitants (U.S. Census Bureau 2010).

Climate

The climate of Tampa Bay is characterised as a humid subtropical climate; hot and humid in summers, while mild to cool in winters (The Weather Channel 2017). Another interesting character of Tampa is the thunderstorms, especially in summers. Florida, and Tampa in particular as many argued, has been titled as the 'lightning capital of the United States', so much so that lightning causes tens of fatalities every year (Accuweather 2017).

Figure 5.10: The three main campuses of University of South Florida (USF System Facts 2016, 3)

Table 5.9 represents some key facts and figures about the three USF campuses; Tampa, St. Petersburg, and Sarasota-Manatee. It shows the total campuses area, the gross floor area of building spaces, and other floor areas of different functions. The statistics in this table is a direct consequence of the numbers in the previous table; large student body and many departments require large size campus.

Table 5.9: Facts and figures about the USF campuses (USF STARS Reporting 2015, 6)

No	Category	Data
01	Total campuses area	6.6 Square kilometres (1,562 Acres)
02	Total gross floor area of building space	1,083,157 Square Metres (11,659,014 Square Feet)
03	Gross floor area of laboratory space	19,648 Square Metres (211,491 Square Feet)
04	Gross floor area of healthcare space	Not available
05	Gross floor area of residential space	165,167 Square Metres (1,777,846 Square Feet)

University campus

Among the USF three campuses, Tampa campus has been selected to be studied given that it is the main campus, the oldest and the original campus of the University, accommodates many of schools and departments and hence most of the USF undergraduate and postgraduate students. Tampa hosts most of the USF educational and research facilities as well as other supporting facilities. Table 5.10 illustrates some data about Tampa campus. It shows the type and size of the campus, number of buildings, total gross floor area, campus population, enrolment, staff, and student housing. Tampa campus is categorised as an urban fringe of mid-size city, which indicates that the campus is located at the edge of Tampa city. The size of the campus is 6.3 square kilometres (1,562 acres). According to the latest statistics, Tampa campus is home to 256 buildings (USF System Facts 2016, 28). The total gross floor area of buildings' spaces is 946 thousands square meters (as of 2016). This in turn means that the floor area ratio, the ratio of building's total floor area to the size of the campus land, is 15%. The enrolment in 2016 was 40,827 full-time equivalent students (Ibid, 9). In 2015, there were 5,673 students living on-campus, which means that almost 14% of the total number of Tampa students. Among the three USF campuses, Tampa is the most densely populated campus (0.008 people per km^2).

Table 5.10: Facts and figures about USF Tampa campus (USF STARS Reporting 2015)

No	Category	Data
01	Campus type	Urban (urban fringe of mid-size city)
02	Campus size (campus acreage)	6.3 Square Kilometres (1,562 Acres)
03	Number of buildings	256 buildings (USF System Facts 2016)
04	Gross floor area of building space	946 thousand Square Meters (10,2 million Square Feet)
05	Campus population	54,729 people
06	Total enrolment	40,827 students (Full-Time Equivalent) (USF System Facts 2016)
07	Faculty members	5,586 members (regular full- and part-time members)
08	Employees	8,316 staff (regular full- and part-time employees) (USF System Facts 2016)
09	Number of beds (Student dormitories)	5,673 beds (2015)

The University of South Florida has recently adopted its 2015-2025 Tampa Campus Master Plan. USF is updating its Master Plan every five years. The document points out that the University is not only taking its own goals and objectives into account, but also the City of Tampa's. In the 2015-2025 Master Plan document (USF Tampa Campus Master Plan 2015, 8), it is indicated that:

> *'Update process includes an Evaluation and Appraisal Report, Data Collection and Analysis, and revisions to the Goals, Objectives, and Policies. Development capacity is governed by the current Campus Development Agreement with the host municipality, the City of Tampa.'*

Figure 5.11 shows the latest update of Tampa Campus Master Plan. It illustrates the existing buildings (in red colour) and proposed buildings (in peach colour). The core campus can be divided into the following six districts:

- Central district consists of the academic buildings. 'USF Tampa has 14 Colleges and Schools with the Marine Science College located on the St. Petersburg campus. The faculty in the 14 Colleges are dedicated to research in many disciplines, including healthcare, water resources management, urban sustainability, practices to improve the quality of life for people with disabilities and being a leading university on Veterans research and integration' (Ibid, 3).
- North West district is home to USF Health, which includes Colleges of Medicine, Pharmacy, Public Health, and Nursing.
- North East district is residential.
- North district is facilities services.
- South East district is recreation / athletics.
- South West district is another residential.

The Master Plan does not include the following three zones:

- USF Research Park zone (south west) (340 thousand Square Meters – 83.8 Acers).
- USF Research Foundation zone (south west) (114 thousand Square Meters – 28 Acers).
- USF Forest Preserve zone (north east) (3 million Square Meters – 735 Acres).

Figure 5.11 also shows the greenway system that runs through the campus from the north east corner to the south west corner. The greenway, which is ‘a continuous system of formal and natural open spaces’, remains a priority in both planning and landscaping of the Tampa campus, since these open spaces can be regarded as the lung of the campus. The developed areas in the campus is ‘complemented and reinforced by the greenway’ (Ibid, 65).

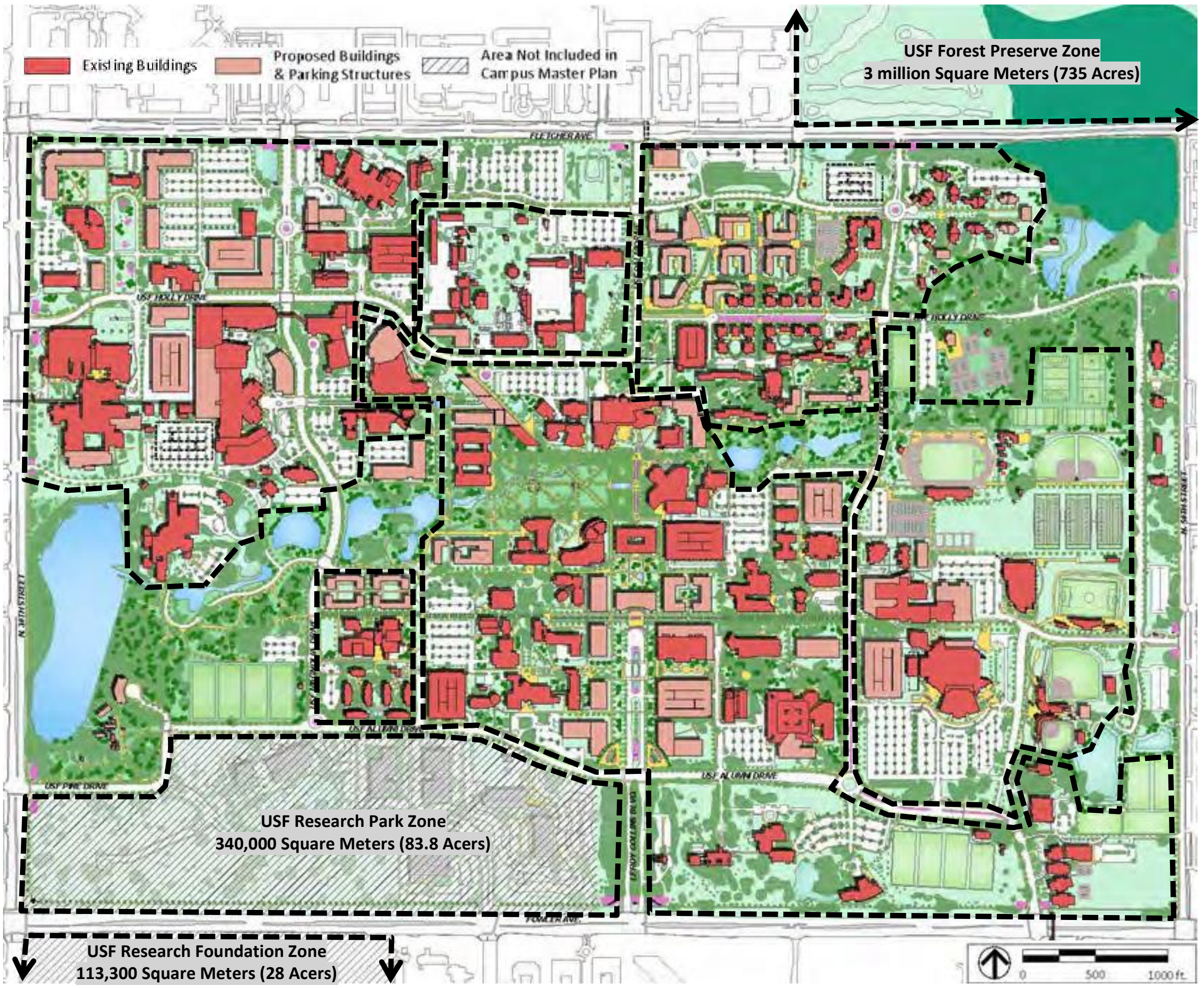

Figure 5.11: Master Plan of USF Tampa campus (USF Tampa Campus Master Plan 2015, 7)

Table 5.11 represents the 10-year capacity planning of USF Tampa campus. The four large districts are: academic, health, housing, and recreation and athletics. In general, the University is expanding its capacity and hence its footprint by over 50%. It can be seen that there will be an increase in square meters of academic districts by almost 70%, followed by housing about 60%, and then health buildings by nearly 50%. The facilities services and recreation and athletics will see an increase of more than 30%.

Table 5.11: Tampa campus future space needs (USF Tampa Campus Master Plan 2015, 67)

No	District	Land area	Existing building area 2015	Future building area 2025
01	Academic	910,543 M^2 (225 Acres)	339,107 M^2 (3,650,119 GSF)	551,649 M^2 (5,937,904 GSF)
02	Health	586,794 M^2 (145 Ares)	284,886 M^2 (3,066,481 GSF)	424,426 M^2 (4,568,481 GSF)
03	Housing	453,248 M^2 (112 Ares)	174,719 M^2 (1,880,668 GSF)	270,024 M^2 (2,906,518 GSF)
04	Facilities Services	202,343 M^2 (50 Ares)	22,139 M^2 (238,297 GSF)	29,757 M^2 (320,297 GSF)
05	Recreation and Athletics	639,404 M^2 (158 Ares)	87,326 M^2 (939,970 GSF)	115,662 M^2 (1,244,970 GSF)
06	Greenway	505,857 M^2 (125 Ares)	326 M^2 (3,516 GSF)	2,111 M^2 (22,716 GSF)
	Total	3,298,188 M^2 (815 Ares)	908,504 M^2 (9,779,051 GSF)	1,393,628 M^2 (15,000,886 GSF)

Gross Square Meters (M^2)
Gross Square Feet (GSF)

Having briefly looked at the USF in general and Tampa campus in particular, the following sections assess USF's sustainability plans and practices. This research focuses on certain areas of sustainability including:

- Management aspects
  (Vision, policy, planning, and commitments)
- Engagement aspects
  (Attitude, knowledge, and awareness of sustainability)
- Environment aspects
  (Location and physical accessibility, flexibility, climate considerations, and space utilisation)

5.4.2.2. Management aspects

(Vision, policy, planning, and commitments)

University of South Florida adopts and defines sustainability as (USF Sustainability Initiative Report 2009, 2):

> *'According to the UNEP, WWF and the IUCN, sustainability is the process of improving the quality of human life while living within the carrying capacity of supporting eco-systems. For the Sustainability Initiative we use the definition where human, environmental, material, and economic activities compose fundamentally integrated dimensions or a nexus of sustainability that are mutually reinforcing.'*

5.4.2.2.1. Vision for sustainability

The University of South Florida's mission is to 'deliver competitive undergraduate, graduate, and professional programs, to generate knowledge, foster intellectual development, and ensure student success in a global environment' (USF 2017). The University's vision is to be dedicated to:

- 'Student access, learning, and success through a vibrant, interdisciplinary, and learner-cantered research environment incorporating a global curriculum.
- Research and scientific discovery to strengthen the economy, promote civic culture and the arts, and design and build sustainable communities through the generation,

dissemination, and translation of new knowledge across all academic and health-related disciplines.
- Partnerships to build significant locally- and globally-integrated university-community collaborations through sound scholarly and artistic activities and technological innovation.
- A sustainable economic base to support USF's continued academic advancement' (Ibid, 2017).

The University has adopted a vision to make its campuses more sustainable. It indicates that the USF is to:

> *'coordinate and build partnerships for university-wide initiatives that advance the University of South Florida's strategic goal of creating a sustainable campus environment. To achieve this mission, we actively support faculty, staff, students, alumni, and neighbourhood partners in their efforts to transform the University of South Florida into a 'Green University', where decisions, structural and routine, consider both individual and collective impacts to our campus, community, economy, and environment'* (USF STARS Reporting 2015, 205).

USF also highlights its sustainability values in which the University highlights the main aspects targeted in order to become more sustainable. The University states that:

> *'we share a sustainability ethic that promotes conserving resources, reducing waste, recycling and reusing materials, finding new sources of clean energy, increasing energy efficiency, and diminishing life-cycle impacts and our consumption of greenhouse gas producing materials. We engage in this ethic of stewardship to guide the development and implementation of programs, policies, and other courses of action in the operation and management of the University of South Florida as well as its institutional teaching, research, and service commitments'* (Ibid 2015, 205).

In an effort to clarify the costs and benefits of sustainability, the University clearly stated the opportunities that can be gained by being more sustainable. It includes not only an environmental protection, but also other great benefits. In its USF Sustainability Report (2007, 9), the University listed some of these possibilities including:
- 'Cost Savings: Savings resulting from the reduction of waste and efficiency gains.
- Community Relations: Promotion of USF as an environmentally conscious and innovative organisation.
- Educational Value: Offering students an environment for cross-disciplinary hands on learning and volunteer/employment opportunities.
- Fit with Campus Cultures and Values: An environmental ethic is embedded at institutions where tomorrow's leaders are being trained.
- Health and Productivity: Improved educational and work environment to maximise health and productivity.
- Donor Interest: Environmental issues are becoming increasing more important to the public and potential donors may be more likely to contribute to environmental friendly initiatives.'

The USF is acknowledging the costs involved in establishing a more centralised sustainability program. Therefore, the University managed the costs of initiating such a program by 'aligning with the numerous sustainability groups and organisations already in existence. Initial start-up expenses for such an office would only need to include salaries and benefit expenses for a Director and several student interns. This funding could be obtained from a variety of sources including grants, donations, sponsorship from other departments, or student fees. Further, after initial funding, the program could be self-sustaining through initiative savings' (Ibid, 16).

5.4.2.2.2. Policy for sustainability

The University of South Florida has laid out its Climate Action Plan showing its 'a long-term climate change mitigation strategy' (USF Climate Action Plan 2014). The plan is expected to be of great benefit to the campus as well as the community. For instance, 'energy efficiency programs lower costs while reducing greenhouse gas emissions. Increasing carpooling and public transportation reduces pollution and traffic congestion in addition to reducing carbon dioxide emissions' (Ibid). The plan's include primary environmental issues such as 'Campus Design, Open Space Network, Greenway Expansion, Integrated Landscape, Forestation, Xeriscape Development, Waterscape Improvement, Irrigation, and Conservation' (Ibid).

The main targets in the USF Climate Action Plan (2014) were:

- '10% reduction of greenhouse gas emissions by 2015,
- 20% reduction of emissions by 2025,
- By the year 2050, the University of South Florida will emit 80 percent less carbon dioxide than it did in 2007-2008 (our GHG baseline fiscal year: 125,761 Metric Tons of CO2 Equivalent),
- Beyond 2050, and with the aid of offsets (representing purchased RECs [renewable energy certificates], carbon offsets [CRTs, or carbon reduction tons], and increased carbon sequestration through the expansion of a long-term Greenway project on campus), USF will be 'climate neutral' by 2070. '

In order to achieve its vision, USF has adopted several policies. These strategies have covered many aspects of sustainability in the institution and its campuses. The following strategies, mentioned in the USF Sustainability Initiative Report (2009, 3), are:

1. 'Curriculum
    - Evaluate what is being taught at USF in the area of sustainability.
    - Evaluate how we compare to similar campuses.
    - Develop a list of suggested changes/addition to enhance sustainability studies on campus.
2. Recycling and Waste Management
    - Summarise what USF is doing in the area of recycling.
    - Brainstorm on what else could be done.
    - Prioritise key projects for the future.
    - Develop initiatives as able.
    - We must adopt 3 or more new approaches to reduce waste on campus in the coming year.
3. Media/Promotion
    - Publish a newsletter each semester on the activities of the group.
    - Get out word on meetings, events.
    - Put out press releases as needed.
4. Greenhouse Gas Emissions
    - Develop an inventory of the University Greenhouse Gas Emissions.
    - Network with other sub-committees as needed.
5. Transportation

- Summarise what USF is doing in the area of green transportation.
- Brainstorm on what else could be done.
- Prioritise key projects for the future.
- Develop initiatives as able.
- Work with Greenhouse Gas Emissions Subcommittee to assist with greenhouse gas inventory.

6. Water
   - Summarise what USF is doing in the area of water conservation and green practices associated with water consumption and wastewater management.
   - Brainstorm on what else could be done.
   - Prioritise key projects for the future.
   - Develop initiatives as able.
7. Green Building
   - Summarise what USF is doing in the area of green building.
   - Brainstorm on what else could be done.
   - Prioritise key projects for the future.
   - Develop initiatives as able.
   - Work with Greenhouse Gas Emissions Subcommittee to assist with greenhouse gas inventory.
8. Research
   - Summarise key research themes in sustainability taking place on the USF campus.
   - What specific research is being conducted on sustainable USF?
9. Finance
   - Examine how the university can establish a policy or a committee that supports climate and sustainability shareholder proposals at companies where our institutions endowment is invested.
10. Procurement
    - Examine current purchasing standards and examine how USF can move ahead in requiring the purchase of Energy Start certified products in all areas for which such ratings exist.
    - Examine how USF can offset greenhouse gas emissions generated by air travel paid for by our institution.
11. USF Alumni and Community
    - Inform USF alumni and the community about sustainability efforts on campus.
    - Seek input on activities taking place associated with sustainability.
    - Invite alumni and the community to important events on campus.
12. Students
    - Prioritise students concerns about campus sustainability.
    - Brainstorm on what can be done to improve campus sustainability.
    - Prioritise key projects for the future.
    - Develop initiatives as able.
    - Network with other subcommittees to keep the student body informed of activities.
13. Energy
    - Summarise what USF is doing in the area of green energy.
    - Brainstorm on what else could be done.
    - Prioritize key projects for the future.
    - Develop initiatives as able.

- Work with Greenhouse Gas Emissions Subcommittee to assist with greenhouse gas inventory.'

What can be noticed about the above mentioned strategies is that it covers almost all five overarching sustainability areas in higher education institutions (Alghamdi et al. 2017):

- Academia (curriculum, and research),
- Management (finance, and procurement),
- Environment (recycling and waste management, greenhouse gas emissions, transportation, water, energy, and green building),
- Engagement (students, media/promotion, and USF alumni and community), and
- Innovation.

5.4.2.2.3. Planning for sustainability

At the University level, the USF is devoted to reduce its carbon footprint through a number of initiatives including:

- 'Increasing student sustainability awareness and expectations.
- USF Student Green Energy Fee to fund campus sustainability projects.
- Increasing USF recognitions in national research and sustainability rankings.
- Leadership through Energy and Environmental Design (LEED) Certifications, reducing utility consumption, increasing conservation and recycling, planting shade trees, improving facilities for pedestrian, bicycle, and transit, among many other efforts' (USF Tampa Campus Master Plan 2015, 48).

At the campus level, the main principles in the Master Plan are (USF Tampa Campus Master Plan 2015, 3):

> *'... increased density by minimising building footprints, maximising height, and replacement of inefficient one and two story buildings in order to optimise land use and conserve open space. The existing surface parking lots in the Academic core will largely become future sites for Academic, Research, and Support facilities.'*

In order to establish a more lively and vibrant campus, USF is planning to modernise some of its facilities as well as build more supporting services. For example:

- Investing in housing on-campus either by demolishing aging buildings and replacing them with new ones to increase the capacity. This not only includes 'state of the art residence halls', but also 'dining and recreation facilities,'
- Investing in supporting facilities which include 'a small grocery store at the campus edge to support the growing student residential community both on-campus and the adjacent off-campus area of apartments to the north, thereby reducing the need to travel to more distant stores for everyday needed items' (Ibid, 50).
- Enhancing the 'interconnected system of public spaces, quadrangles, courtyards and pedestrian ways that are reinforced by coherent building edges'
- Increasing the campus density is 'encouraged to enhance campus vitality, conserve limited land resources for facilities growth, and animate the functional connections between areas of the campus,'
- Promoting and establishing 'a vibrant pedestrian dominated core campus through reorganisation of the campus loop road, concentration of parking at the campus perimeter, and prioritising phased building placement in support of defining pedestrian open space before street edges' (Ibid, 65).

- Supporting ‘campus community engagement with a living dynamic Greenway through incorporation of education, research, and pilot project sites, passive and active informal recreation opportunities, and outdoor gathering and performance sites’ (Ibid, 66).

The University highlights the importance of the future land use of Tampa campus to maintain a more sustainable approach. The proposed policies to manage the land use of the campus can be summed up as following (Ibid, 69):

- ‘reduce distance and improve quality of connections between functions so as to reduce vehicle use on campus by encouraging non-vehicular circulation – walking and bicycling – and shared shuttle and potential tram access.
- Minimum new campus building heights are three stories or more unless granted exception from the University President. New buildings shall be designed to a maximum practical height in order to meet program requirements in order to preserve campus land for potential future expansion and to reduce pedestrian walking distances.
- One-story temporary structures are inefficient in terms of land use, energy consumption, and maintenance funds, and create potential risks in the event of a hurricane or other natural disaster.’

The University of South Florida is helped in addressing other planning issues by its Office of Decision Support. Such Office provides information and analysis for most of the strategic choices, among which is the student enrolment. The USF Tampa Strategic Enrolment Plan 2013-2018 is the latest plan, in which the USF Office of Decision Support (2013, 1) highlighted some of the planning issues as follows:

- Maintain a total student enrolment at around 40 thousand students by 2018; ‘working toward an undergraduate/graduate FTE split of 75%/25%’.
- ‘Renovate on-campus housing and construct new facilities as necessary to meet the on-campus residency requirement for new students and boost student success.
- Optimise investments in instructional facilities and faculty.
- Expand access to higher education through increases in distance learning opportunities.
- Residence hall capacity will increase to accommodate the projected increases in FTIC students [Freshmen and First Time in College], who are required to live on-campus in their first year.
- The Florida high school student population will continue to decline as projected.
- Increase full fee-paying out-of-state and international undergraduate and graduate student enrolment.’

5.4.2.2.4. Commitments to sustainability

University of South Florida is one of few universities in the US to achieve ‘a Gold Rating for building an environmentally-conscious campus’ by the Sustainability Tracking, Assessment & Rating System (STARS), a tool assessing sustainability aspects in universities by Association for the Advancement of Sustainability in Higher Education (AASHE 2017). The following list presents some of the main sustainability initiatives, activities, programs, and practices in USF:

- The University signed ‘The American College and University Presidents Climate Commitment’ in 2008 (USF Tampa Campus Master Plan 2015, 48).
- The University founded its School of Sustainability, the Patel College of Global Sustainability (PCGS) in 2009, in order to ‘foster sustainable urban development and help society live in harmony with the environment’ (PCGS 2017). According to the

College's Annual Report (PCGS Annual Report 2016, 17), the key research areas are: ‘Renewable fuel and products, Global change and the associated uncertainties, Urban form and its influence and impact on resource management, Urban metabolism modelling resources flows (water, wastes, energy, people, goods...etc.), Urban water (integrated urban water modelling, flexible design, transitioning), Sustainable Tourism (Participation in the global research of the UNWTO International Network for Sustainable Tourism Observatories)’.

- The University submitted its Climate Action Plan in 2010, through which it shows the USF’s road map to achieve its goal of reaching carbon neutrality by 2070 (USF Climate Action Plan 2014).
- The University created its Office of Sustainability in 2012, with the aim of coordinating the University efforts to advance sustainability aspects. Such an office is of great benefit and should not be thought of as an extra burden on the institution. The USF pointed out in their USF Sustainability Report (2007, 4) that:

  > *‘The economic cost for starting an Office of Sustainability should be minimal, and substantially offset by savings in many areas facilitated by the office. For example, building construction: Life cycle costs on green building is demonstrating a 2 - 4 year return on investment for any additional design/construction costs, without year savings in energy and maintenance costs that make green building advantageous.’*

- The University has numerous people who specialise in sustainability, covering most disciplines.
- The University is taking advantage of its campus as a living lab and therefore a number of sustainability initiatives have been introduced including sustainability curriculum and research, recycling and waste management, promoting and outreaching sustainability, green transportation programs, green energy, and so on. ‘We have an opportunity, through our curriculum, pedagogy, research and operations, to serve as a model laboratory for sustainability’ (USF Sustainability Report 2007, 5).
- The University is featured in ‘Princeton Review’s Guide to 353 Green Colleges: 2015 Edition as one of 353 institutions of higher education that demonstrate a strong commitment to sustainability in their academic offerings, campus infrastructure, activities and career preparation’ (USF Points of Pride 2017).
- The University was ranked 11th in the 2015 Rankings of America's Greenest Colleges and Universities by Sierra, which is America's largest and most influential grassroots environmental organisation (Sierra Club 2015).
- The University publishes a sustainability newsletter regularly to keep its audience informed about all the sustainability news, updates, meetings, and events. This newsletter is managed by the University Patel College of Global Sustainability.

The University of South Florida (USF) shares many organisational aspects of managing sustainability with Arizona State University (ASU). However, unlike the organisational structure seen in ASU, USF institutionalises sustainability slightly differently. For example, in ASU there are four main parties involved in planning and executing sustainability initiatives and programs. These parties are Institute of Sustainability (which can be regarded as the Office of Sustainability), School of Sustainability, Facilities Development and Management, and University Business Services. In USF, the analysis of the interviews shows that the following structure of planning and implementing sustainability practices and operations:

- Office of Sustainability. The main responsibility is coordinating the sustainability efforts between all parties involved. It offers training programs to faculty and staff members. It organises a number of sustainability activities on- and off-campus. It also deals with some of the technical issues such as gathering data, analysing, and reporting with the help of other university departments. The institution is basically looking at the overall management side of sustainability.

- College of Sustainability. Like any other college in the university, it offers a variety of sustainability topics and subjects for under- and post-graduate levels. Therefore, the main responsibility is education, research, and outreach activities.
- Facilities Management. Under this division, there are many university departments such as Design and Construction, Emergency Management, Environmental Health and Safety, Operations, Planning, and Services. This division is responsibility is to looking after the university's physical assets including planning, management, operations, and maintenance. This department is basically addressing the operation side of sustainability. An interviewed director of sustainability in USF indicates that:

  'The FM [Facilities Management] is a major player in implementing sustainability since it is responsible for managing the largest contributors to greenhouse gas emissions: buildings and transportation.'

5.4.2.3. Engagement aspects

5.4.2.3.1. Attitude, knowledge, and awareness of sustainability

It is confirmed that when the campus community knows that the university top administration is committed, involved, and supportive of the sustainability programs, then green campus initiatives have a much higher success rate (Simpson 1996). To demonstrate the sustainability leadership role in university campuses, top administration has to lead by example including the reviewing of the institution's vision, mission, value, and objectives to promote and implement sustainability in the campus.

The targeted stakeholders at universities are students, faculty members, university staff and employees. They all play a key role in making a change in the university and beyond. Universities help to advance the knowledge and awareness of sustainability through a number of initiatives. The list below shows how committed the USF is to engaging its students, faculty members, and staff in sustainability issues:

- The University coordinates a number of sustainability programs designed for USF's students. One of these programs is the Sustainability Internship Program, organised by USF Office of Sustainability targets all the university 40 thousand students. The program provides training 'Formal training regards familiarising with the sustainability reporting systems, sustainability initiatives in campus, using the office equipment and coordination with other sustainability faculty and staff' (USF STARS Reporting 2015, 48). 'Examples of activities include the distribution of sustainability practices and information during *Bull Markets*, *Week of Welcome*, *Earth-day*, facilitate recycling, and water conservation awareness campaigns, and sustainability competitions in the residence halls' (Ibid, 48).
- The University also offers other student programs such as Sustainability Scholars Program and Sustainability Fellows Program. The former specifically targets undergraduates, while the latter is designed for graduates. Both programs are partially organised by the Office of Sustainability. Other small programs, such as Green Living Learning Community Programs, are mainly run with the help of on-campus housed students and it is supervised by the USF Residential Life and Education staff members.
- The University facilitates engaging students actively on activities and practices that focus on sustainability. For example, 'Student Environmental Association (SEA) is an

active student organisation at the University of South Florida in Tampa. It engages students in volunteer activities, educates the community about the environment, and works towards making USF more environmentally-friendly' (Ibid, 57).
- The University School of Sustainability 'disseminates a monthly electronic newsletter nationally and internationally' (Ibid, 65).
- The USF's Office of Sustainability sustains 'an active listserv for the campus and community, as well as active Facebook, Twitter, YouTube, and iTunes sites/pages/channels' (Ibid, 65).

The USF conducts a sustainability literacy assessment in order to not only evaluate the knowledge level of sustainability topics, but also to raise awareness among students. Such survey may also assess values, beliefs, and behaviours. According to Alvarado (2013), who conducted the assessment as part of her Master's thesis research, the survey explored the environmental literacy among students of USF. The assessment was administered online. The following points highlight the main results of the survey:
- The results of the survey were 'based on the participation of 184 students ranging from freshman status all the way to graduate students' (Ibid, 12).
- The results showed that 'overall, the level of environmental knowledge of student participants at the University of South Florida was relatively even with 56% scoring below a "passing" grade' (Ibid, 14).
- The analysis indicated that 'there were trends found in the environmental knowledge for all areas of study except for the engineering students, who had a higher passing rate than all other majors' (Ibid, 14).
- When students were asked about recycling, the vast majority of them said 'yes'.
- The overall assessment indicated that the USF students showed a general moderate level of knowledge.

The USF offers formal education programs and courses that address sustainability. The total number of courses offered by the University is 2,298 courses for undergraduate and 1,664 courses for graduate (USF STARS Reporting 2015, 13). However, the University offers a number of sustainability courses for undergraduate and graduate, 307 and 231 respectively. Besides, there are other courses that include sustainability in their curriculums for both undergraduate (146 courses) and graduate (122 courses). This shows an institutional commitment to sustainability education at all levels.

On the other hand, the University offers some informal sustainability-focused educational programs. These programs tend to be shorter and very comprehensive. An example of such program is the Environmental Policy and Management Graduate certificate. It provides 'a broad-based, multidisciplinary educational program to professionals, practitioners, citizens, and students who wish to acquire or strengthen their knowledge of the environment' (USF STARS Reporting 2015, 24).

The University's Office of Sustainability offers all students, faculty members, and staff a fund for innovative concepts for more sustainable practices in the university campus. It is reported that 'Over the last 3 years, more than 50 proposals were submitted and 17 projects were funded worth US$ 2.0 million' (USF STARS Reporting 2015, 74). For instance:
- 'Smart parking guidance system that is supported by mobile app was awarded another US$ 500,000.' Figure 5.12 shows how the smart parking system works.

- ‘A smart bike sharing program proposed by student and faculty team got a funding of about US$ 350,000.’ Figure 5.13 represents the app on smartphone devices displaying bikes stations on campus, available bikes, total racks, and the distance.
- ‘A proposal from Housing and Residential Services was awarded $12,340 to install lighting controls.’
- ‘A $50,000 project to reduce electricity consumption will use “state-of-the-art methods” to manage desktop computers on campus submitted by students and a faculty member in the Department of Computer Sciences.’
- ‘The campus has installed more than 60 water bottle refill stations for efficient filling and reuse of water bottles.’

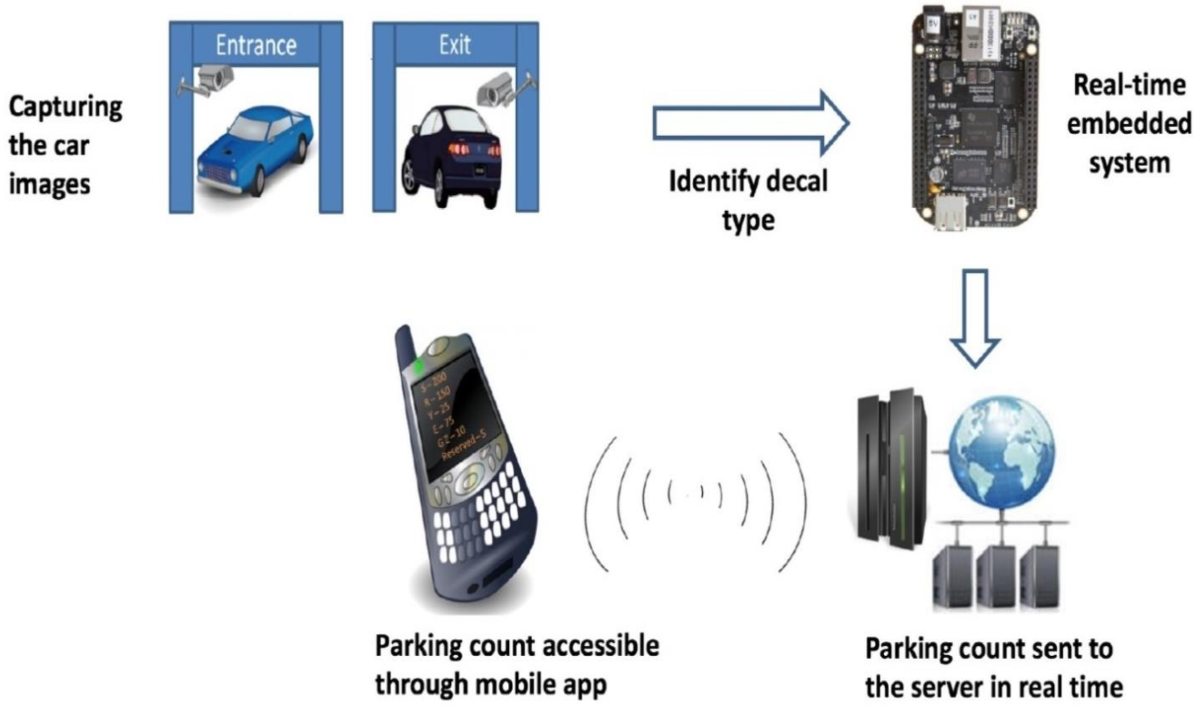

Figure 5.12: Real time parking information to drivers (Dokur 2015, 25)

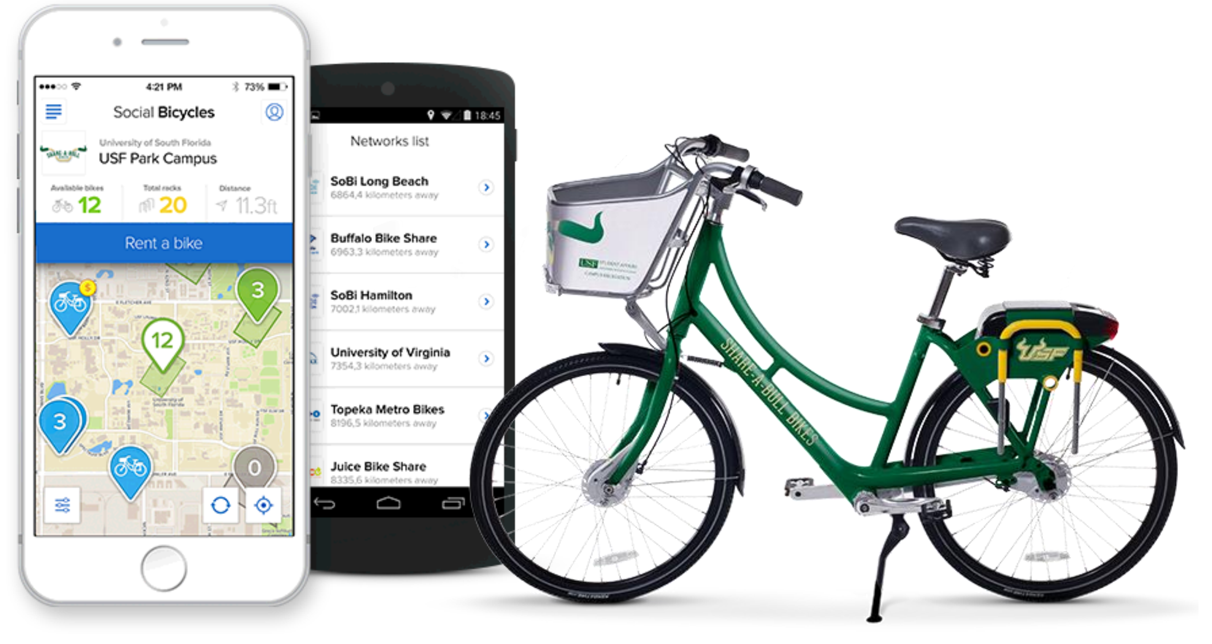

Figure 5.13: USF A smart bike sharing app (USF Share-A-Bull Bikes 2017)

5.4.2.4. Environment aspects

Location and physical accessibility, climate considerations, flexibility, and space utilisation

5.4.2.4.1. Location and physical accessibility

USF Tampa campus is located at the northeast outskirts of Tampa city. The campus is connected to the city of Tampa through a transportation network of buses. The city of Tampa has nine transit centres covering all parts of the city. The USF Tampa campus is well served by one of these centres, known as University Area Transit Centre, located on the west border of the campus. The University has its own shuttle of busses, known as the Bull Runner. Figure 5.14 shows the six routes these buses take. Route C, coloured in red, is the line connecting the city and the campus through the University Area Transit Centre.

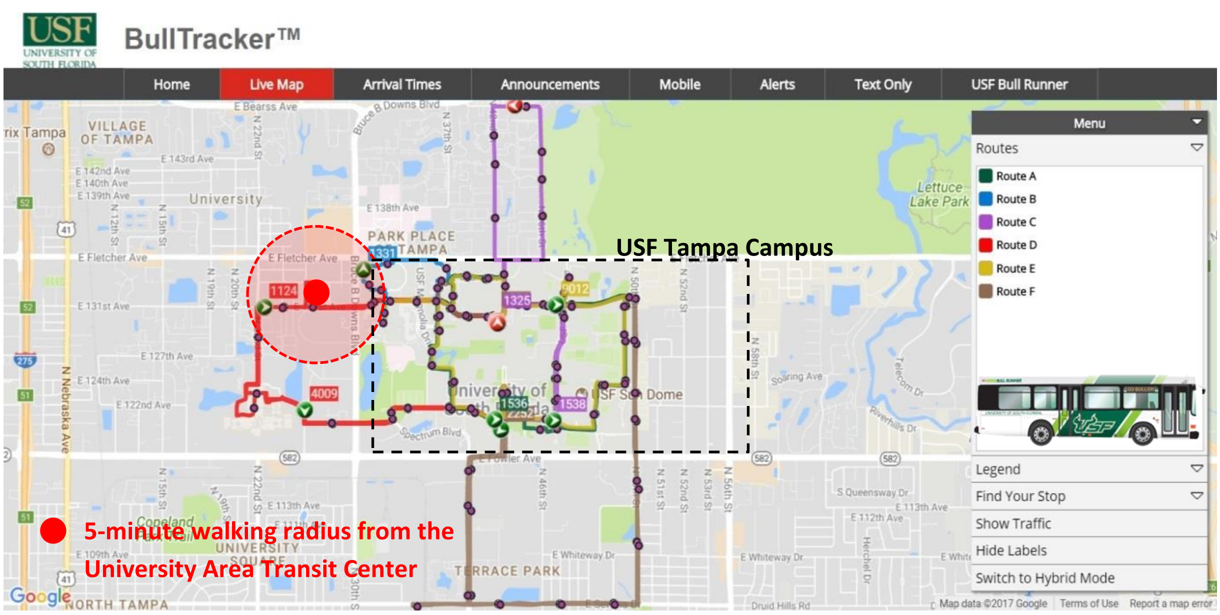

Figure 5.14: USF bus system, known as the Bull Runner, and its routes (USF Bull Runner 2017)

Table 5.12 shows how accessible Tampa campus is. It indicates the commuting comparison between driving and public transportation. It shows that commuting to and from the campus using private modes of transport such as cars seem faster in both cases: from the centre of Tampa city and the airport.

Table 5.12: Accessibility in Tampa campus

No	Category	Data
01	Campus distance from the city centre of Tampa	Driving: 16 km (10 miles) (17 minutes) | Public Transport: 19 km (11 miles) (40 minutes) (Google Maps 2017)*
02	Campus distance from the Airport	Driving: 27 km (17 miles) (22 minutes) | Public Transport: 33 km (20 miles) (90 minutes) (Google Maps 2017)*
03	Car parking	20,840 parking spaces (USF Tampa Campus Master Plan 2015, 94)
	* Note that the time for commuting between the campus and the city centre or airport is changing slightly from time to time depending on various issues such as rout, congestion, accidents, street maintenance...etc.	

Car parking, on the other hand, is another mobility issue to look at. The USF Tampa campus offers over 20 thousand car parking spaces (USF Tampa Campus Master Plan 2015, 94), serving about 55 thousand users on-campus. These figures indicate that almost every three people share one parking space. This number is below the standard ration of one space for each four to five full time students (AAPPA 2002). Nevertheless, this ration can vary from campus to campus and there are several factors influencing this proportion such as ‘locality (city, metropolitan, and country), available public transport, other parking options off campus, student demographics, and available space on campus’ (Ibid, 6). In addition, student housing on-campus plays a key role in the ratio of car parking space.

With that in mind, USF population is expected to grow and this growth demands more car parking spaces not only for students commuting to the campus, but also for students living on-campus, faculty members, staff, and visitors (including medical centre patients). The 10-Year Plan highlights the need for about ‘5,000 spaces in structures in subsequent years for a total of approximately 22,000 campus parking spaces including structured and surface’ (USF Tampa Campus Master Plan 2015, 94). The Plan (Ibid, 94) also emphasises the following parking issues:

- ‘utilization ranging from a low daily average of 57% on Fridays to the high on Tuesdays of approximately 81%,
- campus facilities and infrastructure development will displace approximately 3,350 surface parking spaces,
- significant recent parking expansion... contributes to access and circulation challenges, vehicle-pedestrian conflicts, and occupies space better allocated to programmatic or open space uses, and the cost to construct additional structured parking’.

To overcome such problems, USF’s main goal for sustainable transportation (Ibid, 95) is:

> *‘The Transit, Circulation, and Parking goal of the Tampa Campus Master Plan is to encourage options for sustainable transit and vehicular access to the campus that reduce reliance on single occupant vehicles, reduce overall parking demand, and minimize emissions and fossil fuel consumption, while maintaining essential delivery and service access.’*

In order to translate this goal into practice addressing the transportation issues in Tampa campus, the USF has proposed the following strategies (Ibid, 94):

- ‘migration of the major parking facilities toward the campus edges’, which ‘will reduce the need for vehicle circulation within the campus core’ and hence reducing ‘the potential for vehicle-pedestrian conflicts’ given that ‘major pedestrian corridors intersect the campus loop roads,
- parking utilisation will be elevated to 88 percent,
- Alternative transportation options:
    - Increase the range of services and marketing for commuter options (i.e., vanpool, carpool, car-sharing, telework, cycling, walking, compressed work week, emergency ride home, and transit),
    - Expand Bull Runner shuttle service to additional off-campus residential areas,
    - Improve pedestrian and bicycle facilities’ (see figure 5.15 and figure 5.16),
- Continuation of the U-pass system, giving privileges to University users of the local transit system,
- Construct additional student housing on or near the USF Tampa campus,
- Parking permit price tiers and/or increases
- Parking permit buyback program, and
- Pre-tax deduction for employee alternative commutes expenses’,
- Introducing an internal tram system to ‘supplement other alternative modes in the campus core, connect major parking facilities with the campus core, and which could eventually link the campus to future light rail in the University area’ (Ibid, 94). Figure 5.17 shows the proposed tram map in the USF Tampa Campus.

When measuring the distances between the four major roads forming the boundaries of Tampa campus, it can be noticed that the dimensions are 2,300 meters by 1,500 meters (a 25-minute walk and a 15-minute walk, respectively). Figure 5.15 shows the pedestrian circulation in USF Tampa campus. It also presents three circles. The first one is with a radius of about 400 meters, which means it is in a walking distance of about 5 minutes. The second and third ones are with radiuses of 800 and 1,200 meters, around 10 and 15 minutes walking distances respectively. These distances indicate that the campus is large and that walkability is an issue.

The master plan presents a road map of the campus development in the future. It is the framework though which new developments are guided. The USF Tampa Campus Master Plan document (2015, 65) emphasises that:

> *‘The plan is structured around an interconnected system of public spaces, quadrangles, courtyards and pedestrian ways that are reinforced by coherent building edges. Progressive increases in campus density are encouraged to enhance campus vitality, conserve limited land resources for facilities growth, and animate the functional connections between areas of the campus.’*

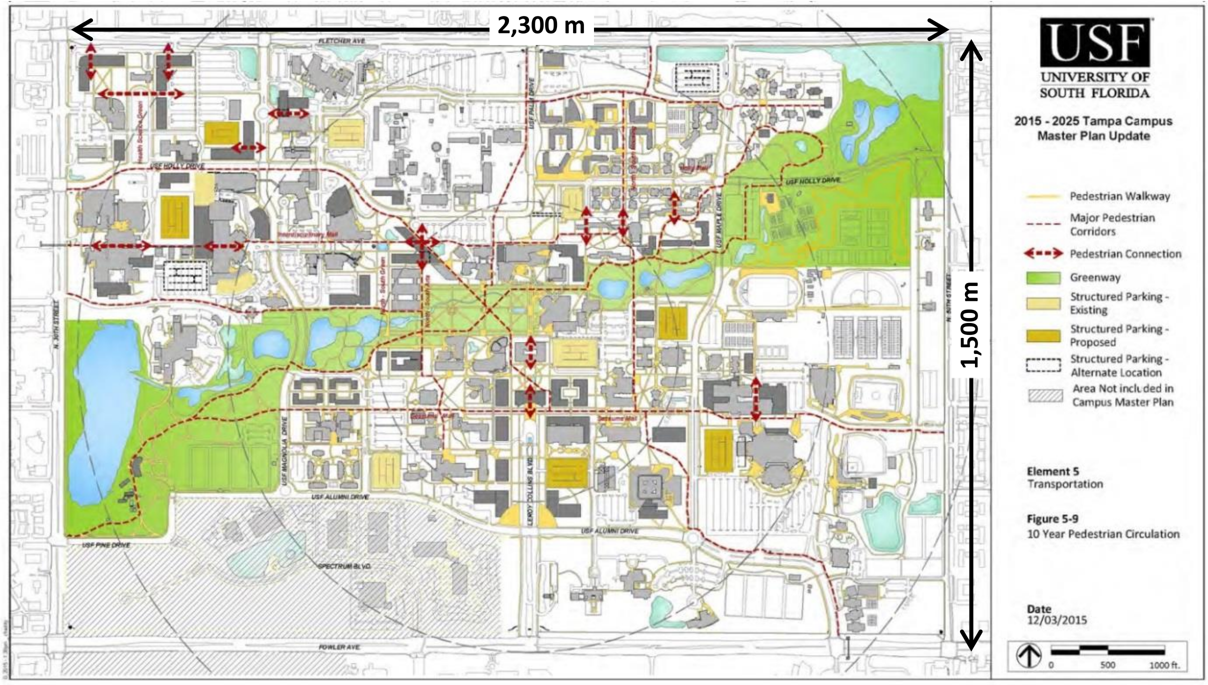

Figure 5.15: Tampa campus Pedestrian Circulation (USF Tampa Campus Master Plan 2015, 116)

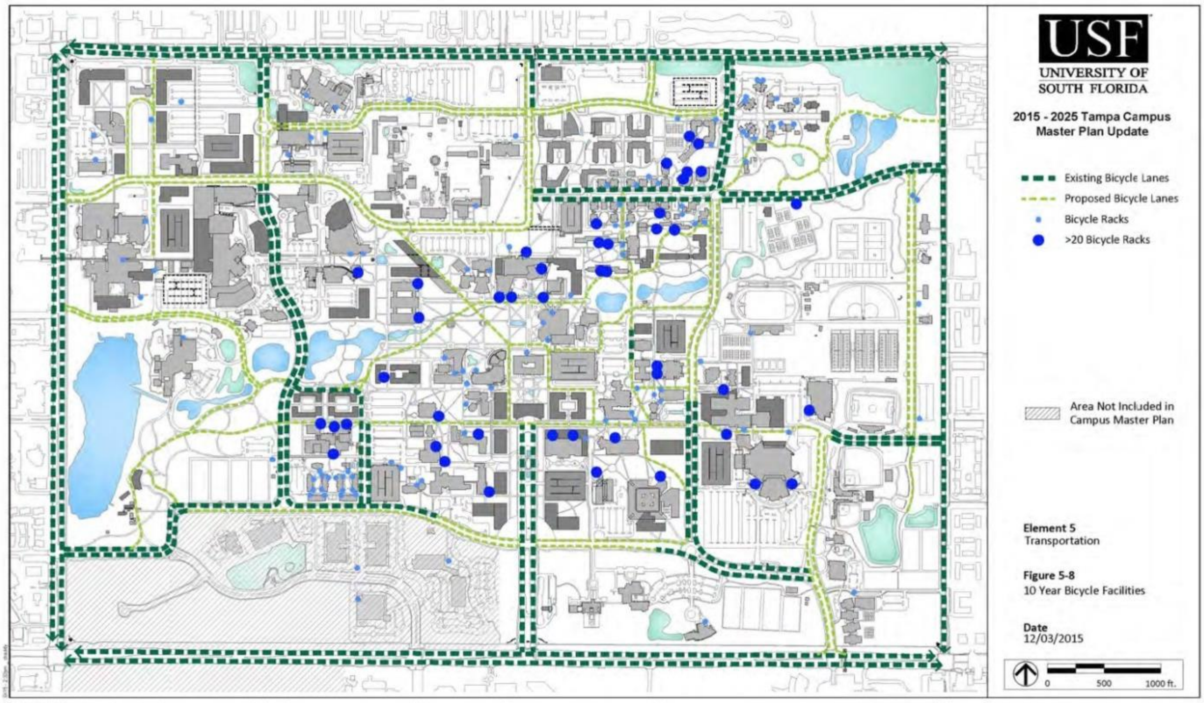

Figure 5.16: USF Tampa campus Bicycle Facilities (USF Tampa Campus Master Plan 2015, 115)

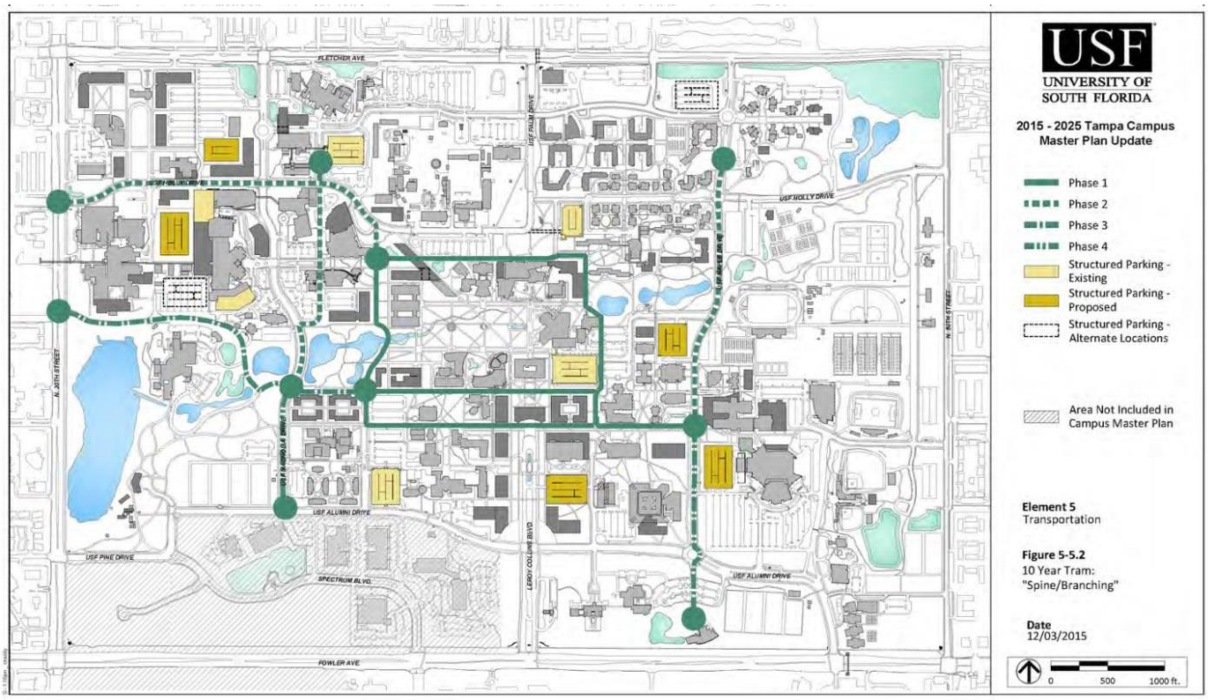

Figure 5.17: USF Tampa campus Internal Tram system (USF Tampa Campus Master Plan 2015, 111)

Figure 5.18 shows the campus main zones known as: Academic, Health, Recreation / Athletics, Facilities services, Residential, and Greenway. The figure presents the existing buildings and the proposed ones. It can be seen that more housing units are proposed around the academic zone. This is one strategy to bring more life to the campus. The other strategy is emphasising the open space and walking corridors that help connect the zones together to promote academic vitality and the richness of campus life. Another advantage of the open space within the academic and health zones is that it allows for alternative uses and allows for more 'flexibility for the research, clinical and community-oriented functions that may arise through unforeseen program expansion and/or funding opportunities' (Ibid, 65). The Greenway is protected and not developed and it will continue to serve the campus as an open natural area.

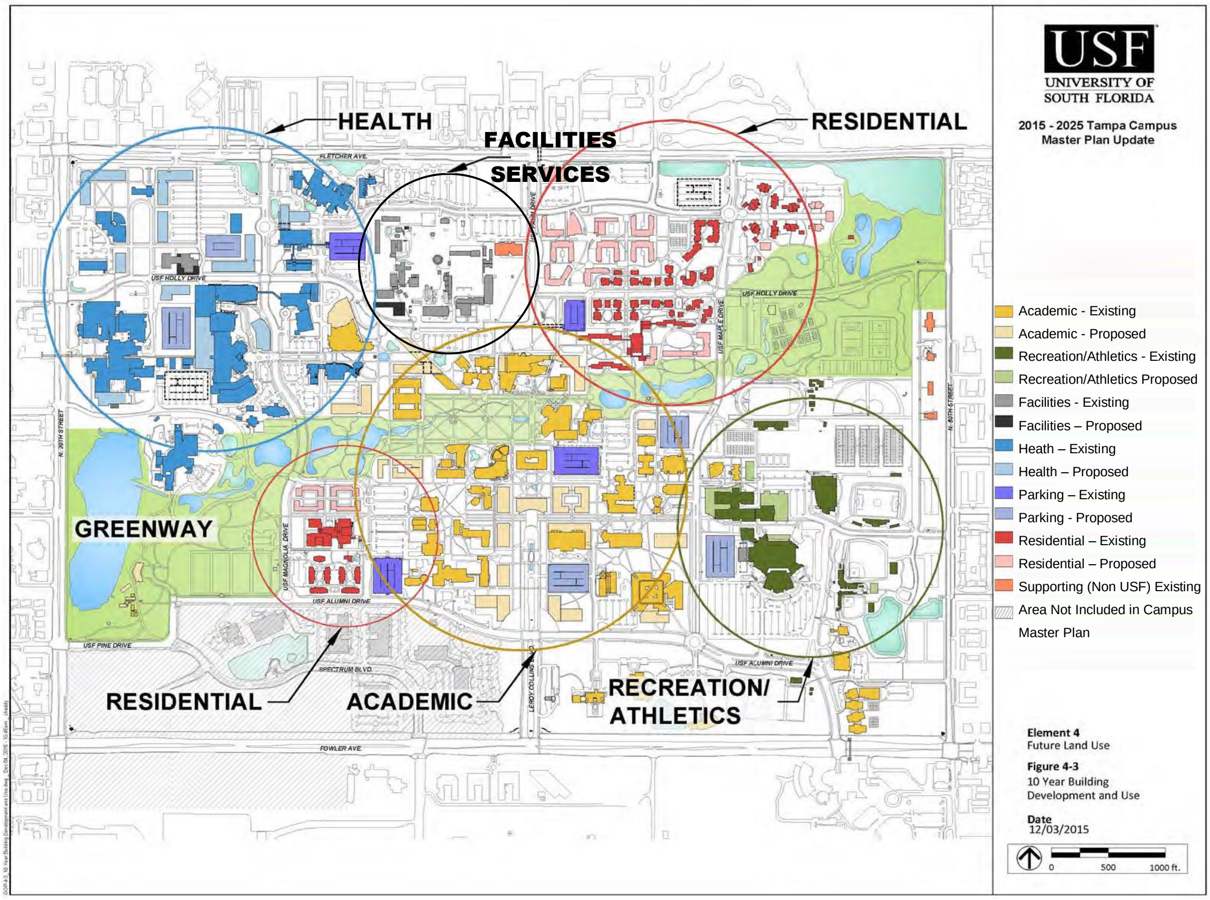

Figure 5.18: Campus 10-Year Building Development (USF Tampa Campus Master Plan 2015, 80)

Colleges and universities in the United States are striving to meet the Carnegie Classification of Institutions of Higher Education, which is a framework for categorising colleges and universities in the United States of America (Carnegie Classification 2017). In order to meet the Carnegie Classification goal of accommodating 25% of undergraduate full-time students in institutionally-managed housing, the USF invests massively in housing. The University aims to achieve this target by 2025. USF Tampa campus plans to add over 2,500 student beds, bringing the total to some 7,800 beds by 2025. This does not include the supporting staff apartments' on-campus and other student housing off-campus.

The main goal of housing in Tampa campus underlines the importance of affordability, appropriateness, and safety. The USF Tampa Campus Master Plan (2015, 122) states that:

> *'The Housing and Student Support Services goal of the Tampa Campus Master Plan is to encourage the availability of diverse, safe, affordable housing and support services for students on and in the vicinity of the campus in support of the educational success, personal development, and social experience of all University students.'*

The USF invests in housing, both on-campus and near off-campus. This investment has a substantial effect on the campus life. According to the USF Tampa Campus Master Plan (2015, 121), housing 'plays a critical role in establishing a more sustainable campus:

- supporting the learning experience by more fully engaging students and providing support,

- influencing transportation demands and strengthening pedestrian and bicycle circulation as desirable options, and
- providing the critical mass necessary to support a more diverse 24 hour campus community with increased demand for a greater range and supply of services and opportunities including food service options, retail, recreation, and entertainment.'

5.4.2.4.2. Climate considerations

The State of Florida is characterised by humid subtropical climate. Tampa Bay area is known for being hot and humid in summers, while mild to cool in winters (The Weather Channel 2017). This type of climate poses, consequently, a challenge for planners and designers. To react to such challenge, USF planners and designers have developed some strategies to alleviate the impact of such climate as well as to make the most of it. In this section, two aspects in Tampa campus were analysed; the approach to addressing the climate and the action plan.

In order to show a commitment in pursuing climate change neutrality, USF signed 'The American College and University Presidents Climate Commitment' in 2008 (USF Tampa Campus Master Plan 2015, 48). The following steps, mentioned in the USF Climate Commitment Letter (2008, 1), sum up such commitment:

- 'develop an institutional action plan for becoming climate neutral, which will include:
    - A target date for achieving climate neutrality as soon as possible.
    - Interim targets for goals and actions that will lead to climate neutrality.
    - Actions to make climate neutrality and sustainability a part of the curriculum and other educational experience for all students.
    - Actions to expand research or other efforts necessary to achieve climate neutrality.
    - Mechanisms for tracking progress on goals and actions.
- Initiate two or more of the following tangible actions to reduce greenhouse gases while the more comprehensive plan is being developed:
    - Establish a policy that all new campus construction will be built to at least the U.S. Green Building Council's LEED Silver standard or equivalent.
    - Adopt an energy-efficient appliance purchasing policy requiring purchase of ENERGY STAR certified products in all areas for which such ratings exist.
    - Establish a policy of offsetting all greenhouse gas emissions generated by air travel paid for by our institution.
    - Encourage use of and provide access to public transportation for all faculty, staff, students and visitors at our institution.
    - Within one year of signing this document, begin purchasing or producing at least 15% of our institution's electricity consumption from renewable sources.
    - Establish a policy or a committee that supports climate and sustainability shareholder proposals at companies where our institution's endowment is invested.
    - Participate in the Waste Minimization component of the national RecycleMania competition, and adopt 3 or more associated measures to reduce waste.
- Make the action plan, inventory, and periodic progress reports publicly available by providing them to the Association for the Advancement of Sustainability in Higher Education (AASHE) for posting and dissemination.'

With the aim of reducing the greenhouse gas emissions, the USF has taken the following actions to translate its commitment into action. These actions, mentioned in its 10-year USF Tampa Campus Master Plan (2015, 173), were based on policies addressing:

- ‘protection and improvement of air quality - Identify mitigation techniques in order to reduce greenhouse gas emissions and improve the air quality by:
    - reduction of campus traffic and parking demands,
    - discourage dependence on single occupancy vehicles,
    - alternative fuel vehicles,
    - parking structures shall be sized and designed to facilitate rapid ingress and egress of vehicles to minimize idling time, and
    - maximize tree planting programs to increase carbon absorption, reduce the heat-island effect on campus, reduce storm water runoff, and enhance outdoor space, providing shade for campus population and encouragement for increased alternative non-vehicular circulation’
- ‘conservation and protection of the quantity and quality of water sources - Conserve and protect the quantity and quality of water sources including groundwater and surface water by:
    - identify all existing and proposed potable well locations as "no build" zones, except for recreation facilities,
    - not undertake activities on-campus which would contaminate groundwater sources or designated recharge areas unless provisions have been made,
    - continue to monitor and test treated potable water on a monthly basis, and
    - continue to implement [the] comprehensive Water Conservation Plan, to include the following measures: a) exploration of the potential interdependencies between chilled water make-up/discharge, storm water, and treated wastewater and irrigation, b) the use of automated timers, irrigation flow monitoring mechanisms, rain and ground moisture sensors, c) application of low maintenance xeriscape, native plant landscape treatments for new and renovated building construction and new and renovated campus open space site and facilities, d) the use of low-flow and low-flush fixtures in new building construction, and water audits and other leak detection programs, and f) continue to maximize the use of condensate and storm water to offset the consumption of water in irrigation, water features, water closets, and urinals.’
- ‘conservation and protection of native vegetation and wildlife habitats - Protect identified jurisdictional native vegetative communities by:
    - maintain campus wide landscape inventories for the purpose of establishing a University tree and plant inventory data base,
    - provide a qualified professional,
    - identify and protect jurisdictional and other environmentally sensitive plant communities from development by designating these areas as "no build" zones,
    - endeavour to use plant species that are indigenous to the natural plant communities of the Tampa Bay area,
    - introduce a greater variety of tree and other plant species and greater numerical balance between various species in order to reduce likelihood of collective loss of a single species or group of species that may occur due to an existing or potential yet unknown blight condition,
    - maintain and improve existing vegetative communities through the removal of ecologically undesirable vegetation,
    - endeavour to reduce the extent of turf grass on campus in favour of alternative native and xeriscape ground covers,

  - continue to require the use of best management construction practices,
  - minimize site disturbance on previously undeveloped sites
  - future development, including buildings, parking facilities, utilities, walkways, paths, storm water facilities, and recreation fields, shall be carefully sited to minimize impacts to existing trees, and
  - construct new facilities in respect of appropriate flood zone requirements,
- ‘energy efficiency - Identify measures to conserve and appropriately reduce energy use and expand the use of conservation and energy saving techniques with the planning, design, and construction of new facilities by:
  - evaluate and implement, as appropriate, solar energy and other clean energy sources as alternative sources of power,
  - establish administrative, operational and other procedures to monitor energy use on a building specific basis and provide enhanced feedback to end users on their energy use, and incentives for reduction,
  - design of new buildings shall be consistent with the climatic response and sustainability guidelines contained in the USGBC LEED requirements and the USF Design and Construction Guidelines,
  - energy conservation fixtures, air conditioning and lighting systems and other building specific energy use and management techniques shall continue to be a required element of all new and renovated buildings constructed on the campus,
  - consider, during development of building programs and design, the building orientation, increased daylighting measures, utilization of courtyards, arcades and
  - other shade and ventilation techniques to further reduce energy demands,
  - consider, during development of building programs and design, use of low-maintenance, local (within 500 miles per USGBC LEED), durable, and sustainable materials, with priority placed on durable materials with long term life cycle benefit, and
  - require all major new construction and renovation projects to seek USGBC LEED certification with goal of achieving Silver rating or above.’
- ‘waste monitoring, disposition, and recycling - Reduce the quantity of waste generated on campus and expand the percentage of waste recycled or reused by:
  - continue its ongoing evaluation of monitoring, reducing, and disposing of hazardous chemical and medical wastes,
  - continue to provide on-campus facilities for the collection and storage of hazardous materials used in University operations as required by federal, state and local regulations,
  - continue to encourage reduction of generated waste materials and expanded use of its recycling and reuse programs,
  - coordinate on-campus recycling programs with those of local government in regard to materials collected, and disposal/collection procedures, and
  - endeavour to establish mechanisms to encourage use of those environmentally preferable products with lower environmental impact’.

Other energy conservation measures taken by the USF (USF Facilities Management 2017) can be briefly summarised as following:

- ‘Green Lights Program: University of South Florida has upgraded the lighting systems throughout the Tampa campus academic buildings with modern, high efficient electronic ballasts and energy conserving fluorescent bulbs. This program currently saves over $1 million annually.

- Motion Sensors: Tampa campus classrooms have been retrofitted with electronic motion sensors that turn off the lights when classrooms are not in use.
- Energy Monitoring: A comprehensive energy metering and monitoring system has been installed to track and help optimize energy usage at Tampa campus buildings.
- Environmental Controls: Many of the Tampa campus buildings have been retrofitted with Direct Digital Control Systems that optimize the usage of air conditioning systems.
- Building Optimization: Air handling units are typically the largest energy consuming equipment in our facilities. Reducing waste by operating them in a scaled down mode when the facilities are unoccupied offer one of the major energy and cost saving opportunities. To accomplish this, the University has implemented and developed a computerized energy management system.
- Solar Efficient Roofs: Many of the Tampa campus buildings have been retrofitted with High Solar Reflective Index roofing materials. This reduces building heat load and cooling energy usage.
- High Efficiency Chillers: The USF Tampa campus has replaced inefficient gas and electric operated chillers with the most energy efficient electric chillers available.
- Boiler Efficiency: The USF Tampa campus has replaced old, inefficient boilers with new high efficiency boilers in order to reduce natural gas usages.
- Heat Pipes: Environmental systems at the MDF, MDH, and BSF buildings are equipped with heat pipe energy recovery systems to reduce energy usage.
- Improvement in Efficiency of Campus Pumping of Chilled Water and Chiller Performance: This current initiative involves converting chilled water distribution system from primary/secondary pumping to variable primary pumping to increase temperature difference between supply and return chilled water in order to improve chiller performance.
- Underground Utilities: USF Tampa campus design standards have been updated to have high efficiency insulation on all underground chilled water and hot water distribution piping.'

Table 5.13 shows an overview of USF energy profile, mainly the energy sources. It indicates that the University is primarily dependent on coal for electricity and on natural gas for heating. Other sources such as biomass, geothermal, hydro, nuclear, solar photovoltaic, or wind have not been used to generate electricity for the University. USF claims that 'University electricity is purchased from the local utility which primarily uses coal generation plants' (USF STARS Reporting 2015, 7). To mitigate the issue of power supply, the University stated that it uses 'USF Tampa campus has replaced inefficient gas and electric operated chillers with the most energy efficient electric chillers available.' It adds that 'USF Tampa campus has replaced old, inefficient boilers with new high efficiency boilers in order to reduce natural gas usages' (Ibid, 8).

Table 5.13: USF energy profile

No	Category	Data
01	Electricity use by source	Coal 100% (USF STARS Reporting 2015, 7)
02	Energy used for heating buildings, by source	Natural gas 100% (USF STARS Reporting 2015, 8)
03	Renewable energy facilities - Number of solar panels installed - Number of wind turbines installed	 1,075 solar panels (USF Marshall Student Center 2017) 0 wind turbines

The USF is exploring other clean energy sources such as thermal energy. Figure 5.19 shows the USF Clean Energy Research Center at the Research and Innovation Park. The project is to install a thermal energy storage system at the solar thermal power generation facility. This project led by USF staff and students. It is funded by the USF Student Green Energy Fund and is expected to be completed by February 2018. The advantages of such a project go beyond being just environmentally friendly and highly economical, but also educationally and socially valuable:

> *'The other main benefit of having an operational on-campus solar thermal power plant is of its educational value. The field is used frequently for educational tours that teach students and the community about electricity generation and solar energy. Several undergraduate and graduate courses (Solar Energy & Application, Design of Solar Power Plants, Mechanical Engineering Lab, etc.) have been using this facility as a part of their curriculum, while the USF chapter of the International Solar Energy Society hosts biannual tours for the Tampa Bay community. Having a fully-equipped plant will serve better in the future for lot of USF students as well as other outside visiting parties.'* (USF Student Green Energy Fund 2016, 5).

Figure 5.19: Thermal energy storage system (USF Student Green Energy Fund 2016, 1)

Since 2011, the USF has been working on its buildings to be certified under the Leadership in Energy and Environmental Design certification (USF LEED Projects 2017). So far, six buildings were certified (two Gold, two Silver, and two certified). The total LEED building gross square meters are 64,997 (699,623 gross square feet). This means that almost 7% of the total gross square meters are certified.

5.4.2.4.3. Flexibility

This research explores some of the properties of flexibility. That is in terms of time, building, and furniture.

Online education is considered by many as convenient and flexible. USF offers such a way of learning for undergraduate, graduate, and other individual short courses. The University established the USF Innovative Education Hub indicating that:

> *'In an effort to meet the growing demand for more flexible educational offerings, USF Innovative Education recently opened the new Innovation Hub, a collaborative space designed to empower USF faculty and staff to create affordable, accessible, high-quality online courses that meet the needs of today's students'* (USF Innovative Education 2017).

The USF currently offers eight undergraduate partially-online programs in subjects such as Information Technology, Criminal Justice, Public Health, Nursing, Women's and Gender Studies. The University also offers 30 graduate partially-online programs in areas including Arts, Behavioural and Community Sciences, Education, Engineering, Global Sustainability, Medicine, Pharmacy, and Public Health. As for the individual single short online courses, the University offers hundreds of individual courses online every semester (Ibid).

In terms of the USF's staff and employees, the University considers the option of staggered 'telework or staggered work hours for faculty and staff' (USF Tampa Campus Master Plan 2015, 99). The University offers the option of condensed work week program for its employees, named as 'a non-standard work week' (USF STARS Reporting 2015, 179). Examples of such work week program (Ibid, 180) include:

> ● *'4.5/40 - during a 1-week period, work 9 hours each on 4 days, work 4 hours on one specified day per week (that day must be the same every week; Tuesdays are not allowed).*
>
> ● *9/80 - during a 2-week period, work 9 hours on 8 days, work 8 hours on 1 day, take off one specified day every two weeks (that day must be the same every two weeks; Tuesdays are not allowed).*
>
> ● *4/40 - work 10 hours on 4 days, take off one specified day every week (that day must be the same every week; Tuesdays are not allowed).'*

The USF has addressed flexibility in the built environment at two levels; campus land use (macro scale) and its buildings (micro scale). For example, in order to address unexpected changes in the future, the USF Master Plan reflects on the new programmatic and functional directions set for the ten-year plan horizon (USF Tampa Campus Master Plan 2015, 65). USF future land use (Ibid) indicates that:

> *'Allowances for secondary uses in the academic and health districts provide flexibility for the research, clinical and community-oriented functions that may arise through unforeseen program expansion and/or funding opportunities.'*

As for its buildings, the micro scale, the USF has adopted some flexibility principles in its new buildings. For instance, in its Interdisciplinary Research Building at Tampa campus, which was completed in 2005 and achieved the Award for Outstanding Special-Use Building Design - 2005, the University emphasised the issue of the flexible design of the building. The architecture firm Perkins+Will (2017) describes their approach to flexibility in this building saying:

> *'The design encompasses a flexible lab building comprised of lab modules of 900 square feet each [83.6 m2]. We have devised 60 modules in the building*

> *with 20 modules per floor. The facility currently features 70% laboratory space and 30% for office and support spaces. The unique design of the building allows this breakdown to be flexible for change with future occupancy.'*

Another aspect of demonstrating the interest in flexible buildings, the USF is hosting the FLeX House, which was built based on a modular building system. This building was developed by Team Florida, which consists of The University of South Florida, Florida State University, The University of Central Florida, and The University of Florida. It was built to be as a living lab for research on flexibility, solar energy, sustainable building materials and emerging technologies. The House is occasionally open for public. The U.S. Department of Energy - Solar Decathlon (2011) described this building as:

> *'FLeX House is designed as a sustainable house that can adapt easily to different site situations and plan configurations. A variety of space-conserving design strategies gives residents of FLeX House an affordable, functional, and comfortable living environment in an unconventionally small footprint.'*

Another example of highlighting the flexibility in college building and its furniture is the Morsani College of Medicine building, USF Tampa Campus. The building was renovated and transformed into vibrant and engaging spaces for learning and teaching by Gresham, Smith and Partners architecture firm. Figure 5.20 shows how the utilisation of moving walls and operable partitions can maximise flexibility within existing building. The floor plans indicate different layouts in order to accommodate various teaching and learning styles. Gresham, Smith, and Partners Firm (2017, 4) described flexibility aspects in this building pointing out that:

> *'The building can now be set up as one massive lecture hall or divided into classrooms by using separation walls that automatically descend from the ceiling. The benefit of using tiered flooring, as opposed to keeping the existing slanted floor, is that it stops the separation walls at specific levels and helps separate each classroom... To maximize flexibility within the existing footprint, we took out every wall in that space and added operable partitions that divide a large space into smaller classrooms. Basically, one half of Group Learning has large classroom setups with partitions. The other half features very intimate classrooms that can be used for smaller classes or study groups... Mobile, ergonomic seating was utilized throughout the classrooms in order to minimize pressure points, support posture and promote student interaction. Tables that can easily be moved and rearranged were also used to maximize flexibility and support various learning and teaching styles.'*

For its used furniture, USF smartly recycles it through a centralised system. The system, managed by the USF's Property Management Department, allows other departments to obtain and use the materials in good condition before the disposal. 'Before you can dispose of assets, advertise their availability on the USF Property Listserv to other University departments for three consecutive days' (USF STARS Reporting 2015, 184). Another example of recycling furniture is in residential halls. In order to decrease residence hall move-in/move-out furniture, the University offers 'a free yard sale where residents can put out unwanted electronics and furniture and other students can select it and take it for free with their student ID' (Ibid).

Figure 5.20: Maximising flexibility in existing building (Gresham, Smith, and Partners Firm 2017, 6)

5.4.2.4.4. Space utilisation

Taking into account the significance of the university's real estate, many universities around the world have a special department or unit for managing their physical plant. University of South Florida has Space Management and Analysis Department working under the Planning Section, which is part of the Division of Administrative Services, which in turns is part of the Facilities Management Administration. The Space Management and Analysis Department engages with the end users (students, faculty, staff, researchers, and specialists) in order to assist them from the planning stage of projects up to the completion of conceptual designs. Additionally, the Department is in constant contact with the whole University's Departments so as to prepare the analysis and report of space utilisation and needs, which is required by the State of Florida.

The main tasks undertaken by the USF Space Management and Analysis Department (2017) are as follows:

- *'Planning and conceptual designs for new spaces or for the improvement, change, or reconfiguration of existing spaces*
- *Development of the preliminary scope, schedule, and budget for projects*
- *Space file management and reporting: Educational Plant Survey'*

The Educational Plant Survey is a systematic study undertaken every five years by all the public colleges and universities in Florida as it is required by the State of Florida. The study reports on the existing facilities and the projected growth in the coming five years. The survey covers three general classifications of space (nine types) including (USF Educational Plant Survey 2017):

- Instructional/research spaces (such as 1. classroom, 2. teaching laboratory, and 3. research laboratory),
- Academic support spaces (4. study facility, 5. instructional media, 6. auditorium/exhibit, and 7. teaching gymnasium), and
- Institutional support spaces (such as 8. office/computer, and 10. campus support services).

The main two components of the survey are the Facilities Inventory Validation and the Space Needs Assessment. The purpose of the former component is to 'ensure that the facilities inventory data, used in the subsequent Space Needs Assessment component, fairly represents the existing facilities available to support educational programs' (Ibid, 7), while the purpose of the latter component is to 'develop specific project recommendations consistent with approved programs in the Campus Master Plan' (Ibid, 8). The formula used to calculate the space needs is based on three types of information (Ibid, 77):

- *'Workload measures such as enrolment, positions, and library materials*
- *Space standards including station sizes and utilization levels*
- *Existing facilities inventory'*

The survey guiding principles (Ibid, 8) indicate that:

> *'Application of the formula results in unmet space needs that are then compared to the effect of proposed projects on the facilities inventory. In cases where the formula does not support a proposed project, the justification provided by the university is considered.'*

Although the Space Management Group UK (SMG 2006, 11) highlighted that the 'utilisation rates were the most frequently cited indicator' for measuring the performance of managing space, some universities use other indicators such as square meters per user. The latter is what USF uses for managing its facilities. Figure 5.21 highlights the formula by each type of space under the three categories. It shows the comparison between the space needs of the existing suitable satisfactory facilities and the unsatisfactory facilities inventory for the USF main campus Tampa. The total unmet needs of space were 948,511 net square feet (88,119 square meters) with the instructional category being the highest especially the needs for research laboratories.

Formula Generated Net Assignable Square Feet by Category

USF Tampa; Site 0001

Space Category	Space Needs By Space Type	Satisfactory Space Inventory	Total Unsatisfactory Space Inventory	Unmet Need
Instructional				
Classroom	262,251	193,126	0	69,125
Teaching Laboratory	327,814	304,709	0	23,105
Research Laboratory	715,350	259,003	0	456,347
Academic Support				
Study	515,052	246,097	0	268,955
Instructional Media	114,456	1,487	0	
Auditorium/Exhibition	65,563	41,225	0	24,338
Teaching Gymnasium	131,126	95,202	0	35,924
Instructional Support				
Office/Computer	858,420	825,207	151,859	-109,633
Campus Support Services	154,516	87,135	0	67,381
Total	**3,144,548**	**2,053,191**	**151,859**	**948,511**

Figure 5.21: Space planning, USF Tampa (USF Educational Plant Survey 2017, 56)

Underutilised spaces are addressed though a number of solutions, one of which is through scheduling; planning and arranging classes equally throughout the week. This issue was raised in the USF Tampa Campus Master Plan (2015, 99) in which it is stated that space utilisation can be optimised though the '[academic] scheduling modifications, including scheduling more classes during non-peak hours'. The scheduling issue has other impacts not only on utilisation of the building spaces (classrooms in particular), but also on the demand for parking spaces. The University indicated that it will:

> *'[continue] to evaluate academic classroom schedules encouraging more classes to be scheduled in off-peak hours, thus reducing parking demands by increasing utilization throughout the day – "reusing" the same parking space'*

5.5. Lessons learnt from best practises

This section aims to draw some lessons from the two cases; ASU and USF. To do so, the similarities as well as the differences from both cases particularly in approaching sustainability in their university campuses are presented. The key aspects discussed in the comparison are the selected sustainability areas this research focuses on:

- Management aspects (Table 5.15)
  (*Vision, policy, planning, and commitments*)
- Engagement aspects (Table 5.16)
  (*Attitude, knowledge, and awareness of sustainability*)
- Environmental/Physical aspects (Table 5.17)
  (*Location and physical accessibility, climate considerations, flexibility, and space utilisation*)

Table 5.14 presents an overall comparison between ASU and USF. It shows clearly that ASU is not only older, but also larger in terms of the numbers of departments, buildings, floor areas, population, enrolment, employees, and on-campus student beds.

Table 5.14: An overall comparison between ASU and USF

No	Category	Arizona State University (ASU) Main campus: Tempe Campus	University of South Florida (USF) Main campus: Tampa Campus
01	Established	1885	1956
02	No. of academic divisions	22 Divisions/Faculties	47 Divisions/Faculties
03	No. of academic departments	83 Departments/Schools	37 Departments/Schools
04	Campus size	2.6 Square kilometres (642 Acres)	6.3 Square Kilometres (1,562 Acres)
05	No. of buildings	288 buildings	256 buildings
06	Gross floor area of building space	1.4 million square meters (15.9 million square feet) (2011)	946 thousand Square Meters (10,2 million Square Feet) (2016)
07	Campus population	65,341 people	54,729 people
08	Total enrolment	51,869 students (Full-Time Equivalent) (2016)	40,827 students (Full-Time Equivalent) (2016)
09	Faculty members	2,317 members (regular full- and part-time members) (2015)	5,586 members (regular full- and part-time members) (2016)
10	Employees	11,155 staff (regular full- and part-time employees) (2015)	8,316 staff (regular full- and part-time employees) (2016)
11	Number of beds - student dormitories	10,432 beds (2011)	5,673 beds (2015)

Table 5.15 sums up the main management aspects including sustainability vision, policy, planning, and commitments for each university. It shows how both universities translate their sustainability visions into reality through their policy, plans, and commitments. There is a great similarity in the approach to advance their effort towards more sustainable university campus. Both universities share almost the same sustainability vision. Their sustainability policy covers a wide range of overarching sustainability areas in higher education institutions (Alghamdi et al. 2017):

- Academia (curriculum, and research),
- Management (finance, and procurement),
- Environment (recycling and waste management, greenhouse gas emissions, transportation, water, energy, and green building), and
- Engagement (students, media/promotion, alumni, and surrounding community).

The same can be said about the planning for sustainability. Both Universities are engaging with similar challenges in order to green their institutions. Examples of these comparable issues include increasing enrolment, increasing density, increasing efficiency, housing more students on-campus, improving mobility, increasing LEED certified buildings, installing on-site renewable energy facilities, and increasing awareness through formal and informal engagement.

However, the noticeable difference is in the targeted year of becoming carbon neutral. Unlike the USF, ASU shows a very ambitious target. The targeted year 2035 is utterly challenging, given the fact that achieving this goal depends on a number of unpredictable often difficult to forecast factors including for example funding, technology, logistics and collaborations, level of awareness...etc.

Table 5.15: Management aspects comparison between ASU and USF

No	Category	Arizona State University (ASU)	University of South Florida (USF)
01	Vision	'To be the worldwide leader in sustainability higher education operations. As an organization, we are among the acknowledged world leaders in sustainability education, research and operational practices for higher education' (ASU Sustainability Plan 2011, 7).	'Coordinate and build partnerships for university-wide initiatives that advance the University of South Florida's strategic goal of creating a sustainable campus environment... actively support faculty, staff, students, alumni, and neighbourhood partners in their efforts to transform the University of South Florida into a 'Green University' (USF STARS Reporting 2015, 205).
02	Policy	Four major policies: Carbon Neutrality, Zero Waste, Active Engagement, and Principled Practice.	Thirteen major policies: Students, Curriculum, Research, Finance, Procurement, Media/Promotion, USF Alumni and Community, Greenhouse Gas Emissions, Green Building, Energy, Water, Transportation, and Recycling and Waste Management.
03	Planning	ASU is planning to: • increase enrolment, increase density, increase efficiency, more online learning, and different models of teaching • house more students on campus so as to convert the campus from a 'commuter campus' into 'residential' • improve mobility by decreasing the number of car parking spaces and promoting walking, biking, vanpooling, carpooling, public transits (using some incentives) • invest more in the university physical plant, providing, expanding, and renovating some campus facilities • ensure preserving of open space areas and pedestrian corridors • activate the campus core through higher density mixed use developments including academic, research, office, and residential uses • reduce university energy consumption (LEED) • On-Site renewable energy facilities • replace all university owned vehicles with alternative fuel vehicles • increase community awareness via engaging students, faculty, and staff so as to be active change agents • mandate the use of ASU Sustainable Guidelines for design, construction, procurements, labs, offices, and publications	USF is planning to: • increase density by minimising building footprints, maximising height, and replacement of inefficient one and two story buildings in order to optimise land use and conserve open space • invest in housing on-campus with 'state of the art residence halls' along with 'dining and recreation facilities • increase student sustainability awareness • fund campus sustainability projects • increase sustainability research and rankings nationally and internationally • increase LEED certified buildings or equivalent • reduce utility consumption, increase conservation and recycling, plant shade trees, • improve facilities for pedestrian, bicycle, and transit, among other efforts • reduce distance and improve quality of connections between functions • reduce vehicle use on-campus by encouraging non-vehicular circulation and shared shuttle and potential tram access • support campus community engagement
04	Commitments	Carbon Neutrality by 2035 (ASU Climate Action Plan 2010)	Carbon Neutrality by 2070 (USF Climate Action Plan 2014)

Both universities, ASU and USF, have shown a huge commitment to sustainability through a number of initiatives including (but not limited to):

- signing a number of sustainability declarations and charters,
- joining a number of sustainability organisations regionally, nationally, and internationally,
- forming many sustainability partnerships with other higher education institutions and businesses locally and globally,
- hosting tens (possibly hundreds) of sustainability specialists covering most disciplines,
- developing tools to measure their advancement in sustainability aspects,
- establishing a specialist sustainability journal,
- establishing Schools of Sustainability as well as Offices of Sustainability,
- developing sustainability action plans such as Climate Action Plan,
- providing funds for sustainability projects on-campus as well as off-campus,
- mobilising their campuses as a 'living lab',
- competing in global rankings of sustainability in universities, and
- providing communication channels (using online mailing news lists or social media sites) to publicise all sustainability news, updates, and events.

Table 5.16 presents a comparison between Arizona State University (ASU) and University of South Florida (USF) in terms of engagement aspects such as Attitude, knowledge, and awareness of sustainability. The two institutions share the same characteristics and features with regards to sustainability education and training, funding, and offering incentives and awards.

However, ASU undertakes an investigation of measuring the level of knowledge and awareness of sustainability among its students on an annual basis. This is not the case with USF.

Table 5.16: Engagement aspects comparison between ASU and USF

No	Category	Arizona State University (ASU)	University of South Florida (USF)
01	Attitude, knowledge and awareness of sustainability	• does make sustainability knowledge and awareness assessment on a yearly base • offers formal and informal sustainability courses and training programs for students, faculty, and staff • provides funds for sustainability projects • offers incentives and awards for students and staff	• does not make sustainability knowledge and awareness assessment on a yearly base • offers formal and informal sustainability courses and training programs for students, faculty, and staff • provides funds for sustainability projects • offers incentives and awards for students and staff

Table 5.17 shows a comparison of environmental/physical indicators that were analysed in the two cases. These indicators include the location and physical accessibility, climate considerations, flexibility, and space utilisation. Overall, it can be said that the table demonstrates a noticeable similarity in approaching environmental sustainability. For example, both campuses are urban and linked to their surrounding areas by mainly road networks. However, each campus is connected with its city or town through either public transit means such as buses (and metro line in the case of ASU), or their own university

shuttle (bus fleet connecting the campus with the neighbouring districts or with other university campuses). Other programs to ease the physical accessibility include promoting walking, cycling, vanpool, carpool, car-sharing, telework, compressed work week, and public transit (using U-Pass).

Another example in similarity is dealing with desert climate (Tampa, Arizona) or costal climate (Tempe, Florida). Both universities emphasise employing the green building principles. However, ASU shows the lead in utilising its campuses to generate renewable energy by installing visible facilities, which in turn communicates a number of messages not only environmentally and economically, but also socially (getting people to think about it).

As for flexibility in time, building, and furniture as well as space utilisation, both universities have taken bold steps in not only extending the span of time of using buildings, but also optimising the use of their facilities. Both institutions gather data, document, analyse, and report the utilisation of buildings as well as car parking spaces.

Table 5.17: Physical aspects comparison between ASU and USF

No	Category	Arizona State University (ASU) Main campus: Tempe Campus	University of South Florida (USF) Main campus: Tampa Campus
01	Location and physical accessibility	• Campus type: Urban (within the metropolitan area of phoenix) • Large on-campus housing facilities • Public transport: buses (Tempe FLASH) and metro line with two stops (using U-Pass) • University Shuttle connects all campuses with the main Tampa campus • Electric vehicle recharging stations • Condensed Work Week option for employees • Incentive to promote living nearby • Campus core mainly designated to pedestrians (walkability) • Support biking by providing a network of routes, several bike lockers, shower facilities, bicycle sharing program (The Bike Co-op) • Cars are the main mode of transport • Car parking: 18,118 spaces (every four people share one parking space)	• Campus type: Urban (urban fringe of mid-size city) • Large on-campus housing facilities • Public transport: buses (Bull Runner shuttle) and metro line with two stops (using U-Pass) • University Shuttle connects the main Tempe campus with the surrounding neighbourhoods • Reducing ‘the potential for vehicle-pedestrian conflicts in campus core • Promoting vanpool, carpool, car-sharing, telework, cycling, walking, compressed work week, emergency ride home, and public transit • Expand Bull Runner shuttle service • Improve pedestrian and bicycle facilities • Construct additional student housing on-campus • Increase parking permit price • Parking permit buyback program • Introducing an internal tram system • Walking corridors help connecting the campus zones together to promote academic vitality and the richness of campus life • Cars are the main mode of transport • Car parking: 20,840 spaces (every four people share one parking space)
02	climate considerations	• Minimise the overall building size (efficient use of space to reduce overall resource consumption) • Increase campus density to minimise environmental impact and maximise efficient use of energy, water, transportation, site, and materials • Increase surface area dedicated to generating on-site renewable energy (solar, biofuels, and other alternatives) • Re-purpose, renovate, and recycle existing campus facilities • Capture and store rainwater for building and landscape use • Orient development in response to the desert environment • Increase use of desert appropriate landscape plants and materials’ • Green Building Council’s LEED	• Green Building Council’s LEED • Protect and improve air quality • Conserve and protect the quantity and quality of water sources • Conserve and protect native vegetation and wildlife habitats • Energy efficiency (Green Lights Program, Motion Sensors, Energy Monitoring, Environmental Controls, Building Optimization, Solar Efficient Roofs, High Efficiency Chillers, Boiler Efficiency, Underground Utilities.) • Waste monitoring, disposition, and recycling

continued...

No	Category	Arizona State University (ASU) Main campus: Tempe Campus	University of South Florida (USF) Main campus: Tampa Campus
03	flexibility	Flexibility in time, ASU: • offers online education to students for both undergraduate and graduate degrees • allows flexibility in work schedules for staff • introduces a condensed work week option for employees Flexibility in buildings, ASU: • plans for a "100-year Building" through flexibility of use and future reuse • designs interior spaces that are flexible and allow for changes in use • minimises the use of custom millwork, custom building systems (door frames, doors, interior windows etc.) to maximise reuse in the future Flexibility in furniture, ASU: • uses standard furniture wherever possible • provides flexibility in gathering spaces and allow for different types of functions by incorporating different types of seating, such as tables with chairs, permanent benches, and moveable furniture	Flexibility in time, USF: • offers online education to students for both undergraduate and graduate degrees • offers the option of condensed work week program for its employees (named as a non-standard work) • considers telework or staggered work hours for faculty and staff Flexibility in land use and buildings: • Allowances for secondary uses in the academic and health districts provide flexibility for the research, clinical, and community-oriented functions that may arise through unforeseen program expansion and/or funding opportunities • The unique design of the building allows this breakdown to be flexible for change with future occupancy • FLeX House is designed as a sustainable house that can adapt easily to different site situations and plan configurations Flexibility in furniture, USF: • Mobile, ergonomic seating was utilized throughout the classrooms in order to minimize pressure points, support posture and promote student interaction. • Tables that can easily be moved and rearranged were also used to maximize flexibility and support various learning and teaching styles
04	space utilisation	• There is a Department that manages space provision, space utilisation, and space operation and maintenance (Planning and Space Management Section) • Underutilised or very low density, single-story buildings in the core causing a problem • Sharing the university facilities with the surrounding community	• There is a Department that manages space provision, space utilisation, and space operation and maintenance (Space Management and Analysis Department) • Using other indicators such as square meters per user (not the utilisation rates) • evaluate academic classroom schedules encouraging more classes to be scheduled in off-peak hours, thus reducing parking demands by increasing utilization throughout the day - reusing the same parking space

In order to have an overall idea of how sustainability planning and execution are carried out, interviews with sustainability experts from both universities, ASU and USF, were conducted. The analysis of the interviews has given a further understanding of how all efforts come together to achieve the institution's sustainability goals. The analysis shows similar responses to the following matters:

- Overestimated and/or underestimated issues while working on sustainability aspects
- Main sustainability hindrances (organisational, technical, or maybe both)
- What really works and what does not and why

The findings present a number of underestimated matters that both universities, ASU and USF, experienced while working on sustainability aspects.

- One of the issues was the tasks of gathering and analysing data. The analysis of the interviews shows that collecting data is challenging. For instance, a sustainability director from ASU points out that having no clear matrices from which to collect information typically results in questionable data quality. He explains that matrices should be 'clear and easy to use'. Another miscalculated challenge was having no sufficient infrastructure for collecting data. For example, to collect reliable data, utility meters and sub-meters should be used to ensure accurate, representative, and high quality data.
- Another issue that was overestimated is the return on investment. An assistant director from USF indicates that a return on investment of some projects was miscalculated given that it is not easy to achieve a high return on investment especially in short-term investments.
- Maintain a high ranking. Some of the interviewees indicate that remaining in the top positions in sustainability rankings is not an easy task. Some people involved in the process often underestimated the amount of time, effort, and expense needed to plan and implement sustainability practices and operations in large institutions such as ASU and USF. The daunting challenge is maintaining a high rank in the sustainability rankings with ever decreasing availability of funds.
- A further issue that was overestimated is marketing before understanding the bigger picture. An assistant director from USF points out that 'no marketing before real work, because things then will be more realistic and achievable'.

As for the main sustainability hindrances, the vast majority of interviewees highlighted the following issues:

- Funding for sustainability initiatives is one of the challenging obstacles facing institutions. This is common especially for public universities who rely heavily on financial support coming from tuition revenue, state funding, endowment income, federal grants, private gifts, and other income sources including residence halls, intercollegiate sports, food services, and savings made by implementing many sustainability programs. Although universities are trying to diversify their income, funding is still an issue confronting many publically-funded institutions in the United States and elsewhere.
- Another obstacle challenging universities attempting to work on all sustainability aspects is understaffing. This is one of the major hindrances given that an understaffed office can negatively impact the sustainability goals set to be achieved. This includes not only having fewer staff members, but also unqualified employees. For example, a director from ASU points out that there was an issue with meeting the institution's target in water conservation. As a result, the initial goals that were set by the sustainability committee had to be revised.

- An additional issue was with the clarity of some of the sustainability goals. An assistant director from USF highlights the fact that some of the goals were not clear enough. He adds that ‘you do not know much until you go further... progress can be made when execution starts.’

With regards to the sustainability issues that work successfully or did not work as they were intended to, the analysis of the interviews suggests the following:

- First, building student momentum was a success story in both universities, ASU and USF. What helps with such accomplishment is a high level of environmental knowledge, awareness, and concern among the university students. In fact, some of the sustainability initiatives and campaigns were initiated by the students. Such a bottom-up approach helps tremendously with institutionalising sustainability in the university.
- Second, the technology has facilitated many challenges in going green on-campus and beyond. However, individual behaviour remains an issue that is difficult to address. This was highlighted by interviewees from ASU as well as USF. They argue that even if people are aware, knowledgeable, and concerned about the environmental impacts of their actions, there are other factors that influence their behaviour such as their culture, norms, and values.
- Third, implementing sustainability policy much earlier in the process. A director from ASU believes that when policies are introduced and executed much earlier, not only higher realisations of sustainability can be achieved, but also the bar can be set even higher in advancing sustainability at the university. He says ‘all levels build on the level before... effective policies can be regarded as the first important level in moving forward towards sustainability.’

5.6. Conclusions

The aim of this chapter was to explore, analyse, and report some of the sustainability aspects in two leading higher education institutions known for their best practices in sustainable campuses, ASU and USF. Both share some of the sustainability challenges facing the majority of Saudi Arabian public universities. The chapter also answers the following sub-research question: *What lessons can the Kingdom learn about sustainable campuses in different parts of the world?*

In this chapter, there are three major findings to highlight:

- First, in order to take a bold step and accomplish much of the sustainability targeted goals in a much shorter span of time, there is a need for implementing a holistic sustainability framework through both approaches: top-down and bottom-up. The top-down approach means that most of the sustainability efforts are based on decisions made by the university rectorate and top academic administration. In other words, the advancement of sustainability aspects is undertaken through an institutional framework that addresses most (if not all) issues of sustainability in the university campus. This includes sustainability issues in management, academia, environment, and engagement. This approach helps to lay the groundwork for much effective and efficient method in achieving ‘sustainable university’. This model of ‘leading by example’ is what can be clearly seen in both cases; ASU and USF. Such universities ‘practice what they preach’ through mobilising their campuses as a ‘living lab’.

  On the other hand, the top-down approach goes hand-in-hand with the bottom-up approach. The latter not only helps to ease the implementation, but also initiates some initiatives which contribute enormously to advance sustainability in universities and beyond. The bottom-up initiatives launched by individuals, such as some student groups or some university departments, give a positive indication for willingness not to just participate in the top-down plans, but also to lead the way forward in advancing the sustainability efforts in greening their institutions. Such an approach is realised in both universities; ASU and USF.

- Second, universities should have a vision, mission, value, definition, and policy for sustainability. Their vision then can be implemented by action plans with specific targets. The sustainability policy should cover a wide range of overarching sustainability areas in higher education institutions (Alghamdi et al. 2017):
    - Academia (curriculum, research, formal and informal training programs...etc.),
    - Management (vision, mission, plans, policy, fund, procurement...etc.),
    - Environment (recycling and waste management, greenhouse gas emissions, transportation, water, energy, and green building...etc.),
    - Engagement (students, media/promotion, alumni, community...etc.), and
    - Innovation.

- Third, universities must show a great commitment to sustainability through a number of initiatives, practices, and operations including, but not limited to:
    - signing a number of sustainability declarations and charters,
    - joining a number of sustainability organisations regionally, nationally, and internationally,
    - forming many sustainability partnerships with other higher education institutions and businesses locally and globally,
    - hosting tens (possibly hundreds) of sustainability specialists covering most disciplines,
    - adopting or developing tools to measure their advancement in sustainability aspects,
    - establishing Office of Sustainability and School of Sustainability,
    - developing sustainability action plans such as Climate Action Plan,
    - providing funds for sustainability projects on-campus as well as off-campus,
    - mobilising their campuses as a ‘living lab’,
    - competing in global rankings of sustainability in universities, and
    - providing communication channels (using online mailing news lists or social media sites) to publicise all the sustainability news, updates, and events.

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PART III

CONCLUSIONS AND RECOMMENDATIONS


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Chapter 6

Planning Guidelines

6.1. Introduction

In chapter five, the focus was to draw some sustainability lessons from best practices in university campuses. The chapter particularly highlighted the lessons learnt from two public universities known for their advanced sustainability leadership, namely Arizona State University and University of South Florida.

The aims of this chapter are not only to present the main research findings from investigating the sustainability aspects in university campuses in Saudi Arabia and United States, but also to ultimately propose an approach through which sustainability can be improved dramatically in university campuses in the Kingdom and elsewhere. This approach presents the broad lines that are argued to be vitally important in order for the Saudi universities to become more sustainable. The approach, which consists of planning guidelines and implementation steps, is to be used as a road map towards sustainability in existing and future higher education institutions. It can be regarded as the empirical output of this research, presenting policies, actions, and steps to guide higher education institutions in pursuing sustainability. The question to be answered in this chapter is '*What approach can university campuses in Saudi Arabia adopt to become more sustainable?*'

In order to achieve the aim of this chapter as well as to answer the above mentioned question, a systematic approach was employed through which a methodical review has been used for not only previous chapters, but also other relevant sources. The latter helped to expand the proposed planning guidelines to include other sustainable solutions which can be applicable in the context of university campuses.

This chapter takes the form of six sections. The second section begins with highlighting the main research findings presenting key conclusions from previous chapters especially from the Saudi Arabian cases and the best practices in sustainable campuses. The third section shows the development process of the preliminary planning guidelines and the implementation steps. It also discusses the evaluation of the preliminary planning guidelines in which the input of sustainability experts from Saudi Arabia and United States of America on the proposed planning guidelines and its implementation is presented. The following section starts with clarifying the purpose and the scope of the guidelines and the way in which they were created and developed. It also introduces the revised planning guidelines where policies and programs were revealed after the feedback from the reviewers. There are policies for improvement (targeting existing universities) and policies for prevention (targeting future developments). It also shows how these guidelines can be implemented, where a step-by-step execution plan is demonstrated. Section five shows the business case for sustainable university campus, where it emphasises the benefits of universities going green and becoming more sustainable. The last section summarises the main arguments and answers the raised question in this chapter.

6.2. Main research findings

6.2.1. Saudi Arabian university campuses

As a developing country, Saudi Arabia is investing massively in sectors such as health, education, infrastructure, among others. Education, in particular, has received a special focus, on which on average, 25% of the national budget has been spent in recent years. The country adopted a long-term strategic plan to advance its higher education system, known as The Horizon 2030. This plan can be considered as part of a national vision known as Saudi Vision 2030. One angle of the strategic plan is to expand higher education. Therefore, 20 new universities were established only in the last decade. In order to accommodate these public institutions, campuses have been built in phases. This research assessed some planning aspects in public universities with a focus on the new university campuses constructed in the first phase. These evaluated aspects include the management aspects (vision, policy, planning, and commitments), the engagement aspects (attitude, knowledge, awareness and willingness to change), and the environment aspects (location, physical accessibility, climate considerations, flexibility, and space utilisation). The methods used in assessing these aspects were a desk study (including reviewing literature, documents, and architectural drawings) and a field study (including 27 interviews, 1,901 questionnaires, and 12-site observations).

The overall analysis suggests that Saudi university campuses are lagging far behind the rest of their counterparts in Europe and North America in sustainability aspects. The following points briefly summarise the main findings from examining and analysing the Saudi Arabian public university campuses:

Management aspects (vision, policy, planning, and commitments)
The findings show that the vast majority of Saudi public universities have no clear sustainability aim and plan for their campuses. In spite of the fact that these universities show a common vision to create a learning environment that is appealing, smart, and sustainable, they lack defined policies to achieve such vision. Most universities have no documented sustainability commitments for their campuses. Public universities in the Kingdom have neither developed tools to measure their advancement in sustainability nor adopted existing tools. There is a noticeable absence of leadership in relation to sustainability as well as a comprehensive sustainability approach in higher education institutions in the country. In general, most university projects lack enough emphasis on sustainability in the project brief. Additionally, the time spent on developing the brief is not enough and that effects the consideration to incorporate some of basic passive environmental sustainability elements (e.g. orientation and building placement, campus compactness, building size...etc.). At the national level, there is a lack of strategic planning for higher education facilities in terms of supply and demand. Feasibility study has not been undertaken for these massive developments (e.g. 20 new large-sized campuses). There is a lack of supply and demand policy to manage physical spaces in higher education institutions at the national level in Saudi Arabia. This accompanied by the absence of a long-term detailed study of the youth population, which the UN recent projections suggest that there is a serious fluctuation and long-term decline in such segment of the society. Although standardising both the college buildings and the landscaping objects has helped the Ministry of Education, who managed the planning and construction of new university campuses, to speed up the process of constructing the new campuses, it did not consider key aspects for each institution. Standardising did not take into account the differences in a) size of student body, b) education programs, c) attitudes to campus housing, d) importance of having a unique image and identity, e) climate (air temperature, humidity, wind, dust storm, rain...etc.), f) landscaping, and g) building materials' specifications, to name but a few.

Engagement aspects (attitude, knowledge, awareness and willingness to change)
The findings show that the majority of students in public universities in Saudi Arabia have little knowledge about the sustainable development. This rate of unawareness of one of the most important and hot topics worldwide is alarming. No public university assesses its students about their knowledge and awareness of sustainability on a regular basis. There is a lack of policies to integrate sustainability into the existing education courses. Students showed a lack of interest and willingness to take part in some sustainable initiatives on-campus. Most of the Saudi Arabian policy- and decision-makers have inadequate knowledge and awareness about the recent sustainability developments in university campuses.

Environment aspects (location, physical accessibility, climate considerations, flexibility, and space utilisation)
The findings show that the location of and the physical accessibility to public university campuses in Saudi Arabia have been emphasised by many interviewees as particularly difficult issues. The remote locations, the absence of public transportation, incompleted infrastructure projects, and the challenging topography of some sites are some cases in point. A large number of Saudi university campuses, especially new ones, are located far away from their own cities. The vast majority of surveyed people indicated that they live off-campus and few of them prefer to live on-campus. This is not only because of the long distance between the campus and the city centre, but also because of the lack of basic supporting facilities and services such as school, bookshop, clinic, supermarket, restaurants, places of worship, some of which are still under construction. On average, Saudi students, academics, and supporting staff commute some 44 kilometres distance between their place of living and their university campuses. Two-thirds of people indicated that they take between 30 minutes to one hour driving to their university campuses almost on a daily basis. The vast majority of surveyed people use their own cars to come to the university campus. That is obvious given that the Kingdom is a car-oriented country. As for the climate considerations, the findings show that analysing the master plans of new campuses as well as the college buildings show that the issue of compactness has not been considered. Compactness has a number of advantages especially for the Saudi context given the extreme climate. The idea to occupy as little space as possible was not realised. In fact campuses and college buildings are large in size. This negatively impacts the density, outdoor walking distance, and the amount of exterior envelope to be exposed to the sun, among others. There are issues with the environmental quality including the orientation of buildings, shading and day-light, passive ventilation strategies, and other energy free facilities (e.g. solar panels and wind turbines). Regarding flexibility (time, space, and furniture), the findings show that over a half of the academics have a flexible schedule and are willing to deliver lectures in the evening (between 5 pm and 9 pm), whereas around a quarter of students and supporting staff favour the evening period instead of morning. Two-thirds of participants indicated that the spaces in their college buildings can be used for multiple purposes, whereas one-third pointed out that spaces can easily adopt new functions. Only a quarter of surveyed people believed that the spaces of college buildings can be expanded and/or contracted. Physical flexibility in the layout of college buildings in campuses of recently founded universities has been highlighted as an issue. This limits the prospect for adjustment in college buildings now and in the future. Over one-third of surveyed people pointed out that the furniture is flexible. In terms of space utilisation of facilities in campuses, the findings show that the surveyed people indicated that more than two-thirds of classrooms in Saudi campuses are either half-filled or even have plenty of seats available. More than a half of people are pleased with the overall size of classrooms in their college buildings. The assessment of space utilisation in some college buildings in public universities suggests low rate of utilisation of 23%. The average rate of space utilisation of new college buildings is 22%, whereas average of old colleges is 27%. It is noticeable that almost all public sectors in the Kingdom, including higher education, are not familiar with space utilisation studies. The lack of expertise and knowledge are just two reasons for not undertaking such study.

6.2.2. Best practices in sustainable campuses

In order to draw some sustainability lessons from best practices available, this research has looked at higher education institutions known for their advanced sustainability leadership, namely Arizona State University (ASU) and the University of South Florida (USF). The following points briefly sum up the main findings from examining and analysing the two American university campuses:

Management aspects (Vision, policy, planning, and commitments)
The findings show that there is a top-down leadership that is committed to sustainability comprehensively. This means that both universities, ASU and USF, implement sustainability though their practices and operations. Both universities, ASU and USF, translate their sustainability visions into reality through policies, plans, and commitments. Universities are working systematically to green their institutions. Increasing enrolment, increasing density, increasing efficiency, increasing on-campus housing for students, improving mobility, increasing LEED certified buildings, installing on-site renewable energy facilities, and increasing awareness through formal and informal education and engagement are all cases in point. Both institutions have set a target to be climate neutral. These two universities have signed a number of sustainability declarations and charters, joined a number of sustainability organisations regionally, nationally, and internationally, formed many sustainability partnerships with other higher education institutions and businesses locally and globally, employed tens of sustainability specialists covering most disciplines, developed tools to measure their advancement in sustainability aspects, established Schools/Colleges of Sustainability as well as Offices of Sustainability, developed sustainability action plans such as Climate Action Plan, provided funds for sustainability projects on-campus and off-campus, mobilised their campuses as a ‘living lab’, competed in global rankings of sustainability in universities, and provided communication channels (using online mailing news lists or social media sites) to publicise all sustainability news, updates, and events.

Engagement aspects (Attitude, knowledge, and awareness of sustainability)
The findings show that in terms of engagement aspects such as Attitude, knowledge, and awareness of sustainability, the two institutions share the same characteristics and features with regards to sustainability education and training, funding, and offering incentives and awards. Both universities make sustainability knowledge and awareness assessment on a yearly base (except USF), offer formal and informal sustainability courses and training programs for students, faculty, and staff, provide funds for sustainability projects, and offer incentives and awards for students and staff.

Environment aspects (location, physical accessibility, climate considerations, flexibility, and space utilisation)
The findings show that there is a noticeable similarity in approaching environmental sustainability. For example, both campuses are urban and linked to their surrounding areas by mainly road networks. However, each campus is connected with its city or town through either public transit means such as buses (and metro line in the case of ASU), or their own university shuttle (bus fleet connecting the campus with the neighbouring districts or with other university campuses). Other programs to ease the physical accessibility include promoting walking, cycling, vanpool, carpool, car-sharing, telework, compressed work week, and public transit (using U-Pass). The findings also show that both universities have employed green building principles and guidelines (such as LEED) in addressing the issue of climate. ASU shows the lead in using its campuses to generate renewable energy by installing visible facilities, such as solar panels and wind turbines, which in turn indicates a number of messages not only environmentally and economically, but also socially (getting people to think about sustainability). The findings also show that in terms of flexibility in time, building, and furniture as well as space utilisation, both universities have taken bold steps in

not only extending the span of time of using buildings, but also in optimising the use of their facilities. Both institutions gather data, document, analyse, and report the utilisation of buildings as well as car parking spaces.

Therefore, comparing advanced universities such as ASU and USF to the Saudi universities, it can be said that higher education institutions in the Kingdom need to take drastic measures to advance their efforts to become more sustainable and this research has attempted to help in just doing that. As it is said *'there is always room for improvement'*, the following sections present the preliminary planning guidelines, which have been developed through learning from the best practices available. The planning guidelines are to improve the existing universities by advancing their sustainability efforts and to also prevent some unsustainable practices from happening again in future developments.

6.3. The preliminary planning guidelines

6.3.1. Development process

After systematically assessing, analysing, and reporting the sustainability issues in Saudi Arabian campuses and exploring the existing best practices in well-known institutions for their advanced leadership in sustainability in universities, this section presents the process of developing the planning guidelines. The planning guidelines were designed based on lessons drawn from best practices both locally and internationally. The former means that some sustainability lessons were learnt from campuses in Saudi Arabia and neighbouring countries such as United Arab Emirates and the State of Qatar. The latter means that some lessons were drawn from many developed countries including United Kingdom, United States, Canada, and Netherlands.

The planning guidelines dealt with and attempted to address two different perspectives in the built environment. The first is the physical angle (the hard aspect – facilities, infrastructure, grounds, and landscape). The second is the angle of use (the soft aspect – behaviour and willingness to change).

The planning guidelines comprise of a set of policies that are argued to be of help to improve sustainability aspects in university campuses in Saudi Arabia and elsewhere. Given the focus of this research, the planning guidelines were developed to cover certain aspects (management, engagement, and physical environment) through the following performance indicators (vision, strategy, planning, commitments, attitude, knowledge, awareness, and willingness to change, location, accessibility, climate considerations, flexibility, and space utilisation).

The planning guidelines can be implemented using a proposed execution plan, which can assist higher education institutions to become more sustainable. The step-by-step plan shows what should be happening in every stage of the process. The plan was developed after scanning the scholarly literature for practical approach to implementation. The order of the steps was according to the priority of execution and the necessary steps to be taken beforehand. This is to ensure smooth, effective, and practical implementation of the planning guidelines.

6.3.2. Reviewing process

Aim, type, and content of the interviews

The main aim of undertaking these interviews at this stage of the research is to improve the preliminary planning guidelines through an evaluation involving some experts from the

Kingdom of Saudi Arabia and the United States of America. The review aims to assess the proposed planning guidelines for further possible improvements.

The type of interview was a semi-structured interview. Such type was selected because of the fact that i) 'participants can provide important historical information and background' (Creswell 2003, 186), ii) 'interviewees are briefed about the main issues to cover during the interview, rather than giving them specific questions. This gives more freedom to follow up points as necessary. Such structure encourages the interviewees to say more on these follow-up questions' (Thomas 2011, 163), iii) 'interview is focused, because certain areas are questioned with scope for respondents to express themselves at a reasonable length' (Collins 2010, 134), and iv) 'interview is open-ended and assumed a conversational manner' (Yin 2014, 111).

Although the plan was to make face-to-face interviews, this was not possible at this stage of the research; due to time constraint and other logistics such as the inability to acquire a USA visiting Visa. The research acknowledges the advantages of in-person interview compared to online or telephone interview. Yet, every method of interviews has pros and cons. Some scholars have argued that one of disadvantages of face-to-face interview is that 'researcher's presence may bias responses' (Creswell 2003, 186). To minimise the disadvantages, online Skype meetings were arranged with the interviewees. The advantages were 'low cost, high response rate, and limited interview bias' (Collins 2010, 135).

The content of the interview was reviewing the planning guidelines; the policies, actions, and implementation steps. The topics discussed in the interviews were mainly the focus of this study: three aspects of sustainability management, engagement, and environment. These aspects were reviewed through their indicators (vision, strategy, planning, commitments, attitude, knowledge, awareness, and willingness to change, location, accessibility, climate considerations, flexibility, and space utilisation). Interviewees were also asked about their point of view on the six steps for implementing the proposed planning guidelines (commit, evaluate, plan, implement, track, and review).

Interview analysis and results

The plan was to interview as many experts as possible. In the Kingdom of Saudi Arabia (KSU), nine people were contacted, while in the United States of America (USA), 18 experts were asked to take part in reviewing the preliminary planning guidelines. However, experts who agreed to participate were 11 people in total, which is about 40% of the 27 people contacted. Table 6.1 shows that there were four interviewees from the KSU and seven from the USA. The vast majority were from public universities, while only one interviewee from the Saudi Ministry of Education (Higher Education Division). Over half of the participants have a position in sustainability related aspects, which can be advantageous to the reviewing process.

Table 6.1: Numbers and positions of interviewees

No	Position	Country	Organisation	No. of interviewees
01	Sustainability Director	USA	Universities	2
02	Sustainability Assistant Director	USA	Universities	2
03	Sustainability Expert (Practices and Operations)	KSA + USA	Universities	1 + 2
04	Campus Facility Manager	KSA + USA	Universities	2 + 1
05	Higher Education Consultant	KSU	Ministry	1
	Total			11

* Kingdom of Saudi Arabia (KSU)
* United States of America (USA)

In general, the reviewers believe that the main issues to take on board when formulating the policies and their actions in the planning guidelines and also the implementation steps were:

- Sharing facilities. This is one of the issues that interviewees have highlighted repeatedly. In Saudi Arabia, well-established universities tend to focus more on research along with education, while recently established universities seem to give more attention to education, given their young age, shortage of staff, and incomplete facilities and infrastructure. In order to help recently established universities to cope with such challenge and conserve some resources, some university facilities can be shared. This is not an easy task to undertake, but certainly can help conserve some resources. In this way, some savings can be made available to support research as well as education activities.
- Involving the private sector. Public universities have been financially impacted by the low oil price in recent years, given the fact that crude oil exporting is the backbone of the Saudi economy. Therefore, almost all construction activities in public universities have slowed down including housing units for staff and student dormitories. The latter can be built and operated by private sector, as suggested by some interviewees. This can help universities to provide enough accommodation on-campus. A project manager from a public university pointed out that:

  > *'Universities should not wait for the Government to finance much needed infrastructure and facilities. They should be more innovative and use other types of contract such as build–operate–transfer (BOT), through which a private sector builds a project, operates it for a certain period of time, and then ultimately transfers its ownership to the university. In this case, we can provide facilities and services without necessarily waiting for long for public funds. This would help universities to focus more on very important issues like education, research, community services, and so on.'*

- Involving other public sector(s). Some of the interviewees indicated the need to involve other parties such as the Saudi Ministry of Culture and Information (MCI), given the key role of the media in raising knowledge and awareness. Youth segment forms one-third of the population of Saudi Arabia. This precious segment of society can be mobilised for the good of the country, climate, economy, and beyond. To do so, the MCI can target the youth with many campaigns to promote more sustainable practices and operations. What helps in doing so is that people in Saudi Arabia especially young ones are known for their huge interest in social media sites and applications. Recent research suggests that there are '18.3 million users' of social applications and programs in the Kingdom, 'equivalent to 58 % of the population of Saudi Arabia' (CIT 2016). With such huge interest in social media, organising sustainability campaigns by the MCI can do a huge favour for education (in general) and higher education (in particular) in raising knowledge and awareness of sustainability. In this way, the effort and time in promoting sustainability are shortened.

- Approaching sustainability. Establishing a new unit or an office/administration such as the suggested Office of Sustainability can be feasible if only the university rectorate is convinced about it. To be convinced, one needs to be aware of its benefits. Convincing policy- and decision-makers in public universities in Saudi Arabia needs a huge effort. An interviewer from one of the public universities in Saudi Arabia said ‘it would be a challenging task to *educate the educators* about sustainability and the way to approach it holistically’. Another interviewee from Saudi Arabia underlined the issue of implementing sustainability institutionally as well as comprehensively saying:

  > *‘If the truth to be told, out higher education institutions are now, to some extent, managed by the same mentality of the 20th century. If, and it is a big if, we in universities were to change, then we need to deal with sustainability and climate change with the mind-set of the 21st century. Approaching and implementing sustainability will only be effective if it was comprehensive, institutional, and gained momentum.’*

- Managing expectation. An interviewee from the United States indicates that one should not expect all university departments to implement the sustainability initiatives with the same pace of the others. There will be some departments that require extra logistical support in order to catch up with the rest. Therefore, the point to bear in mind is ‘do not expect everyone to be as committed as others’.
- Learning from mistakes. An interviewee from the United States emphasises that her university was not very successful in implementing some of the sustainability initiatives. For example, when introducing the concept of car-pooling in their campuses, many students did not buy into the idea. She indicates that the university is now trying to investigate why such sustainable transportation initiative did not work for many students and why it did work for others.
- Contiguous improvement. Most interviewees highlighted the fact that all sustainability plans, targets, and implementation steps have to be revised regularly. ‘Every time you set the bar even higher, so progress can be made’, a sustainability director said.
- Celebrate achievement. One of the comments from some interviewees was to regularly celebrate the achievement accomplished. It is also important to acknowledge the efforts made by those who participated in such accomplishment.

The above mentioned issues reported by the interviewees were incorporated and emphasised more in the planning guidelines and in the recommendations to the Ministry of Education. The following sections present the revised planning guidelines, the implementation steps, and the business case for sustainable university campus.

6.4. The proposed planning guidelines

6.4.1. Statement of the planning guidelines

The proposed planning guidelines consist of a set of policies, strategies, recommendations, and plans to accelerate the effort of advancing sustainability in Saudi public universities.

Each proposed policy is supported with some programs. The latter consists of actions to be taken by universities either voluntarily or maybe coercively through governance bodies locally, nationally, or internationally.

The policies proposed in the planning guidelines for both existing and future universities were not only grounded principally on evidence-based results derived from this research, but also on policies emulated from well-known best practices worldwide. This means that some policies were developed based on scientific findings of this study, whereas others were adopted from supplementary literature of cases.

6.4.2. Purpose of the planning guidelines

The main reason for these planning guidelines to exist is because of the fact that the vast majority of university campuses in Saudi Arabia are not as environmentally sustainable as they should be. In fact, this research has shown that the Saudi public universities are lagging far behind in terms of sustainability aspects in higher education institutions compared with their counterparts, especially in the developed countries. Therefore, the purpose of the planning guidelines is to advance sustainability aspects in public universities in Saudi Arabia and possibly elsewhere.

6.4.3. Scope of the planning guidelines

This research deals with existing and new public universities in Saudi Arabia. However, since more than two-thirds of Saudi university campuses were established in the last decade alone, which in turn means that 70% of campuses are yet still under construction, this research pays more attention to the recently founded universities. This is because they are still under construction (phase one) and hence improvement/prevention (in phase two) can be appropriate, affordable, and feasible.

The proposed planning guidelines provide a set of sustainable recommendations of vital importance specifically to a number of stakeholders involved in higher education system. This includes not only the Ministry of Education (Higher Education Division – Planning as well as Projects Departments), but also public universities (students, faculty and staff members, administrators, planners, designers, and facility managers).

This research has found that there are five domains when addressing sustainability in university campuses. These benchmarks, which form an essential holistic framework, are management, academia, engagement, environment, and innovation (Alghamdi et al. 2017). Although this research focuses largely on the environmental aspect of sustainability, other aspects such as management and engagement are also explored. Table 6.2 presents the sustainability aspects examined (management, engagement, and environment) and their explored indicators (vision, strategy, planning, commitments, attitude, knowledge, awareness, and willingness to change, location, accessibility, climate considerations, flexibility, and space utilisation).

Table 6.2: Sustainability aspects and indicators

Aspects	**Management**				**Engagement**	**Environment**				
Code	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Indicator	Vision	Strategy	Planning	Commitments	Attitude, Knowledge, Awareness, and Willingness to change	Location	Physical accessibility	Climate considerations	Flexibility	Space utilisation

6.4.4. The planning guidelines: Policies and programs

The following policies are presented in a way in which it addresses the four questions of what, how, who, and when (What is the policy? How to implement it? When to implement it, and Who is in charge to implement it?).

Policy code
Policy name

Aspects	Management				Engagement	Environmental/physical				
Code	1	2	3	4	5	6	7	8	9	10
Indicator	Vision	Strategy	Planning	Commitments	Attitude, Knowledge, Awareness, and Willingness to change	Location	Physical accessibility	Climate considerations	Flexibility	Space utilisation

Policy description	Vision for sustainability in universities
Programs	The set of actions are: 1.1. This research has found that almost all public universities in Saudi Arabia have no institutional vision for sustainability. In spite of the fact that they do have a modest vision for their campuses, they have not shown a roadmap in order to achieve it. Universities are supposed to have sustainability visions for their institutions and for their campuses. The vision should be ambitious, yet achievable. The vision should be clear for every stakeholder, who ought to be involved in creating a shared vision. This means that 'identifying and bringing together visionary people who are determined to realise their individual projects' which 'create the stimulating atmosphere of the campus' (Schmitt 2007, 27). The sustainability vision would indicate the future plan for both the institution and its campus. Therefore, **university is advised to adopt an ambitious long-term sustainability vision; that is clear and achievable**. 1.2. The government of Saudi Arabia has recently adopted a long-term vision, Vision 2030, to move the economy away from depending only on exporting oil and gas to greener alternatives. The **sustainability vision at public universities needs to be in line with the Saudi Vision 2030** and can be the principle character in helping the Kingdom achieve its 2030 Vision.
Implementation time framework	Long-term vision to be introduced immediately
Leading figure	This should be the responsibility of the rectorate of each university

Policy code
Policy name

Aspects	Management				Engagement	Environmental/physical				
Code	1	2	3	4	5	6	7	8	9	10
Indicator	Vision	Strategy	Planning	Commitments	Attitude, Knowledge, Awareness, and Willingness to change	Location	Physical accessibility	Climate considerations	Flexibility	Space utilisation

Policy description	Strategy for sustainability in universities
Programs	The set of actions are: 2.1. The research has identified that Saudi Arabian public universities have no clear definition of 'sustainable university campuses'. **Universities are recommended to define (or adopt a definition of) sustainable university and sustainable campus**. Therefore, these key terms are clear, understandable, and agreed upon by all stakeholders involved. This leads to identifying and explaining the most important elements, characteristics, and uses of these key terms right from the start.

	2.2. This research has shown an absence of developing or adopting a tool to measure the advancement of sustainability aspects in public universities in Saudi Arabia. **Universities need to develop their own tool (or adopt a tool) to measure sustainability aspects in their campuses**. As each university faces different challenges, they can tailor their own tool based on the proposed framework in Alghamdi et al. (2017). ‘In this way, individual universities can be helped – contrary to the “one-size-fits-all” approach of conventional mainstream assessment tools. This is not to disregard the existing tools, but to empower higher education institutions to decide for themselves the development of their own processes. Once this has been established, **institutions should use assessment tools not only for guiding or assessing but also for comparing and reporting and hence making sure that universities are heading in the right direction**’ (Ibid, 108). In general, sustainability assessment tools, frameworks, systems, models, or instruments ‘can help a university to reorient itself towards a sustainable future and assist the university to explicitly acknowledge areas to be recognised, addressed and hence improved’ (Ibid, 109). ‘Tools ought to develop indicators in easily measurable ways, clearly defined, and agreed upon’ (Ibid, 112). 2.3. Although most Saudi universities show common vision – in which they aim to create a learning environment that is appealing, smart, and sustainable – they lack defined strategies to accomplish such a vision. In order to achieve the long-term vision, universities are required to develop a plan of action. Sustainability should be approached holistically. This means that it should be incorporated not only in the campus planning, management, and operations, but also in teaching, learning, and research. As a result, the **sustainability plan needs to be embedded across the university throughout its curriculum, research, campus planning, operations, and engagement with its internal and external community and beyond**. In doing so, every stakeholder will act directly or indirectly as an ‘agent of change’ and the campus will become ‘a living lab’. 2.4. On one hand, higher education institutions which show leadership in sustainability have proposed or adopted principles of action to advance and implement green practices on campus and beyond. These principles can be formulated in a sustainability plan guiding the institutions to achieve their goals. These plans tend to have targets to be reached. For example, Arizona State University plans to be climate neutral by 2035 (ASU Sustainability Plan 2011, 9), University of British Columbia projects to 100% reduction of greenhouse gas emissions by 2050 (UBC 2014, 6), and University of South Florida sets the year 2070 as its target for climate neutrality (USF STARS Reporting 2015, 182). On the other hand, this research shows that public universities in Saudi Arabia have neither sustainability plans nor climate neutrality targets. Therefore, **universities are expected to have a sustainability plan with defined targets of becoming climate neutral**. The plan should address sustainability aspects though curriculums, research, university management, campus planning, operation, and engagement with the campus community. 2.5. In order to show a leadership in greening the campus, **universities shall approach sustainability holistically**. For example, the 2006 Green Campus Initiative at Harvard University employs the following approach in making the campus sustainable (Dan + Ginger Kenney 2008, 52) (Harvard 2006): • ‘Provide leadership from the top, • Start with planning at the campus level rather than with individual buildings, • Take advantage of low- or no-cost opportunities first, • Accomplish multiple objectives with each project, • Integrate physical resources with curriculum, • Institutionalise sustainability, • Create and work within a sustainable development plan.’
Implementation time framework	Short-, medium-, and long-term implementation plans with defined goals to be achieved in each term
Leading figure	This should be the responsibility of Office of Sustainability and College/School of Sustainability in cooperation with various university’s departments, agencies, and students' representative council.

Policy code
Policy name

Aspects	Management				Engagement	Environmental/physical				
Code	1	2	3	4	5	6	7	8	9	10
Indicator	Vision	Strategy	Planning	Commitments	Attitude, Knowledge, Awareness, and Willingness to change	Location	Physical accessibility	Climate considerations	Flexibility	Space utilisation

Policy description	Planning for sustainability in universities

Programs

The set of actions are:

3.1. This research has identified a lack of institutional planning for sustainability in public universities in Saudi Arabia. In order to plan for realising the overarching sustainability goals, **universities are advised to start with carrying out an evaluation of existing sustainability policies, practices, activities, and resources** (if any) through the following steps (USGBC 2010, 22):

- ‘Identify current environmental initiatives and course offerings
- determine current staff capacity
- Identify what training resources are available locally and beyond to enhance current staff capability
- Assess current operating budgets and funding mechanisms
- Review existing policies and plans’.

Arizona State University (ASU Sustainability Plan 2011, 9) uses the following approach in the initial stage of planning for achieving its sustainability objectives:

- ‘determine the critical components that contribute to whatever we are trying to reduce or eliminate (e.g., carbon emissions, solid waste, waste water)
- establish metrics baseline before implementing any change
- prioritise the components from largest impact to smallest impact
- create projects to address each component and execute them
- measure and report changes annually based on the project outcomes.’

3.2. This research has shown that there is a projection that indicates an increase of youth population in Saudi Arabia until the year 2035, followed by a sharp decline. Therefore, this would be reflected in the demand for higher education. However, an increase in student population should not lead to an increase in space provision. **Universities are expected to accommodate the growth in student population by exploring alternative solutions** such as optimal utilisation of existing space, offering more online education, and explore different methods of teaching, such as flipped classrooms.

3.3. With the above mentioned policy in mind, it is of vital importance that **public universities shall undertake an examination of a long-term projection of student enrolment**. Knowing approximately how many students are expected to enrol in certain year help universities to be prepared in terms of providing facilities such as classrooms, labs, offices, housing...etc.

3.4. What helps realise the aforementioned policies is having **enough information along with the involvement of as many stakeholders as possible which are key factors in successful campus planning**. Dober (1963, 45) points out that good campus planning are based on two main elements:

> *‘a body of information sufficient to undertaking and as broad a participation as possible in the process of planning. The former comprises all serviceable data from which the future can be constructed. The latter is essentially that commonwealth of effort necessary to finding and supporting a consensus of what the future should be.’*

3.5. The planning for becoming a sustainable campus can be divided periodically into three ranges: short-term, medium-term, and long-term. Although the time span for each term is known commonly as five, ten, and fifteen or twenty years, respectively, recent sustainability plans tend to be shorter. In order to be able to accomplish the targeted sustainability objectives, **the span of time needs to be reflected in the sustainability plan**

	of the university. The plan should be regarded as a 'living document', which means that it can be updated and improved frequently so that it accommodates recent developments in many areas e.g. technologies. 3.6. Higher education institutions around the world continue to develop their campuses. These developments take the form of either through constructing new facilities or expanding or renovating existing premises. In order to provide cutting-edge facilities, **universities shall continue to invest wisely in modernising their buildings with state-of-art technologies and not necessarily by constructing new buildings**. This investment includes not only research and collaborative learning space, but also supporting facilities such as on-campus housing, dining, hotel, conference centre, bookstore, athletic facilities, grocery store and other related amenities. This leads to increasing the campus density and connectivity between different functions especially in the campus core. The advantages of such investment are to improve the quality of campuses and to establish a more lively and vibrant campuses.
Implementation time framework	Short-, medium-, and long-term implementation plans with defined goals to be achieved in the course of each period
Leading figure	This should be the responsibility of Office of Sustainability and College/School of Sustainability in cooperation with various university's departments, agencies, and students' representative council.

Policy code
Policy name

Aspects	Management				Engagement	Environmental/physical				
Code	1	2	3	4	5	6	7	8	9	10
Indicator	Vision	Strategy	Planning	Commitments	Attitude, Knowledge, Awareness, and Willingness to change	Location	Physical accessibility	Climate considerations	Flexibility	Space utilisation

Policy description	Commitment to sustainability in universities
Programs	The set of actions are: 4.1. This research has found that institutional commitment to sustainability in Saudi universities is lacking. The purpose of showing commitment is to 'lay a solid foundation for developing and implementing a green campus plan and to communicate those goals to faculty, staff, students, alumni, and the community' (USGBC 2010). **Universities are requested to establish a formal and campus-wide commitment to sustainability** through the following initiatives, activities, programs, and policies: • **Show leadership**. The university top administration shall show leadership in institutionalising sustainability in the university campus in all aspects at all levels (Top-down approach). • **Establish an Office of Sustainability**. This is one of the first steps in order to institutionalise sustainability in the university. It is one of the most important steps, given its essential role in assessing, evaluating, planning, implementing, monitoring, supporting, advancing, and reporting sustainability in the university campus. The Office is responsible for managing sustainability in the university campus through policies, practices, and programs. This team can consist of specialists in sustainability aspects as well as representatives from i) the university's stakeholders, departments, and agencies and ii) the community. Establishing this office should be a priority to be created at early stage, given the enormity and importance of the tasks ahead. The Office is responsible for coordinating educational and community-based programs on sustainability. It works with the university departments or the university's Academic Affairs to develop policies and programs relating to sustainability in teaching, learning, and research. The Office could help in establishing the university future School/College of Sustainability. Such office can be seen in many universities around the world especially in North America, Europe, and eastern Asia. Such an office can be named as Sustainability Office, Office of Sustainability, Office of Campus Sustainability, Environmental Office, or Environmental Council.

- **Identify and involve stakeholders**. Students, faculty members, and university staff can all play a key role in building momentum for sustainability practices and operations in university campuses (Bottom-up approach). Their initiatives can advance the efforts of the institution and help to implement sustainable initiatives on-campus and off-campus. Students, in particular, can be regarded as potential agents of change, now and in the future.
- **Employ sustainability specialists**. Leading universities hire numerous people who specialise in sustainability, covering most disciplines. They can work in either the Office of Sustainability as sustainability professionals or consultants and in the School/College of Sustainability as sustainability scholars or researchers (or they can be working in both). For example, in its webpage, Arizona State University (ASU) states that it has more than 400 sustainability scientists, scholars, and fellows.
- **Evaluate and document existing sustainability initiatives**. Identify the current sustainability initiatives through assessing the university's strengths, weakness, opportunities, and challenges that can help or maybe hinder advancing sustainability in the institution. This can also assess in acknowledging the in-house capabilities and to what extent can it help in progressing towards more sustainable university campus.
- **Establish metrics baseline to check progress**. This can be used as a method of tracking progress made from the starting point in order to check and compare advancement.
- **Make a sustainability plan** or a climate action plan. This plan of action shall approach sustainability holistically, which means sustainability should be incorporated not only in campus planning, management, and operations, but also in teaching, learning, research, and engagement. This indicates that many stakeholders could be involved including capital planning and projects, facility management, procurement, rectorates, administrators, deans, faculty members, students, alumni, and community representatives. In their sustainability plans, universities are advised to set their sustainability goals that are specific, measurable, realistic, relevant, and timely-bound.
- **Fix a date to be climate neutral**. Leading universities have fixed a target date for becoming climate neutral, showing their commitment to sustainability and to climate change. For example, Arizona State University plans to be climate neutral by 2035 (ASU Sustainability Plan 2011, 9), University of British Columbia projects to 100% reduction of greenhouse gas emissions by 2050 (UBC 2014, 6), and University of South Florida sets the year 2070 as its target for climate neutrality (USF STARS Reporting 2015, 182). In order to achieve such an ultimate target, universities should have short- and medium-term targets to check the progress.
- **Adopt or develop sustainability tool**. Leading colleges and universities either adopt or develop their own sustainability instruments (or as some named as toolkit). Assessment tools can be used as 'key performance indicators'; assisting universities to measuring their advancement in all sustainability aspects by evaluating and improving. Examples of these tools include SAQ, SUM, BIQ-AUA, USAT, and AMAS.
- **Declare a sustainability commitment**. Universities are advised to establish a formal and campus-wide commitment to sustainability, which shows a dedication to sustainability practices and operations. Institutional sustainability commitment can be done through distributing such declaration to students, faculty members, university employees, and visitors. Universities can also display such commitment on the institution's website.
- **Sign sustainability declarations**. Institutions can also show commitment to sustainability on campus by signing sustainability declarations, charters, treaties, or agreements nationally (if existed), or internationally. The aim of these agreements was to inculcate environmental, social, economic and educational sustainability in colleges and universities. These treaties were designed to encourage and support sustainable development in higher education institutions (Lozano et al., 2013). Examples of such agreements include Stockholm Declaration, Talloires Declaration, Halifax Declaration, Declaration of Thessaloniki, Ubuntu Declaration, Declaration of Barcelona, and Tokyo Declaration.
- **Form sustainability partnerships**. In order to facilitate the daunting challenge of developing and implementing sustainability policies and practices, universities can

choose some strategic partners and form partnerships to work together. This results in great progress and innovation especially with advanced public or private associates. Partners can be other higher education institutions and/or businesses locally or globally.

- **Join sustainability networks**. There are a number of sustainability networks that aim to unify and share the efforts of leading colleges and universities in advancing and implementing green practices on campus and beyond. Examples of such networks include International Sustainable Campus Network (ISCN), UN Green University Network (UNGUN), and Sustainable Universities Network (SUN).
- **Attend (or hold) sustainability conferences.** There are many organisations that hold specialised conferences, symposiums, or seminars on an annual base to address sustainability in universities and discuss the latest developments in the field. Examples of such organisations include Association for the Advancement of Sustainability in Higher Education (AASHE), International Sustainable Campus Network (ISCN), and Environmental Management for Sustainability in Universities (EMSU).
- **Compete in global ranking tables of sustainability in universities**. Universities are recommended to participate in these ranking systems so that their sustainability efforts can be not only evaluated, but also recognised and publically awarded. There are a number of ranking systems that encourages healthy competition among universities and raise awareness and sustainability standards. Examples of such ranking systems include Green Matric, Green League, Cool Schools, and STARS.
- **Mobilise the campus as a living lab**. Leading universities have been using their campus facilities and infrastructure as a living laboratory through which many sustainable initiatives and programs are implemented on-campus. The main principle is to integrate teaching, learning, research, campus planning and operation, and outreach into living lab for sustainability (König 2013).
- **Fund for sustainable initiatives**. Universities have made some savings from sustainability programs and then they use that savings to provide generous funding to finance potential projects on-campus and off-campus. University of South Florida (USF) indicates that 'funding could be obtained from a variety of sources including grants, donations, sponsorship from other departments, or student fees. Further, after initial funding, the program could be self-sustaining through initiative savings' (USF Sustainability Report 2007, 16).
- **Establish communication channels**. Colleges and universities use online mailing news lists and or social media sites to publicise all the sustainability news, updates, events, and programs on-campus as well as off-campus.

Implementation time framework	Short-, medium-, and long-term implementation plans with defined goals to be achieved in the course of each period
Leading figure	This should be the responsibility of the university rectorate, administrators, Office of Sustainability, College/School of Sustainability, and students' representative council.

Policy code
Policy name

Aspects	Management				Engagement	Environmental/physical				
Code	1	2	3	4	5	6	7	8	9	10
Indicator	Vision	Strategy	Planning	Commitments	Attitude, Knowledge, Awareness, and Willingness to change	Location	Physical accessibility	Climate considerations	Flexibility	Space utilisation

Policy description	Attitude, knowledge, awareness, and willingness to change
Programs	*"... before we can change the world, we have to change ourselves... Understanding our own environmental impact and seeking to reduce it is a choice that all of us can make every day"*

The President of Spelman College, which is a women college, located in Atlanta, Georgia, United States (USGBC 2017).

The set of actions are:
5.1. This research has shown that the vast majority of students in public higher education institutions in the Kingdom have little knowledge about the notion of sustainable development. The rate of unawareness of one of the most important and hot topics worldwide is alarming. **Higher education institutions need to lead the Saudi Arabian society to advance sustainability in the Kingdom**. This problem is what policy- and decision-makers in Saudi Arabian government ought to address in order to take advantage of its large youth population. **Decision-makers have no option but to place sustainability knowledge and awareness top on the agenda, since it will be of great benefit in implementing the Saudi Vision 2030**. Sustainability has to be prioritised in order to become a culture and a norm. To do so, **universities are requested to take the leadership role to address this demanding issue that may hinder the country moving towards a more sustainable future**. Thomashow (2014, 3) believes that 'university leadership is our last best hope for addressing the global climate challenge, and campus sustainability initiatives are the foundation of that leadership'. Simpson (1996) also indicates that when the campus community knows that the university top administration is committed, involved, and supportive of the sustainability programs, then green campus initiatives have a much higher success rate. **To implement this leadership role, faculty and staff members need to be involved. They are believed to be key agents in the efforts to achieve lasting progress towards sustainability** (Brinkhurst et al. 2011). The present study has found that the Saudi academics are enthusiastic enough about sustainability and this should be taken advantage of.
5.2. This research has identified that the more you know about sustainable development, the more likely you are willing to act sustainably. On one hand, some professionals including projects and facility managers in Saudi public universities have limited level of knowledge and awareness of recent sustainability developments in campuses. On the other, faculty members in Saudi public universities have shown very decent knowledge and awareness of sustainability. The question to be raised regardless of the groups surveyed (students, academics, supporting staff, or professionals) is will the knowledge be enough to operate more sustainably. This has been answered by Heeren et al. (2016) in which they indicate that 'there are many valuable justifications for educating and training people about sustainability, but that does not mean an increase in environmentally conscious behaviours'. Therefore, to achieve greater deal not only in knowledge and awareness of sustainability, but also in sustainable behaviours, **Saudi policy- and decision-makers in universities along with related government agencies are advised to address other aspects such as the social norms, attitudes towards sustainable behaviours, and the perceived behavioural control** (Ibid).
5.3. This research has also found that only half of the Saudi students are interested in sustainability. Additionally, around half of them are not willing to change, especially when it comes to using public transportation, university fleet, or even share a car. This clearly indicates the size of problem Saudi Arabia has to deal with now and in the future. In order to ease the issue of participation in sustainable initiatives on-campus and beyond as well as facilitate the willingness to change, **universities can**:

- **Clearly articulate the benefits of sustainable development,**
- **Educate (through integrating sustainability into the university curriculums),**
- **Train (through training programs for faculty and staff),**
- **Inform all stakeholders in universities about sustainability (through presentations, orientations, and signage...etc.),**
- **Address the social norms and attitudes towards sustainable behaviours, and**
- **Invest more in sustainability programs and facilities** (for example installing clearly visible renewable energy facilities on-campus. This is to get the message across for the campus community and beyond so that the adding value will be through attracting attention and getting everybody thinking about sustainability).

5.4. **Universities need to employ various schemes in building awareness and capacity of sustainability** such as the ones highlighted by the U.S. Green Building Council (USGBC 2010, 48) including:

- '**Institutional sustainability commitment**. Distribute to faculty, staff, students, and visitors and display on the organisation's website

- **Job Descriptions**. Include sustainability specific responsibilities in job descriptions
- **Orientation**: Acquaint new employees, faculty, and staff with campus vision and resources for sustainability
- **Sustainability Training**. Offer in person and online courses
- **Personal Sustainability Pledge**. Develop language and a forum (e.g., website) for faculty, staff and students to make pledge
- **Dissemination of Policies & Guidelines**. Present environmental policies and procedures to applicable departments, building occupants, and residents
- **Peer-to-Peer Best Practice Exchanges**. Communicate and engage with peers at
- other institutions to share experiences and lessons learned
- **Internal Competitions**. Promote and support sustainability competitions
- **Gain Consensus**. Host educational programs to promote and inspire sustainability on campus
- **Sharing Successes**. Share internal successes and projects to all campus stakeholders'.

5.5. In order to advance the knowledge and awareness of sustainability among the university students, leading **institutions undertake a sustainability assessment on an annual base**. This is to gauge how knowledgeable students are and how the level of knowledge and awareness change over time as students' progress in their studies at the university. An example of such assessment is the one executed by Arizona State University, known as ASU Student Sustainability Literacy Survey.

5.6. To complement the efforts to teach students about sustainability aspects, leading **universities confer not only Bachelor, Masters' and Doctor of Philosophy (Ph.D.) degrees in sustainability aspects though their School/College of Sustainability, but also offer modules or units of study through the university's faculties and departments**. In this way, almost all the university's students are exposed to the notion and practices of sustainable development and hence acting accordingly.

5.7. In order to encourage the universities faculties and departments to incorporate sustainability in some of their existing courses, **universities need to give incentives for faculties and departments to promote integrating sustainability in their curriculums**.

5.8. Universities are advised to celebrate the collaboration of their faculty members and staff who involve actively in the sustainability movement. **Faculty and staff need to be recognised, incentivised, and rewarded for their efforts in advancing and implementing sustainability aspects** in the curriculums and on-campus. For instance, ASU's President awards faculty members for their effort to develop sustainability courses with the "President's Award for Sustainability" (ASU STARS Reporting 2015, 35).

Implementation time framework	Short-, medium-, and long-term implementation plans
Leading figure	This should be the responsibility of the Ministry of Education (Higher Education Division), the university rectorate, administrators, college/school deans, department heads, Office of Sustainability, College/School of Sustainability, and students' representative council.

Policy code

Policy name

Aspects	Management				Engagement	Environmental/physical				
Code	1	2	3	4	5	6	7	8	9	10
Indicator	Vision	Strategy	Planning	Commitments	Attitude, Knowledge, Awareness, and Willingness to change	Location	Physical accessibility	Climate considerations	Flexibility	Space utilisation

Policy description	Location of college buildings and university campuses
Programs	The set of actions are:

6.1. The 20 recently established public universities in Saudi Arabia have been located in provinces that have had no history of hosting such institutions. This has many profound positive aspects to every province and its cities and towns, economically, socially, and beyond. However, this research has found that some of these campuses have been located a) in challenging sites and b) far away from their main cities and towns. Some sites have difficult topographies including rocky mountains, hilly, sandy, or low-line ground. The decision and the process of selecting these sites were taken in a very short span of time. The Ministry of Education along with the authority of each local municipality were the parties involved in taking such decision. Whether the selected sites for the recently founded university campuses were the right decision or not, only ongoing research and time will tell. This research has identified that there are four main reasons for selecting these locations. First, many university campuses were intentionally located in remote sites 'to avoid the conflict and distractions presented by cities' (Haar 2011, xx). Historically, and especially in the United States of America, a number of campuses located in the countryside believing that 'the academic ideal has been profoundly suburbanised, where a rural setting is part of the definition of academic excellence' (Bender 1988, v). Thus, the Saudi campuses might follow the same traditional principle. A second, and perhaps more acceptable reason, was because of the size needed to accommodate all the institution's facilities and services, a decision made based mainly on size. As expected, there is not enough space within the city tissue to house a large scale development with the proposed size. Third, it might be also because these municipalities have no master plan for their cities that takes a university campus into account. Four, it might be because of the need to establish a new and large development outside the city that characterised as 'big and far' (Alonso 1968); aiming at a regional balance or a de-concentration by making the campus as an attractive starting point for such new development (growth-pole) (Parr 1999). Regardless of the reason, there is no easy fix to the problem of selecting such locations. Therefore, the following policies can be taken into considerations in order to ease the issue of remote locations:

- Selecting a location for a university campus is exceptionally strategic decision to take. The **Ministry, local authorities, and universities need to take enough time in reviewing all the options available and decide based on a feasibility study to avoid selecting undesirable and unsustainable location for university campus**.
- Many people in the Ministry, local authorities, universities architects and planners argue that the selected locations for the recently founded universities are appropriate given that with time, cities will grow towards the campuses citing the case of King Saud University (KSU), which is the oldest university in the Kingdom. The campus of KSU is about 20 kilometres away from the centre of Riyadh. The opposite view to this argument is that although cities grow, they differ in the growth rate. Riyadh is the capital of the country and it is one of the fastest growing cities in the world with a population of '6.5 million in 2016' and an 'average annual growth of 3.8%' (United Nations Report 2016, 19). Therefore, **when selecting a location for university campuses, decision makers who involve in taking strategic decision with this magnitude should bear in mind other factors (such as growth rate of cities)**, because not every city can grow with such annual growth rate. The consequence of such decision seriously impacts commuters, universities, and the environment.
- The decision to locate university campuses in rural areas, edge of the city, or not within the urban tissue was, to a large extent, because there is not enough space for the campus with this size. The question to be raised is why this size of campus is needed in the first place and who determines that. Historically, university campuses in Saudi Arabia are planned to be in one single site, owning the land and buildings. Leasing properties are not common, but it has become normal especially with the establishment of recently founded universities. There are countless well-established universities around the world that have a number of campuses (main campus and branch campuses/satellite campuses). For example, University of Copenhagen, Denmark, founded in 1479, has four campuses scattered all over the city: North Campus, City Campus, South Campus, and Frederiksberg Campus (University of Copenhagen 2017). Each campus houses related fields of knowledge. 'South Campus (Humanities, Law, and Theology), North Campus (Natural, Pharmaceutical, and Health and Medical Sciences), Frederiksberg Campus (Veterinary, Bio, Plant and Geo Science as well as Nature Management), and City Campus (Social Sciences)' (Danish Agency for University and Internationalisation 2013, 230). It is interesting to also notice that the North Campus is located in close proximity to the Bispebjerg Hospital, which acts as a teaching hospital for training the university's medical students. Therefore, the lessons learnt are that **decision makers in universities could have**

explored other alternatives in locating their campuses; the institution's colleges and units can be divided into a number of locations within the city.

- Up until now, 'the University of Copenhagen leases the majority of the buildings from the Danish Property Agency. The rest is either freehold or leased from private landlords' (Ibid). **Universities can also consider not always owning their buildings, but maybe leasing and adopting them** if this is a much feasible option. Leasing is exactly what happened with the 20 recently established universities in Saudi Arabia. They rented out properties within their cities and towns, which were very physically accessible by students, faculty members, staff, and visitors. Although these leased properties were not purpose-built, they can be adopted to serve the purpose.
- In order to improve the current locations, there are two strategies: **increasing density and increasing diversity**. Universities are recommended to increase a) the density by creating smaller footprint and hence creating highly compacted campuses and b) the diversity by providing a variety of services that are essentially required within the campus community including supporting facilities and services such as housing, schools, bookshop, clinic, market, restaurants, and places of worship. These facilities will bring life to the existing campuses and make them dynamic, liveable, and ultimately flourishing places. For example, University of Utrecht, Netherlands, has implemented a number of strategies to increase the density of their Uithof campus, the largest in the Netherlands. The strategies employed were: i) 'new buildings should seek out the proximity of existing buildings', ii) 'developing a concentration and network of different functions in order to create identifiable neighbours', iii) 'encouraging people to make contact with each other, exchange ideas, and share facilities' (Zaaijer 2007, 62).
- One of the characteristics of university campuses in Saudi Arabia is the gates and walls along the border. Each campus is carefully guarded, giving the impression that the campus is 'not open to all' (Deplazes 2007, 42). The drawing of borders surrounding the campuses 'creates a clear line of demarcation that has to be overcome' (Ibid). Such **borders as well as gates communicate unnecessary physical and perceptual messages. Universities need to be connected with their surroundings and open to the world, certainly not an enclave, excluded, or gated community**.

6.2. As for locating new college buildings or university campuses, choosing a location is of vital importance not only to the university, but also its community. In the Green Building and LEED Core Concepts Guide (USGBC LEED 2010, 52), there are six strategies to be used when selecting a site:

- **'Choose redevelopment and infill development**. Build on previously developed land and brownfield sites.
- **Locate near existing infrastructure**. Avoid triggering suburban sprawl and unnecessary materials use by consolidating development along existing roads, power lines, and water supplies.
- **Protect habitat**. Give preference to locations that do not include sensitive site elements and land types.
- **Increase density**. Create a smaller footprint and maximize the floor-area ratio or square footage per acre.
- **Increase diversity**. Provide the services that are most needed within communities and support a balance of jobs and housing.
- **Encourage multiple modes of transportation**. Enable occupants to walk, bicycle, and use public transit.'

The advantages of good location of the university campus can be used as an attractive factor. Research shows that 'where universities possessed a particularly distinctive campus (and/or location), the survey results clearly indicated that this was a marketing lever' (CABE 2005, 22).

Implementation time framework	Short-, medium-, and long-term implementation plans
Leading figure	This should be the responsibility of the Ministry of Education (Higher Education Division), the university rectorate, the project and facility managers, and the planners and architects.

Policy code
Policy name

Aspects	Management				Engagement	Environmental/physical				
Code	1	2	3	4	5	6	7	8	9	10
Indicator	Vision	Strategy	Planning	Commitments	Attitude, Knowledge, Awareness, and Willingness to change	Location	Physical accessibility	Climate considerations	Flexibility	Space utilisation

Policy description	Physical accessibility in universities

Programs

The set of actions are:

7.1. This research has found that on average, Saudi students, academics, and supporting staff commute some 44 kilometres distance between their place of living and their university campuses. Two-thirds of people indicated that they take between 30 minutes to one hour driving to their university campuses almost on a daily basis. The research has also shown that the vast majority of surveyed people use their own cars to come to the university campus. The physical accessibility is clearly an issue in Saudi Arabia’s public universities, which is a direct result of selecting remote locations. Meanwhile, it should also be highlighted that the Kingdom is a car-oriented country and what exacerbates the situation is that i) the price of fuel is very cheap compared to other countries, ii) no parking fees and also no road taxes, and iii) very limited options of public transportation in the whole country. However, this is one of the problems that has no simple, quick, or cheap fix. ‘Tackling the issues of the automobile’s impact on campus is not easy, but it can have great rewards’ (Kenney et al. 2005, 187). Therefore, the following policies (management strategies and campus planning and design strategies) shall be taken into account in order to ease the issue of automobile and physical accessibility. Note that there are some policies that can be implemented immediately, others cannot unless some alternatives are ready and available:

- **Highlight the impact of automobile**. The aim is to underline the importance of the negative impacts of automobile. This can help in implementing more environmentally friendly initiatives to overcome the issue of transportation and improving safety on campus. Poor air quality, traffic congestion, lack of land for parking, cost of constructing parking garages, the impact on surrounding neighbourhoods are all cases in point (Poinsatte & Toor 2001).
- **Address transportation behaviour (now and in the future)**. This can be crucial given its influence on not only the current campus community (students, faculty, and staff), but also on the future generations through affecting their transportation habits. The long-term impact is that today’s students are the potential agent of change as Tolley (1996, 214) puts it ‘they will progress to occupy influential roles in government, companies, or other organisations’.
- **Review automobile policies**. The goal of such policy is to ‘provide more movement options (move people not cars)’ and ‘enable the highest and best uses of resources (land and capital)’ (Kenney et al. 2005, 186). Universities could offer ‘subsidies and incentives for other means of transportation that can lower single-occupancy automobile use, including walking, bicycling, use of remote lots, carpooling, vanpooling, mass transit, and other kinds of shared transportation’ (Ibid).
- **Promote more sustainable means of transportation**. Putting into place incentives that encourage using other modes of transportation. This cannot be undertaken unless there is an investment in the campus facilities, infrastructure and landscape. In order to promote walking or biking, which are the most sustainable modes of transportation, universities need to provide adequate facilities ranging ‘from protection from the weather and good illumination, to visual appearance and amenities (litter containers, benches, etc.)’ (Balsas 2003, 38). According to Kenney et al. (2005, 187), ‘people will be happy to walk fifteen to twenty minutes if the experience is pleasant’. They indicate that ‘a pedestrian-oriented campus provides an efficient and safe network of pedestrian pathways. Landscaping, shade trees, arcades, and good lighting after dark can all enhance the quality of the pedestrian experience, as well as a chance to see and

be seen by others.' The design of the campus core is expected to be designated to pedestrians only. For biking, on the other hand, facilities that encourage riding a bicycle include 'bicycle paths and lanes, intersection treatments, signage, and parking' (Balsas 2003, 38).

- **Manage the parking lots/structures/garages**. Many rural university campuses around the world especially in car-oriented societies (such as Saudi Arabia, United States, and Canada) face a daunting challenge in managing their university parking lots and parking garages/structures. Introducing (or increasing) parking fees has been implemented in many campuses. Yet, this cannot be introduced unless there are other attractive and economical alternatives including availability of other modes of transportation. Additionally, facility managers in universities do undertake utilisation studies on parking lots and structures to examine the actual provision of space as well as its utilisation. For example, the University of South Florida (USF) found that the utilisation rates of car parking range between 57% on Fridays and 81% on Tuesdays (USF Tampa Campus Master Plan 2015, 94). The University aims to elevate the utilisation rate to 88% (Ibid).
- **Introduce other soft solutions**. Many universities across the world use other soft approaches such as telecommuting (staff working from home for a day or so), flex-time (flexible working schedule), compressed work week / condensed work week (e.g. Four-day/40-hour work week) and distance learning (on-line education offering classes to student at home).
- **Transportation demand management (TDM)**. The concept of TDM includes a wide-range of solutions such as 'market prices for parking, expanding transit access, park and ride lots complemented by bus shuttles, rideshare programs, bicycle and pedestrian facilities, and traffic-calming schemes' (Balsas 2003, 35).
- **Explore alternative fuels to the university fleets**. Many universities are replacing the conventional fuels for their cars and buses with greener alternatives such as compressed natural gas or electricity (Keniry 1995). Universities work with partners to provide electric bicycle (e-bikes), electric cars (e-cars), and recharging stations on-campus.

- **Provide more on-campus housing**. Universities need to invest more in their own campuses especially in student dormitories and staff housing. This is to help not only accommodate as many people on-campus as possible, but also to make the campus thrive. This research has shown that almost 40% of surveyed people prefer to live on-campus, especially if the supporting facilities and services are provided. This research has also found that the vast majority of surveyed people indicated that they live off-campus and few of them prefer to live on-campus. This is not only because of the long distance between the campus and the city centre, but also because of the lack of basic supporting facilities and services such as school, bookshop, clinic, supermarket, restaurants, some of which are still under construction. On-campus housing strategy has been employed by many universities in order to reduce the impact of automobile and hence the environment. In the US, there is a classification of universities to accommodate 25% of full-time undergraduate students in institutionally-managed housing (Carnegie Classification 2017). Similar policy can be applied in Saudi Arabia in order to help solve the issue of remote locations, physical accessibility, and automobiles. To help public universities speed up the process of building housing units on-campus, they can use other types of contracts such as build–operate–transfer (BOT), in which a private sector builds the housing units, operates them for a certain period of time, and then ultimately transfers its ownership to the university. On-campus housing has become a significantly important in the competition of attracting students. Zaaijer (2007, 66) argues that 'the ability to provide sufficient student accommodation become a key factor in this competition.' He states that the University of Utrecht, Netherlands, has seen on-campus housing as a real opportunity 'to become real campus, housing members of the university within its own boundaries' (Ibid). Additionally, 'providing housing on campus also reduces parking demand in the core as automobiles are no longer need to commute to classes' (Dan + Ginger Kenney 2008, 51).
  - **Incentive to promote living nearby**. Some universities use this incentive to encourage students and staff to live in close proximity to the campus.
  - **Mass transit (Pass Programs)**. Universities are recommended to work hand-in-hand with other partners such as transport agencies to provide reduced (or free of charge)

price transit passes to students, faculty, and staff to access local modes of transportation. This can be funded entirely by student fees or partially by involving other partnerships such as local municipalities. This is known as 'Unlimited Access' (Brown et al. 2001) or 'U-Pass'.

- **University Shuttle**. Another option to ease the accessibility to university campuses is by using the university's fleets which connect the campus with the surrounding neighbourhoods or between satellite campuses.
- **Future transport revolution**. The new generation of modes of transportation is believed to be smart, flexible, reliable, punctual, driverless, and sustainable (zero emissions). Masdar City, Abu Dhabi, United Arab Emirates has shown leadership in many aspects of sustainability as it aims to be the world's first zero emission city. 'Since November 2010, Masdar City has been operating a personal rapid transit (PRT) system, which has now carried more than 2 million passengers between its two stations without a single accident or injury. System availability and vehicle reliability consistently exceed 99.6% and 99.9% respectively. The PRT system is operational 18 hours a day, from 06.00hr until midnight, every day' (Masdar City 2017). Universities are advised to explore these cutting-edge technologies and be the frontrunners in developing and implementing such technologies.

Implementation time framework	Short-, medium-, and long-term implementation plans
Leading figure	This should be the responsibility of universities (planners and facility managers), local authorities, local municipalities, and students' representative council.

Policy code

Policy name

Aspects	Management				Engagement	Environmental/physical				
Code	1	2	3	4	5	6	7	8	9	10
Indicator	Vision	Strategy	Planning	Commitments	Attitude, Knowledge, Awareness, and Willingness to change	Location	Physical accessibility	Climate considerations	Flexibility	Space utilisation

Policy description: Climate considerations in universities

Programs:

The set of actions are:

8.1. **Climate considerations**. Given the size of Saudi Arabia, the country has a variety of climate that differs from place to place (or province to province). Although the Kingdom is characterised by its desert climate (extreme hot during the day and sharp decline in temperature at night), there are some exceptions. For example, the west side of the country is characterised as tropical arid climate (mild temperature in winters) and the southwest side of the country is characterised as temperate climate (moderate temperature given the highlands). Therefore, these **different climates give an indication that they have be taken into account when planning and designing for projects such as university campuses**. This research has shown that the 20 recently established university campuses have been located all over the country. This means that there should be a consideration for each province's climate. However, this research has found a lack of attention to deal with each climate accordingly. Instead, the design was standardised and the same prototype of college building can be seen in different provinces. On the other hand, when analysing the master plan and building design of the recently established university campuses, a number of planning and design issues can be noticed. Compactness, orientation, environmental quality, occupants' comfort and well-being are all cases in point. As a result, the following policies shall be taken into account in order to address the issue of climate considerations:

8.2. **Campus plan and layout.** Compactness has a number of advantages especially for the Saudi context given the extreme climate. The idea to occupy as little space as possible was not realised. In fact campuses and college buildings are believed to be big in size. This impacts negatively on the density, outdoor walking distance, and the amount of exterior envelope to be exposed to the sun. The following aspects are expected to be considered:

- **Campus design**. Traditionally, the urban design of cities and towns in the Arabian

Peninsula is as compact as possible. The settlement patterns respond to the sensitivity of climate, among others. The passive strategies employed have a huge impact on the performance of buildings, users, and beyond. **Compactness, natural light, natural ventilation, and shading are all basic elements of planning and design, to which planners and designers must pay close attention when designing in such environment.** This is to limit the dependence on other solutions to climate such as the active strategies (insulations, renewables, water and energy saving gadgets, and sensors).

- The increase in the scale of facilities needed, along with the increase in complexity of educational system poses a daunting challenge for planners and designers in such harsh climate. To deal with this unpleasant condition, **university planners and architects could employ both passive and active design strategies. The former (passive strategies) can tremendously help the latter (active strategies) by making the climate considerations much easier**. Examples of sustainable campuses that were designed using passive as well as active measurements in the Arabian Peninsula are King Abdullah University for Science and Technology (KAUST) in Thuwal, Saudi Arabia, Masdar Institute (MI) in Abu Dhabi, United Arab Emirates, and Qatar University (QU) in Doha, State of Qatar. They all share the same principle of compacted pattern. To show the importance of passive solutions, the architect HOK, who designed KAUST, has borrowed five design strategies from local culture and traditions to address the environmental issues. These five strategies were summarised by the Architecture and Design Journal (2010, 112) as:
  i. *'Structured like traditional Arabic cities, the campus is compressed as much as possible to minimise the amount of exterior envelop exposed to the sun and reduce outdoor walking distance.*
  ii. *As found in a traditional souk or Arabic market, shaded and passively cooled circulation thoroughfares are characterised by dramatic light and social spaces.*
  iii. *The Arabic Bedouin tent inspired designers to create a monumental roof system that spans across the building masses to block sun on buildings facades and into the pedestrian spine, to facilitate natural ventilation and to filter light. Solar panels covering the surface capture the sun's energy.*
  iv. *Passive ventilation strategies of the traditional Arabia house influenced the design of iconic, solar-powered wind towers that harness energy from the sun and wind to passively create air flow in pedestrian walkways.*
  v. *Similar to Arabic screening called 'mashrabiya', the campus shades windows and skylights with an integral shading system that reduce heat load while creating dramatic dappled light.'*

  Another example of employing a range of passive along with active solutions is Masdar Institute. The Institute, which forms part of Masdar City known as the most sustainable city in the world, designed by Foster and Partners who emulate many of the local elements. According to Mitchell (2015, 41):

  > *'Buildings are arranged to create a series of narrow alleys and open plazas, one of which contains a large-scale wind tower with integrated mist generators to direct breezes down into open court... Masdar Institute buildings employ a number of passive measures, such as louvers and glass-reinforces concrete (GRC) screens to block direct solar radiation and allow airflow. Buildings rely on natural ventilation during cooler months – air enters into the ground floor and, as it is heated, rises and escapes through openings on the upper floor.'*

  University architects need to bear in mind the suitable campus layout and the placement of buildings. 'The campus layout of building sites should be designed to maximise daylighting and provide natural ventilation' (Dan + Ginger Kenney 2008, 45).
- **Campus density**. Density is one of the most important principles that support sustainability. It has a positive impact on infrastructure, mobility, land utilisation, operation, and safety on campus. It also enriches the sense of community on campus as well as stimulating collaboration and innovation through encouraging 'encounters between different users or user groups, aligning with organisational goals to work on cross-disciplinary products... increasing occupancy and frequency rates in combination with reducing the footprint per user' (Den Heijer 2011, 98).
- **Mixed use**. 'Sharing uses within a single building or district can reduce overall space

requirements, provide higher utilisation of multipurpose spaces and promote more efficient use of both buildings and infrastructure, reducing overall energy requirements' (Dan + Ginger Kenney 2008, 47).

- **Campus landscape**. Universities shall increase the use of appropriate local landscape plants and materials. Universities are supposed to conserve and protect native vegetation and wildlife habitats. Well-maintained campus landscapes provide great benefits to human and environment. On one hand, landscaping the campus can be regarded as an added value and hence acting as an attractive element for the institution. It enhances the experience of users, visitors, and surrounding communities. 'The sensory richness of colour, texture, and scale in the landscape contribute to its beauty, and is also a deeply satisfying experience in itself... The campus landscape can provide a laboratory for classes in biology, ecology, and related work' (Kenney et al. 2005, 145). On the other hand, 'trees are valuable assets on campus' (Ibid, 146). Trees on campus provide both environmental and economic benefits. For example, in summers, trees can provide much needed shade for buildings and hence decrease the heating load. In winters, however, trees can be used as windbreaks, which then cut the heating bills (Ibid).

8.3. **Building design**. The following aspects are recommended to be implemented:

- **Size the building appropriately**. A building that is larger than necessary to serve its function will create costly and wasteful energy demand. The size of the university campus and college buildings in terms of square meter per user has to be addressed. University's architects and planners are advised to minimise the overall size of buildings, given that efficient use of space reduces the overall resource consumption. This will increase the campus density and hence not only minimise the environmental impacts, but also maximise efficient use of energy, water, transportation, site, and materials.
- **Building orientation**. The orientation of the campus buildings can save substantial amount of energy through using the facility's orientation and appropriate shades, windows, and vents to take advantage of natural ventilation, solar energy, and daylight. University's architects and planners are required to orient developments in response to the local climate. Dan + Ginger Kenney (2008, 45) point out that 'optimising the overall building siting, spacing and massing, and to orient buildings for energy efficiency costs nothing.' Kenney et al. (2005, 162) have highlighted the importance of 'solar orientation, wind patterns, and topography'. They argue that 'given a particular climate and topography, proper building orientation can provide significant lifecycle savings, cutting operating costs by up to 60 percent.'
- **Increase energy efficiency**. Universities need to invest in green strategies to increase energy efficiency. University of South Florida (USF) employ a number of initiatives such as Green Lights Program, Motion Sensors, Energy Monitoring, Environmental Control, Building Optimisation, Solar Efficiency Roofs, High Efficiency Chillers, Boiler Efficiency, and Underground Utilities (USF Facilities Management 2017).
- **Adopt green building principles**. Universities are recommended to adopt green building principles highlighted in the guidelines of systems such as Building Research Establishment Environmental Assessment Method (BREEAM) and Leadership in Energy and Environmental Design (LEED). These systems, among others, help universities to green their campuses through assessing, rating, and certifying the sustainability of institution's buildings.
- **Address the issues of occupants' well-being and comfort**. Universities could address the issues of occupants' well-being and comfort through the use of daylighting, operable windows, temperature and ventilation controls, and appropriate acoustic surfaces.
- **Reuse of existing facilities**. From a sustainability point of view, 'reusing an existing building is often better than tearing it down and building a new one' (Dan + Ginger Kenney 2008, 45).

8.4. **Energy and carbon emissions**. The following strategies can be employed to address energy consumption and carbon footprint in university campuses:

- **Inventory current energy consumption and carbon-dioxide emissions**. The first step is to undertake this inventory so that it can be used as 'a baseline against which improvements can be measured' (Dan + Ginger Kenney 2008, 49).
- **Develop goals to achieve the targeted reductions**. Having known the current

	consumption and emission, universities 'can then develop goals based on their findings and a specific plan to achieve the targeted reductions' (Ibid, 50). • **Take other actions to reduce energy use**. This includes energy conservation and other techniques such as: 'using cleaner fuels, co-generation, groundwater heat pumps' (Ibid, 50). • **Invest more in renewables**. Universities are recommended to 'increase surface area dedicated to generating on-site renewable energy (wind, solar, biofuels, and other alternatives)' (ASU Master Plan 2011, 28). 8.5. **Water**. Given that water is one of the most important issues in the country, the following strategies need to be taking into consideration in order to manage water on university campus: • **Watershed land planning**. Universities in Saudi Arabia are advised to adopt such strategy to protect water from runoff. Other strategies include 'porous concrete or porous asphalt' which is recommended for pavements, parking, and also streets. • **Storm-water management**. Although rain-fall in the Kingdom is scarce, managing it can help universities utilising the rainwater in e.g. irrigation. • **Green roofs**. Green roofs can 'reduce energy costs and runoff and enhance habitat' (Dan + Ginger Kenney 2008, 48). • **Water reuse**. The use of building greywater can be of great benefit. Universities can 'utilise building greywater systems to reduce potable water needs for buildings and landscape' (ASU Master Plan 2011, 28). • **Capture and store rainwater**. Universities are required to make the effort to 'capture and store the rainwater for building and landscape uses' (ASU Master Plan 2011, 28). 8.6. **Materials and resources**. The following strategies can be explored in order to manage waste and resources: • **Sustainable purchasing policy**. Such a policy outlines the social and environmental conscious of the institution through their procuring practices. It means that the university preferably purchases i) from locals, ii) green goods, and iii) recycled materials. For example, Arizona State University has a policy, known as Sustainable Purchasing and Procurement, which 'means purchasing products and services that cause minimal adverse environmental impacts. It incorporates human health and environmental concerns into the search for high quality products and services at competitive prices' (ASU Resources 2017). • **Waste management**. Universities need to have a waste management in place, including solid, liquid, chemical, or biomedical. The Department of Facilities Management at the University of South Florida (USF), USA, has developed guidelines not only to deal with each type of waste, but also to minimise waste in general (USF Hazardous Waste 2017). On the other hand, Michigan State University, USA, has developed a technology that turns agricultural waste into food and energy (MSU 2017). • **Reuse instead of buying new facilities**. Re-purpose, renovate, and recycle existing campus amenities (such as machines, devices, computers parts, furniture, and other stuff). For example, the University of Sao Paulo (USP), Brazil, has established a Recycling Centre for electronic gadgets (desktop computers, laptops, screens, and telephone devices) with the purpose of either fixing these gadgets so that they can be used again or disassemble them and take advantages of their parts for other purposes. Although the USP plans to expand it in the future, this Centre serves only the campus community (students, faculty, and staff), for the time being.
Implementation time framework	Short-, medium-, and long-term implementation plans
Leading figure	University's project and facility managers and the university's planners and architects.

Policy code Policy name	

Aspects	Management				Engagement	Environmental/physical				
Code	1	2	3	4	5	6	7	8	9	10
Indicator	Vision	Strategy	Planning	Commitments	Attitude, Knowledge, Awareness, and Willingness to change	Location	Physical accessibility	Climate considerations	Flexibility	Space utilisation

<table>
<tr><td>Policy description</td><td>Flexibility in college buildings and university campuses</td></tr>
<tr><td>Programs</td><td>
This research has focused on only three properties of flexibility. That is in terms of time, building, and furniture. The set of actions to address flexibility are:
9.1. Flexibility in time. The following strategies can be employed by universities in order to improve flexibility in time:

Online education. Universities need to offer distance education or distance learning to both undergraduates and postgraduates.
Flexible work schedules. Universities are advised to allow for flexible work schedules for staff. This non-standard work can be found in many universities around the world. Universities should also introduce a condensed work week option for employees.
Remote work. Universities need to explore other alternatives to conventional arrangement of working options, known as tele-work, tele-commute, or work-from-home.

9.2. Physical Flexibility (Flexibility in buildings). Kuuskorpi & González (2011, 1) believe that tomorrow's physical learning environments are ‘flexible, modifiable, and sustainable while supporting the teaching and learning processes’. Fisher (2016, 10) confirms this indicating that ‘innovation and creativity so prized in the 21st-century economy thrives not in isolated, specialized spaces, but in open, flexible environments.’ The advantage of flexible environment is that it facilitates ‘interdisciplinary exchange and collaborative opportunities’, which ‘requires flexible teaching, learning, and student life spaces’ (Pieprz & Sheth 2017, 5). The following strategies can be used by universities in order to address physical flexibility:

Master plan and land use. In their master plan and land use, universities need to allow for secondary uses that ‘may arise through unforeseen program expansion and/or funding opportunity’ (USF Tampa Campus Master Plan 2015, 65).
Building design for future use. Universities may plan and design for serving not only the current use, but also for future use. Arizona State University has a policy to plan for ‘100-year building’ through flexibility of use and reuse now and in the future (ASU Master Plan 2011). Kenney et al. (2005, 163) have pointed out that ‘a sustainable approach follows several principles that also contribute to creating memorable buildings and spaces:
- Build for the long term while maximise building flexibility for reuse
- Reduce maintenance requirements
- Strive to minimise the full life-cycle costs of the materials used
- Use materials with low environmental impact.’
Flexible spaces and furniture can serve a variety of teaching and learning practices. For example, the Instituto Tecnológico de Monterrey (Institute Tec), one of the Mexico’s largest private universities, has planned for multipurpose space, in which it is ‘designed with flexible bleachers and movable furniture that allow varied activities to take place—lectures, student presentations, end-of-semester student exhibits, student group activities, and so on’ (Pieprz & Sheth 2017, 14).
Interior design. University architects need to design the interior spaces of buildings that are flexible and allow for changes in uses through for example moving walls, operable partitions, and modular raised flooring.
Minimise customisation. University architects are advised to minimise the use of custom millwork building materials, elements, and systems (door frames, doors, windows...etc.) to allow maximum reuse in the future.

9.3. Flexibility in furniture. The following strategies can be employed by universities in
</td></tr>
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	order to enhance flexibility in furniture: • **Standardise furniture**. Universities need to consider standardising furniture wherever possible. • **Mobile furniture**. Universities are recommended to minimise fixed furniture and provide easily movable furniture to allow maximum flexibility, support posture, and promote students' interaction. Seats and tables could be movable to support various learning and teaching styles.
Implementation time framework	Short-, medium-, and long-term implementation plans
Leading figure	University's project and facility managers and the university's planners and architects.

Policy code
Policy name

Aspects	Management				Engagement	Environmental/physical				
Code	1	2	3	4	5	6	7	8	9	10
Indicator	Vision	Strategy	Planning	Commitments	Attitude, Knowledge, Awareness, and Willingness to change	Location	Physical accessibility	Climate considerations	Flexibility	Space utilisation

Policy description	Space utilisation in college buildings and university campuses
Programs	The set of actions are: 10.1. Higher education institutions invest heavily in their physical plant. The latter is considered to be one of the most expensive assets. One key aspect of planning is managing space provision and space utilisation. This cannot be managed unless both supply side and demand side are addressed (De Jonge et al. 2009). The demand side is concerned with the existing student body as well as with the projected capacity. Generally speaking, universities accommodate certain segment of society aged, mainly between 18 and 24 years. This research has found that the youth population projections in Saudi Arabia might have a huge drop after the year 2035. Therefore, **universities need to adopt a proactive approach in planning their facilities and hence measure what they have now in terms of square meters and what they should have in the future**; taking into account i) the projections of youth population, ii) student enrolment plans, and iii) the expected rates of admission. This is because of the fact that a reactive approach usually results in extreme, rushing, and an expensive outcome, and is consequently unsustainable. 10.2. In order to avoid over-provision of space in colleges and universities in Saudi Arabia, space management is urgently needed to address this issue. Such management would effectively and efficiently control the supply and demand of space in all public institutions, saving energy and money. To do so, there are two steps to be taken: First, **a regulatory body that manages space in campuses at the national level has to be established**. Second, **space management tool is needed to audit and therefore manage space**. The tool highlights important information to be collected in order to develop baseline data to help the decision-making process for space provision and utilisation. 10.3. Universities can estimate the on-campus FTE student body in short-term as well as long-term and act accordingly. **The growth in the numbers of students must not lead to an increase in the provision of space (m2)**. In order to address this issue, there are many strategies to explore. Better space management through optimal utilisation, high quality of spaces, multi-functional spaces, distance learning, to name just a few. 10.4. Having more space (m2) is on its own unsustainable; regardless of how sustainable the space is or how efficiently operated and maintained, because in any case it is yet increasing the carbon footprint. **Universities need to be aware of the fact that the most sustainable campus or building is the one that never built** (Haggans 2016). 10.5. **In order to improve the utilisation of university buildings, institutions need to promote mixed use spaces**. 'Sharing uses within a single building or district can reduce overall space requirements, provide higher utilisation of multipurpose spaces and promote more efficient use of both buildings and infrastructure, reducing overall energy

	requirements' (Dan + Ginger Kenney 2008, 47). 10.6. This research has shown that late-afternoon or evening sessions are not popular option with students, faculty members, or staff in public universities in Saudi Arabia. However, **in order to promote higher utilisation of spaces in college buildings, universities can offer incentives**. For example, University of Oregon, USA, has offered students 'a tuition discount for late-afternoon classes' instead of classes during the core hours (Kenney et al. 2005, 157). 10.7. This research has found that the existing stock of premises is not utilised as they should be. The overall utilisation rate was 22%, which is astonishingly low given that this result was based on i) analysing the 150 busiest rooms in five college buildings and ii) analysing the planned utilisation (timetable). Had this study measured how space is actually being used (the real-time use), the space utilisation rate would have been even lower, since the difference between the predicted and surveyed rates is 15% (SMG 2006, 10). Furthermore, the low overall utilisation rate was confirmed by the result of the questionnaire in which the 1,290 participants indicated that 65% of teaching rooms in the five college buildings were half filled or have plenty of seats available. In order to optimise the utilisation of spaces, the following strategies can be employed (Sharma 1991, 04): • **'Increasing after hour's space usage.** • **Annual review of space utilisation.** • **Promoting off-campus studies.** • **Analysing request for specialist space in terms of the department's utilisation of existing space and rejecting requests where low usages of similar facilities exist.** • **Retaining central control of general purpose teaching spaces.** • **Spreading classes as evenly as possible throughout the week.** • **Consolidating of small classes.** • **Encouraging students to use under-utilised teaching spaces for private study during times when the rooms are vacant.** • **Encouraging extracurricular community activities on campus.** • **Spreading load to evening sessions for part-time students.** • **Conversion of specialised space which is under-utilised to other space types which are in demand.'**
Implementation time framework	Short-, medium-, and long-term implementation plans
Leading figure	University's project and facility managers and the university's planners/architects and students.

6.4.5. Implementation of the planning guidelines

Universities are expected not only to 'talk the talk', but also to 'walk the walk'. They have to 'practice what they preach'. This section presents how implementations can be executed. There are steps to be taken in order to implement these planning guidelines, which ultimately aim to help universities in their journey to pursue sustainability. The implementation steps have been constructed after reviewing the following approaches:

- International Alliance of Research University (IARU 2014) (9 steps),
- Arizona State University (ASU Sustainability Plan 2011) (5 steps),
- U.S. Green Building Council (USGBC 2010) (10 steps),
- University of South Florida (USF Sustainability Initiative Report 2009) (13 steps), and
- Harvard Green Campus Initiative (Harvard University 2006) (7 steps).

The above mentioned institutions are either universities (ASU, USF, and Harvard) or organisations related to higher education and/or sustainable development (IARU and USGBC). Table 6.3 sums up the main steps recommended by these institutions in order to advance sustainability aspects, practices, and operations in higher education institutions and their campuses. These steps can be categorised into the following overarching sustainability areas, as mentioned in Alghamdi et al. (2017):

- Academia (curriculum, research, educate, train...etc.).
- Management (leadership, commitment, institutionalise sustainability, determination, finance, organisation, procurement, purchasing, communication, establish matrices baseline, documentation, prioritisation, chart the course, plans, measurement, reporting, promote, reassess...etc.).
- Environment (greenhouse gas emissions, projects, design and construction of green buildings, operations, labs, water, energy, transportation, recycling and waste management...etc.).
- Engagement (students, faculty members, employees, campus community, media, promotion, alumni, surrounding communities...etc.).
- Innovation (universities as catalyst for a sustainable society, the campus as a living lab...etc.).

Table 6.3: Common steps to advance sustainability aspects in university campuses

IARU (2014)	ASU (2011)	USGBC (2010)	USF (2009)	Harvard (2006)
1. Sustainable campus organisation. 2. Campus-wide operations. 3. Buildings. 4. Laboratories. 5. Green purchasing. 6. Transport. 7. Communication 8. Employee and student. engagement 9. Universities as catalyst for a sustainable society.	1. Determine components. 2. Establish matrices baseline. 3. Prioritise components. 4. Create projects. 5. Measure and report changes annually.	1. Commit to a green campus. 2. Examine and document existing activities. 3. Chart the course. 4. Plan. 5. Educate and train. 6. Design and construct green buildings. 7. Operate and maintain green buildings. 8. Engage the campus community. 9. Use the campus as a living lab. 10. Report, promote, and reassess.	1. Curriculum. 2. Research. 3. Finance. 4. Procurement. 5. Recycling and waste management. 6. Greenhouse gas emissions. 7. Transportation. 8. Water. 9. Energy. 10. Green Building 11. Students. 12. Media and promotion. 13. Alumni and community.	1. Leadership from the top. 2. Planning at the campus level. 3. Take advantage of low- or no-cost opportunities. 4. Accomplish multiple objectives with each project. 5. Integrate physical resources with curriculum. 6. Institutionalise sustainability. 7. Create and work within a sustainable development plan.

The hierarchy of implementing the proposed planning guidelines has taken into consideration the capacity's variation between universities. Each and every university is different and faces various challenges including social, cultural, behavioural, financial, organisational, physical, and operational. Universities have different capacities, traditions, and conditions. The following indicators (variables) can play an essential role in the hierarchy of implementing processes in each university:

- Types of institution (public or private)
- Locations (rural, suburban, or urban)
- Campus (single or multiple)
- Kinds of climate (tropical, subtropical, moderate, desert...etc.)
- Growth of university enrolment
- Age of facilities and infrastructure

Therefore, how, when, and by whom these steps can be implemented will certainly be varied from one institution to another. For that reason, as well as the fact that the vast majority of public universities in Saudi Arabia are still at an early stage of planning and implementing sustainability policies and practices, the following 6-step approach to sustainability is important for all higher education institution in the Kingdom and elsewhere.

With this in mind, figure 6.1 shows the proposed six steps to approach sustainability in university campuses comprehensively. These steps are designed for universities at an early stage of planning and implementing sustainability. However, other advanced universities in implementing sustainability can also benefit from such steps. The six steps are as follows:

1. **Commit**: It is recommended for universities to commit to institutionalising sustainability through showing leadership in approaching sustainability holistically in the university and its campus.
2. **Evaluate**: It is recommended for universities to start by assessing the existing sustainability initiatives and programs. They could also document these practices and operations for the purpose of further improvement. This can be undertaken using a metrics baseline, which acts as a baseline measurement to evaluate the progress made since the start of improvement.
3. **Plan**: It is recommended for universities to approach sustainability comprehensively. This means addressing all aspects of sustainability in the university: academia, management, environment, engagement, and innovation. Planning would be of great impact if policies are in place with clear and achievable targets.
4. **Implement**: It is recommended for universities to implement their sustainability plan. To do so, there could be a set of actions taken by each stakeholder. Taking responsibility and showing accountability would be important in order to implement sustainability practices and operations.
5. **Track**: It is recommended for universities to track their progress in advancing and implementing sustainability initiatives and programs. Assessment tools can be of great help in undertaking such steps. Reporting the progress is also important and it can be undertaken on a regular basis for a comparison reason, among others.
6. **Review**: It is recommended for universities to revise and reassess their sustainability policies, plans, programs, and initiatives periodically. To do so, representative stakeholders along with internal and external experts could be involved in the process of reassessment and improvement.

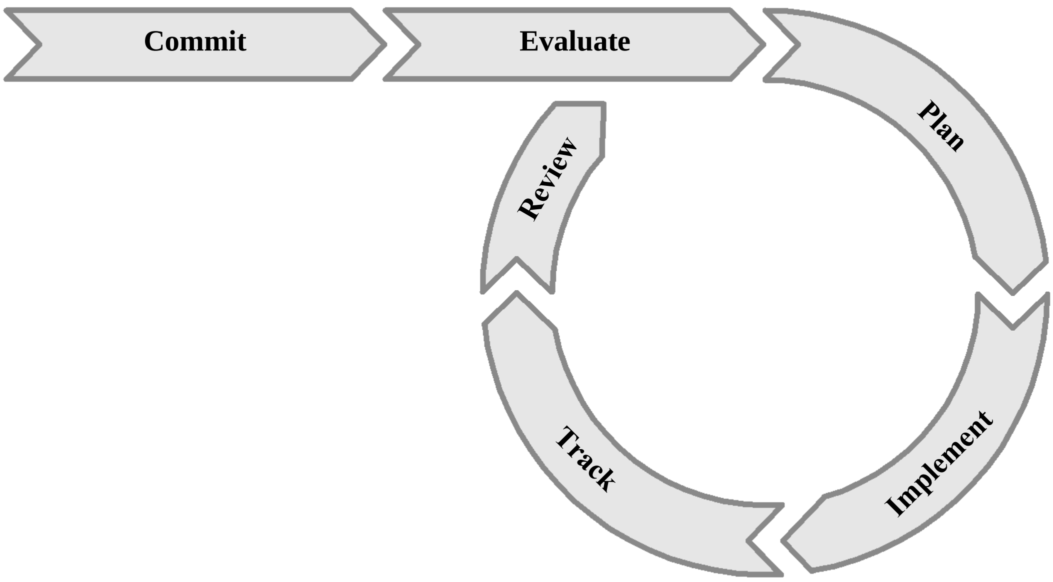

Figure 6.1: The 6-step comprehensive approach to sustainable university campus

The proposed implementation of the planning guidelines can be undertaken within short-, to medium-, or long- term time horizon. There are a number of categorisations for the period of each term, as can be shown below:

- **Category 1**: short-term (1-5 years), medium-term (5-10 years), and long-term (10-15 years and onwards) (ERYC 2016, 5).
- **Category 2**: short-term (1-2 years), medium-term (3-5 years), and long-term (6-10 years) (Jittrapirom & Jaensirisak 2017, 3988).
- **Category 3**: short-term (1 year), medium-term (1-5 years), and long-term (5-15 years) (University of Michigan 2010, 56) (University of California 2008, 7).

This research adopts the latter time frame, namely short-term (1 year), medium-term (1-5 years), and long-term (5-15 years), which was used by University of Michigan and University of California, U.S. Two reasons justify such selection:

- First, the timeframe implemented in these two universities has been used in their sustainability plans.
- Second, is because of the urgent need for implementation of sustainability practices and operations, particularly in universities that are still in an early stage.

Table 6.4 presents the step-by-step planning guidelines to green higher education institutions in Saudi Arabia and elsewhere. The table shows each step along with some of its bold actions. These actions would, preferably, be implemented in the short-term and medium-term time horizons. However, the time framework of some policies may take longer than others, given their requirements. Therefore, the suggested order of executing these strategies, practices, and operations is as follows:

Table 6.4: Proposed steps and actions to advance sustainability aspects in university campuses

Steps	Some bold actions to be implemented	Time
No. 1 Commit	● Show leadership in institutionalising sustainability in the university ● Establish Office of Sustainability (assemble a team; representatives and experts) ● Identify and involve stakeholders (students, faculty and staff members) ● Declare a sustainability commitment ● Sign sustainability declarations/charters/treaties/agreements	Short-term
No. 2 Evaluate	● Identify existing sustainability initiatives, policies, and schemes ● Use a metrics baseline acting as a measurement to evaluate the progress to be made ● Gather data, analyse, and document current sustainability practices and operations ● Define existing personnel capability ● Identify funding sources	Short-term
No. 3 Plan	● Systematically plan for sustainability (well begun is half done) ● Place sustainability knowledge and awareness top of the agenda (make it a priority) ● Formulate a clear and achievable vision for sustainability ● Establish sustainability goals (e.g. climate neutrality target) ● Mainstream sustainability in campus planning (e.g. Campus Master Plan) ● Create sustainability knowledge and awareness among students and staff ● Match the supply and demand for space (m2) ● Increase campus density and diversity to make it liveable and dynamic ● Design buildings using green principles (e.g. BREEAM and LEED) to address issues such as energy, water, waste, transport, flexibility, utilisation, occupants' well-being and comfort	Short-term and Medium-term
No. 4 Implement (living lab)	● Assess students' sustainability knowledge and awareness periodically ● Integrate sustainability into the university curriculums ● Offer under- and post-graduate degrees in sustainability ● Train university faculty members in sustainability practices ● Outline roles, responsibilities, and accountability procedures of stakeholders ● Form partnerships to address sustainability challenges (e.g. technical issues) ● Join sustainability networks to learn and share experience and knowledge ● Attend/hold sustainability conferences to highlight latest developments ● Establish fund to support sustainability initiatives and practices ● Publicise sustainability news, and events through appropriate communication channels ● Introduce incentives and rewards to promote sustainability practices and operations ● Integrate teaching, learning, and research with campus planning and operations ● Operate and maintain facilities using green building principles (e.g. BREEAM and LEED) to address issues such as energy, water, waste, transport...etc. ● Mobilise campus as a living lab (use campus facilities and infrastructure as a lab)	Short-term, Medium-term, and Long-term
No. 5 Track	● Utilise sustainability assessment tools to evaluate progress ● Use the assessment tools as a broad guide to achieve sustainability ● Prepare sustainability progress reports ● Compare university sustainability progress with national and international benchmarks	Short-, Medium- and Long-term
No. 6 Review	● Re-assess and revise sustainability policies, plans, programs, and initiatives ● Engage stakeholders and in-house specialists in the process of revision ● Involve external partners to gain important insights ● Re-orient towards a more sustainable approach ● Celebrate achievement (reward involved parties to keep them committed)	Short-, Medium- and Long-term

Higher education institutions in Saudi Arabia and elsewhere can be helped to implement their sustainability plan and achieve their sustainability goals by other related national or international organisations. To help implement green campus policies and practices, there is a need to consult other key organisations for more guidance and support. For example, in the United States, there are a number of organisations that assist universities including:

- American College and University Presidents' Climate Commitment (ACUPCC)
- Association for the Advancement of Sustainability in Higher Education (AASHE)

- Association of Higher Education Facilities Officers (APPA)
- National Association of College and University Business Officers (NACUBO)
- Society for College and University Planning (SCUP)

In the United Kingdom, there are many organisations to which British colleges and universities can refer in order to be assisted in managing their universities and campuses sustainably, such as:
- Environmental Association for Universities and Colleges (EAUC)
- Association of University Administrators (AUA)
- Association of University Directors of Estates (AUDE)
- British Association of Cleaning in Higher Education (BACHE)
- University and College Union (UCU)
- Higher Education Funding Council for England (HEFCE)

Other organisations from different parts of the world that provide technical and organisational sustainability support to colleges and universities in their own countries and beyond including, but not limited to:
- Australasian Campuses Towards Sustainability (ACTS)
- Campus Sustainability Network in Japan (CAS-Net JAPAN)
- China Green University Network (CGUN)
- International Green Campus Alliance (IGCA)
- International Sustainable Campus Network (ISCN)
- Nordic Sustainable Campus Network (NSCN)

Higher education institutions can be also helped by the existing green building councils and the rating systems. The International Facility Management Association (IFMA Foundation 2015, 14) and its Sustainability Committee (ISC) have highlighted some of the most widely used green rating systems in the world as follows:
- Building Research Establishment Environmental Assessment Method (BREEAM was established in 1990, United Kingdom)
- Leadership in Energy and Environmental Design (LEED was established in 1998, United States of America)
- Green Globes (established in 2000, Canada)
- Indian Green Building Council (2001, India)
- Green Star (established in 2002, Australia)
- Green Building Certification System (GBCS was established in 2002)
- Green Mark (established in 2005, Singapore)
- 3-Star (established in 2006, China)
- German Sustainable Building Certificate (established in 2008, Germany)

Saudi Arabia’s public as well as private universities can be also helped by the Saudi Ministry of Education in planning and implementing their sustainability vision. The Saudi Ministry of Education (especially Higher Education Division) is advised, therefore, to take into account the following recommendations:
- The Ministry (specifically the Ministry’s Agency of Planning and Information) should be monitoring and analysing the trend in the numbers of high school students and also reporting to the public universities to ensure proper planning for future facilities needed regarding college buildings, housing, and other supporting facilities. This can be done using the national census data. The Ministry should make short-, medium-, and long-

term enrolment projections for both the province level and the national level. These projections should be taken into account when planning for campus facilities, especially in public universities. There are many factors that might play a great role in changing the conservative projections of enrolment including mortality rate, social or economic conditions, and less interest in higher education (Dober 1963).

- Based on the United Nations projections for the Saudi youth population, this research shows that there might be an increase in the number of students until the year 2035. In this scenario of a sharp rise in the demand for higher education, the Ministry (as an organisation responsible for higher education system and infrastructure) should plan for better management of the system and its infrastructure. The Ministry might explore other alternatives such as expanding the existing overseas scholarship program. This is to avoid increasing space provision in public university campuses, given that the projections also indicate a noticeable fall in the youth population in the Kingdom. In case of a decline in the number of students, the Ministry should facilitate attracting international students through supporting scholarship programs and education grants. Such planning is known as 'scenario planning'. De Puy & Van der Schaaf (2007, 89) highlighted the benefits of scenario planning as:

  > *'... anticipating and preparing for the uncertain future... can create a better understanding of the organisation's present situation. By thinking about the future, an organisation can formulate targets, which can be used to guide today's decisions... can be used to analyse the implications of possible future events... scenario planning functions as an important learning tool'.*

- Plan accurately for the proportions of admission for each university so that universities can be well prepared, given that each university has a certain capacity of admission, and exceeding such capacity leads to a stretch of resources and low level of satisfaction, productivity...etc.
- This research has assessed and analysed the space provision and space utilisation in some public universities in Saudi Arabia. It found that space in some campuses is not managed as it should be. Facilities were surprisingly under-utilised and yet more college buildings are planned to be constructed in the near future. As a result, this research has offered two important measures to be taken urgently in order to manage space effectively and efficiently. The first is to establish a national regulatory body (maybe named as Centre for Campus Management) which can not only control the supply and demand of space in all public institutions, and hence saving energy and money, but also monitor the utilisation of higher education facilities. Such national regulatory body exists in many countries such as Tertiary Education Commission in Australia. The second step is that this research offers a tool named Space Management Tool (see appendix E), which universities in Saudi Arabia and elsewhere can use for managing space provision (Alghamdi 2018).
- The Ministry of Education is advised to involve other government ministries and agencies to help raise sustainability knowledge and awareness. For example, the Ministry of Culture and Information (MCI) has a key role using the media in order to raise awareness and inform the public. The youth segment in particular, forms one-third of the population of Saudi Arabia. This precious segment of society can be mobilised for the good of the country, climate, economy, and beyond. To do so, the MCI can target the youth with many campaigns to promote more sustainable practices and operations. What helps in doing so is the popularity of social media sites and applications in the Kingdom.

As for the real execution of the proposed planning guidelines by the Saudi public universities and the Ministry, the implementation is likely to be faced with many challenges and 'encounter considerable entrenched opposition' (Tolley 1996, 216). This can be considered as 'a normal part of the process of change' (Balsas 2003, 46). Swift change is not anticipated, given the fact that 'the extent of what is possible and realistic will change over time as costs rise, technology changes, and awareness and understanding increase' (Creighton 1998, 289).

6.5. The business case for sustainable university campus

> *'The real challenge lies in convincing university management to invest in more sustainable buildings which reduce long term costs. It is important to understand and effectively communicate the benefits, which include greater resources efficiency and associated cost savings, as well as better health and productivity for employees and students.'*
>
> International Alliance of Research University (IARU 2014, 37)

There are many ways to convince university management to be committed to sustainability, one of which is to present facts and figures about the advantages of becoming more sustainable. Therefore, this section presents the benefits of sustainable university campus beyond climate. It demonstrates the impacts of sustainable practices and operations on:

- Stakeholders (e.g. students, faculty members, staff),
- Institutions (e.g. competitive advantage, resources efficiency, cost-effective, productivity, comfort, satisfaction, health, well-being, funding opportunities), and
- Community (e.g. public relations, partnerships).

6.5.1. Stakeholders

Sustainability education has become of great importance in order to prepare students for the future. More and more employers underline the sustainability competencies required, given the fact that sustainability has become vitally significant to the strategy of governments, businesses, and societies (Thomas & Depasquale 2016; The Higher Education Academy 2015; Hanning et al. 2012). 'The jobs of the future are sustainability jobs... the fastest growing segments of many industries are sustainability-oriented (e.g., renewable energy, organic agriculture, green buildings and electric vehicles)' (AASHE 2017, 3). Faculty members and university staff, on the other hand, 'are found to be critical leaders in efforts to achieve lasting progress towards campus sustainability' (Brinkhurst et al. 2011, 338). Higher education institutions and other organisations and corporations (both public and private) have started to recruit sustainability specialists. Many colleges and universities 'include sustainability specific responsibilities in job descriptions' (USGBC 2010, 48).

6.5.2. Higher Education Institutions

Higher education institutions continue to invest in their facilities and infrastructure, even 'Open University' or 'Electronic University'. Planning, designing, constructing, operating, maintaining, renovating or replacing facilities, infrastructure, and landscape are well under way practicing in each and every university campus. Robinson (2016, 115) believes that the 'main driver is competition'. He argues that 'having well-designed and maintained buildings is going to be a key driver for all universities; but how much value should be given to these aspects, in relation to the other contributors of a positive student experience?' The Commission for Architecture and the Built Environment in the UK (CABE 2005, 43) has found that teaching facilities and support facilities influence the performance of students and staff. CABE also found that the quality of the university campus is also impacting on the performance of students (81%) and staff (64%). Furthermore, according to recent study by the

Association of University Directors of Estates in the UK (AUDE), UK students ordered the most significant factors in selecting a university as following: type of course (79%), location of the institution (69%), quality of facilities (67%), reputation of the institution (47%), and students' union (18%) (Elmes 2015; Robinson 2016, 116). These figures clearly show the importance of a university's buildings and campuses in attracting students, faculty and staff members. Such investment can be regarded as an added value not only to the institution, but also to the country's economy. Warren Buffett, an American business magnate and investor, once said 'Price is what you pay. Value is what you get'.

Institutions with green buildings and sustainable campuses are placed in a favourable or superior business position. This is one of the competitive advantages that can be used as a 'winning card', since it increases the value of the real estates of universities in the market. For example, research has shown how LEED-certified buildings (in campus and elsewhere) can be of marketing benefit to the institutions. In their research, Matisoff et al. (2014, 2001) show the 'importance of the marketing based benefits that accrue to Leadership in Energy and Environmental Design (LEED) buildings due to green signalling mechanisms, specifically related to the certification itself.'

As for the resources efficiency and cost-effective, McGraw Hill Construction (2012) has highlighted some of the main benefits of green buildings. Table 6.5 shows some of the benefits of green buildings in terms of operation cost, building value, asset value, and the payback time. According to McGraw Hill Construction (2012, 2), green building can decrease the operation costs in new building by 8% and by 9% in green retrofit building. The value of green new building increases by 7%, while it increases in green retrofit building by 5%. The payback time for green investment in new green building can be within 8 years, whereas it takes 7 years in green retrofit building.

Table 6.5: Some benefits of green buildings (Adapted from McGraw Hill Construction 2012, 2)

Benefit	New green building	Green retrofit response
Decreased Operating Costs Over One Year	8%	9%
Decreased Operating Costs Over Five Years	15%	13%
Increased Building Value for Green versus Non-Green Projects (According to AEC Firms)	7%	5%
Increased Asset Value for Green versus Non-Green Projects (According to Owners)	5%	4%
Payback Time for Green Investments	8 Years	7 Years

With regards to productivity, comfort, and satisfaction, it can be said that research has shown that there is a correlation between how sustainable and green the institution is and the productivity of its users. Magali & Pekovic (2013, 245) argue that labour productivity in green buildings is higher than conventional ones with 16%. They add that 'greener firms are associated with higher labour productivity' (Ibid, 264). It has been also argued that comfort and satisfaction of occupants can be impacted positively by 'environmentally friendly' buildings. Certified green buildings are associated with higher comfort and the overall satisfaction of employees in their workplaces (Thatcher & Milner 2014; Kim et al. 2015).

Green buildings are planned to have fewer negative impacts on the environment as well as on users' health and well-being. Researchers have shown that there is a relation between green facilities and health and the well-being of occupants. For example, MacNaughton et al. (2016, 138) show with some objective measurements of health the fact that green buildings do indeed improve the health and the well-being of occupants. Their analysis and results 'suggest that occupant health in green and conventional buildings is driven by both environmental perceptions and physiological pathways.' Other sources have also indicated a noticeable reduction in reported symptoms of health in green buildings compared to conventional ones (Colton et al. 2014; Singh et al. 2010).

As for attracting fund opportunities, sustainability initiatives are a powerful promotor for potential donations. There is no doubt that 'the work to fund and advance more sustainable colleges and universities has never been easy and it is a journey without end' (Joseph 2013, 27), and therefore, there is a need for 'whole-system approach to the conservation, alignment and development of resources in support of more sustainable institutions' (Ibid, 4). 'Grants programs' and 'targeted gifts' are among several innovative financing mechanisms (USGBC 2010, 38). For example, Catawba College, a private college in North Carolina, United States, has installed campus-wide solar energy panels on 'eight buildings and a parking lot canopy' (Sundance Power 2016). It is believed that a 'significant part of this project was funded by donations'... and 'a group of investors that includes board members, alumni, and community leaders that helped make this project feasible' (Ibid). Similar funding approach has been used in countless numbers of colleges and universities around the world.

6.5.3. Community

Communities can greatly benefit from sustainability initiatives, practices, and operations undertaken by their colleges and universities. Sustainability can improve the 'town-gown' relations by enhancing and supporting the community's environmental goals through collaborations and partnerships. For example, the City of Vancouver and the University of British Columbia (UBC) have a sustainability partnership named Greenest City Scholars, in which 'UBC graduate students work on projects at the City that help to advance sustainability targets' (Munro et al. 2016, 812). Hope (2016, 807) argues that higher education institutions have the capacity to stimulate and strengthen sustainability aspects in cities in a number of ways:

> *'through their function as educators providing the skills and knowledge necessary for the design, construction and management of sustainable cities; through their research roles generating new knowledge for sustainable cities and codifying existing strategies and disseminating case studies; and through their participation in the governance of societies assisting in nurturing and developing links between different community stakeholders.'*

Overall, the Association for the Advancement of Sustainability in Higher Education (AASHE 2017, 3) has briefly shown why 'sustainability is not just the right thing to do, it is also smart business.' The World Green Building Council (WGBC 2013, 94) has succinctly presented what green building 'can deliver in terms of design and construction costs, asset value, operational cost minimisation, productivity and risk mitigation.' The following points highlight the advantage gained from implementing sustainability in colleges and universities (AASHE 2017, 3):

- 'Sustainability education prepares students for career success and responsible citizenship.
- Sustainability improves organisational efficiency, decreases operational costs and reduces risk.
- Sustainability catalyses increased giving and new funding sources.
- Sustainability helps attract, retain and motivate top students and employees.
- Sustainability strengthens community relations and facilitates new partnerships.

- Sustainability research and education demonstrates relevance in addressing grand challenges and helps unify the campus around a shared sense of purpose.'

6.5.4. The cost of doing nothing

In theory, change is easy. In practice, however, it may take years (if not decades) to effect. Johnson (2012) believes that 'most people usually associate costs with doing something... but actually, the highest costs come from doing nothing.' This argument can be applicable in the case of climate change and how to deal with it. Given their key roles in societies, higher education institutions should lead the way in handling the daunting task of climate change mitigation and resilience, since doing nothing is not an option. Cortese (2003, 19) asks 'If higher education does not lead the sustainability effort in society, who will?' Ways to handle this task can be through promoting, advancing, and implementing sustainability through all possible mediums in universities (e.g. education, outreach, and operations). The point is what better place to start than the university campus. Many universities across the world - who show advanced leadership in sustainability, climate change mitigation and resilience - are currently using their campuses as living laboratories. This means that universities integrate teaching, learning, research, campus planning and operation, and outreach into living lab for sustainability (König 2013).

The research acknowledges the fact that 'no pain, no gain'. Colleges and universities have a long journey to pursue sustainability; in practices and operations. There are obstacles (e.g. organisational or technical difficulties) with side-effects that universities have to deal with. Sustainability may come at a cost and universities should do whatever it takes to ensure balancing the equation. For example, sharing workplaces or labs might be seen by users (students and/or staff) as limiting their academic freedom or restricting their choice. On the other hand, from a facility management point of view, there are higher operation costs for providing oversupply of facilities and services. This could be addressed, to a large extent, by managing the mismatch between the supply and demand of space or facilities (De Jonge et al. 2009). Users should be engaged so that they are aware of the fact that there are bills to be paid. Such an approach can balance the operation and maintenance costs and the level of user satisfaction.

Another interesting point to debate is the cost, especially when communicating with decision makers at the universities about new sustainability initiatives or projects. In general, research has shown that indeed there are extra up-front costs involved in constructing green buildings (WGBC 2013). However, some argue that green buildings may cost the same or even less than conventional buildings. Gómez (2008, 5) believes that 'many beneficial features have little or no additional capital cost but deliver benefits in use, hence it is a myth that a more sustainable building will always cost a lot more to develop than a traditional one.' Besides, there is a gap in perception of actual and estimated costs of constructing green buildings. Figure 6.2 shows that the actual cost premiums for green buildings can be up to 12.5%, whereas the estimated cost premiums are projected to be up to almost 30%. In this figure, the actual cost premiums have been reported from various sources and 'taken from a wide variety of building types, including offices, homes, schools, warehouses, banks, supermarkets, health centres, community facilities, academic buildings, and public buildings' (WGBC 2013, 26).

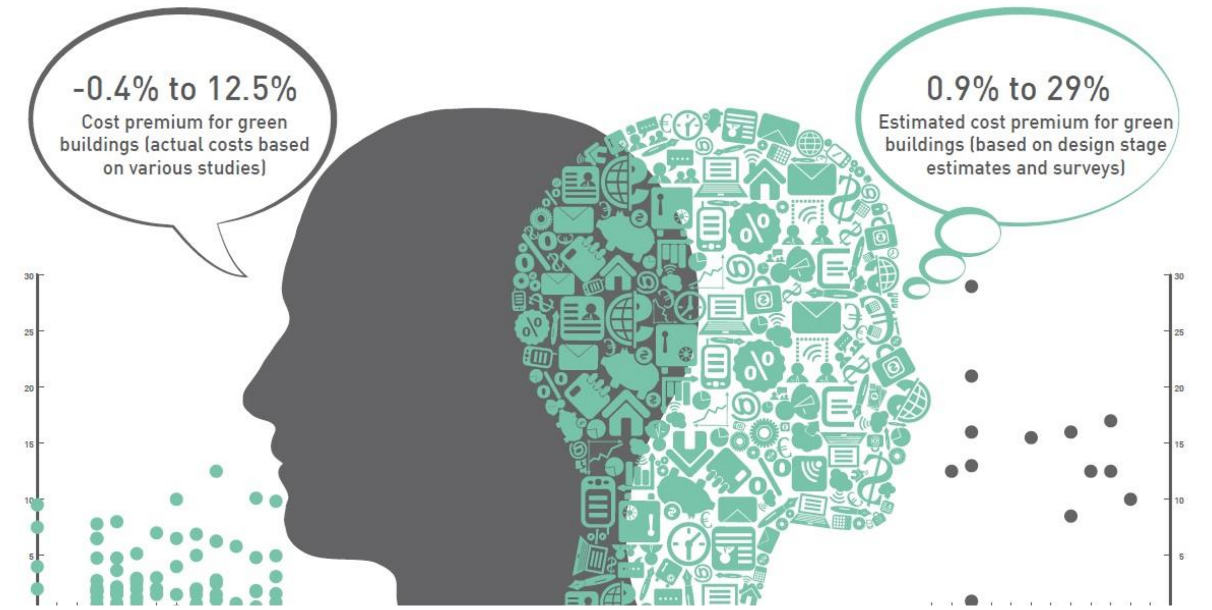

Figure 6.2: The perception gap between the estimated & actual cost of green buildings (WGBC 2013, 26)

Therefore, it is safe to conclude that sustainability might not be the major cost driver in the majority of green projects. The overwhelming challenge to meet is to plan, design, and 'deliver green buildings within conventional budgets' (WGBC 2013, 26).

Cost can be assessed throughout the building lifetime, known as building life-cycle cost analysis or 'cradle to grave' analysis. Cost analysis can be examined in four overarching stages. These stages can be grouped as follows:

- **Planning/Designing**. The main tasks in this phase are programming, designing, analysing, and documenting.
- **Constructing**. The main tasks in this phase are fabricating or manufacturing building components and erecting the building.
- **Operating and maintaining**. The main tasks in this phase are occupying, using, and maintaining the building.
- **Renovating or demolishing**. The main tasks in this phase are either refurbishing the building and upgrading its facilities or if that is not a feasible option, then demolishing the building (and recycling and reusing some of its elements) are regarded as the end of the building life.

The analysis of building life-cycle cost shows that overall, the cost of operation and maintenance accounts for almost two-thirds of the costs of the building life-cycle. This emphasises the importance of investing more at earlier stages of projects (planning, design, and construction) which leads to substantial saving in the long run. The consequence of such venture is a great return on investment in the medium- and long-term. Figure 6.3 illustrates the cost of the three stages of building life-cycle; design and construction, operation and maintenance, and end of life (either renovation or demolition). Hensel Phelps (2017), an 80-year old American construction company, states clearly that:

> *'Life-Cycle Cost Analysis is the key to saving money over the long term. Design and construction account for approximately 20 percent of the total cost of a building during its lifetime. The remaining 80 percent will be spent*

on operations and maintenance over the life of the facility. Too often, up-front cost savings sabotage long-term performance.'

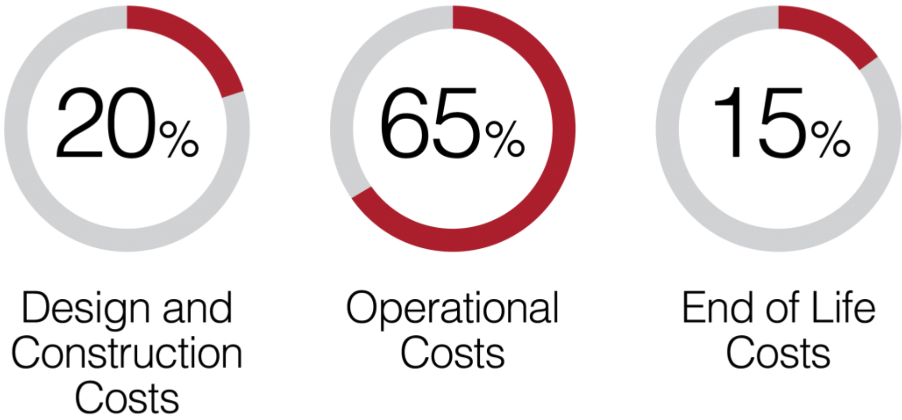

Figure 6.3: Building life-cycle cost analysis (Hensel Phelps 2017)

To conclude, the aim of this section was to highlight the significant benefits of going green in higher education institutions. Sustainable campuses can be advantageous to the institution as an organisation, its people, the community, and the environment. The section underlines the values gained from investing in sustainability and the perception gap between the estimated and actual cost premiums for green buildings. It also emphasises the real costs of not committing to sustainable practices especially at the early stages of the building. Sustainable university campus means green practices and operations with a great positive impact on people, planet, and profit.

6.6. Conclusions

The purposes of this chapter were not only to present the main research findings from investigating the sustainability aspects in university campuses in Saudi Arabia and United States, but also to ultimately propose an approach through which sustainability can be improved significantly in university campuses in the Kingdom and elsewhere.

This proposed approach emphasises the broad lines that are argued to be vitally important in order for the Saudi universities to become more sustainable. The main aim of the proposed planning guidelines was to be used as a road map towards sustainability in existing and future higher education institutions.

This chapter has shown how the planning guidelines were developed, revised, and articulated. The policies and their programs (set of actions) were presented in a way in which they can be easily comprehended. That is through showing the policies, actions to be taken, actors responsible, and timespan for implementation. Introducing the policies was followed by implementation plan, so that every university can be helped through deciding what steps to take first.

This chapter serves as a practical outcome of this research. The significance of this chapter is that it contributes to the existing body of knowledge by providing empirical output helping to advance sustainability aspects in higher education institutions in Saudi Arabia and elsewhere. The policies and the implementation plan can be of great assistance for universities, especially those institutions who are still at early stage pursuing sustainability.

In its introduction, this chapter raised the following question:
What approach can university campuses in Saudi Arabia adopt to become more sustainable?

The answer to the chapter's question is the proposed six steps: commit, evaluate, plan, implement, track, and review. Table 6.6 shows more details about the way in which sustainability can be approached comprehensively, especially for universities that are still at early stage of implementation. The table sums up the steps, actions to be taken, actors responsible, and the timeframe for each step (short-, medium-, and/or long-term).

As a final remark, the proverb 'where there's a will, there's a way' is appropriate here. Commitment (the will) is what Saudi Arabian public universities need. The approach presented in this research (the way) is the green light for universities in Saudi Arabia and elsewhere to become more environmentally sustainable.

Table 6.6: Steps, actions, actors responsible, and timeframe to advance sustainability in campuses

Step	Strategies, actions, and responsible actors	Time
No. 1 **Commit**	● Show leadership in institutionalising sustainability in the university ● Establish Office of Sustainability (assemble a team; representatives and experts) ● Identify and involve stakeholders (students, faculty and staff members) ● Declare a sustainability commitment ● Sign sustainability declarations/charters/treaties/agreements ☚ **Actors: University rectorate and top management**	Short-term
No. 2 **Evaluate**	● Identify existing sustainability initiatives, policies, and schemes ● Use a metrics baseline acting as a measurement to evaluate the progress to be made ● Gather data, analyse, and document current sustainability practices and operations ● Define existing personnel capability ● Identify funding sources ☚ **Actors: Office of Sustainability**	Short-term
No. 3 **Plan**	● Systematically plan for sustainability (well begun is half done) ● Place sustainability knowledge and awareness top of the agenda (make it a priority) ● Formulate a clear and achievable vision for sustainability ● Establish sustainability goals (e.g. climate neutrality target) ● Mainstream sustainability in campus planning (e.g. Campus Master Plan) ● Create sustainability knowledge and awareness among students and staff ● Match the supply and demand for space (m2) ● Increase campus density and diversity to make it liveable and dynamic ● Design buildings using green principles (e.g. BREEAM and LEED) to address issues such as energy, water, waste, transport, flexibility, utilisation, occupants' well-being and comfort ☚ **Actors: Office of Sustainability & other university's departments & agencies**	Short-term and Medium-term
No. 4 **Implement (living lab)**	● Assess students' sustainability knowledge and awareness periodically ● Integrate sustainability into the university curriculums ● Offer under- and post-graduate degrees in sustainability ● Train university faculty members in sustainability practices ● Outline roles, responsibilities, and accountability procedures of stakeholders ● Form partnerships to address sustainability challenges (e.g. technical issues) ● Join sustainability networks to learn and share experience and knowledge ● Attend/hold sustainability conferences to highlight latest developments ● Establish fund to support sustainability initiatives and practices ● Publicise sustainability news, and events through appropriate communication channels ● Introduce incentives and rewards to promote sustainability practices and operations ● Integrate teaching, learning, and research with campus planning and operations ● Operate and maintain facilities using green building principles (e.g. BREEAM and LEED) to address issues such as energy, water, waste, transport...etc. ● Mobilise campus as a living lab (use campus facilities and infrastructure as a lab) ☚ **Actors: Office of Sustainability & other university's departments & agencies**	Short-term, Medium-term, and Long-term
No. 5 **Track**	● Utilise sustainability assessment tools to evaluate progress ● Use the assessment tools as a broad guide to achieve sustainability ● Prepare sustainability progress reports ● Compare university sustainability progress with national and international benchmarks ☚ **Actors: Office of Sustainability & other university's departments & agencies**	Short-, Medium- and Long-term
No. 6 **Review**	● Re-assess and revise sustainability policies, plans, programs, and initiatives ● Engage stakeholders and in-house specialists in the process of revision ● Involve external partners to gain important insights ● Re-orient towards a more sustainable approach ● Celebrate achievement (recognise and reward involved parties to keep them committed) ☚ **Actors: Office of Sustainability & other university's departments & agencies**	Short-, Medium- and Long-term

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Pedestrian spine, King Saud University, Riyadh

Chapter 7

Sustainable Campuses

7.1. Introduction

In the previous chapter, the focus was on presenting the main research findings and the proposed approach through which sustainability in university campuses can be advanced in Saudi Arabia and elsewhere. The chapter highlighted the practical outcome of this research. It offers policies, actions, and steps to guide higher education institutions to become more sustainable.

The aim of this chapter, however, is to highlight the theoretical output of this research. It shows what this research has added to the existing body of knowledge. This chapter also answers the main research question. Other objectives are to briefly clarify the societal and scientific contributions, the limitations, the future research needed, and some reflections on the research approach, methods, and data-collection phases and methods.

The question to be answered in this chapter is '*What information, tools, and approaches will allow existing and new college buildings and campuses in Saudi Arabia to become more sustainable?'*

Methodologically, the present research raised five sub-research questions which have been answered in previous chapters. These five sub-research questions fundamentally helped to answer the main research question. Therefore, in order to achieve the goals of this chapter as well as to answer the main research question, this chapter systematically scanned the previous chapters and relevant literature.

This chapter has been organised in the following way. Section two highlights the information, tools, and approach for universities to become more sustainable and hence answering the main research question. Section three emphasises the empirical and theoretical contributions of this research. Section four presents brief reflections on the quality of the research. Section five underlines the research limitations. Section six recommends further research to be undertaken given that this study has thrown up many questions in need of further investigation. The last section, section seven, shows the final remarks of this study emphasising some implications and recommendations.

7.2. Information, tools, and approaches for universities to become more sustainable

This section answers the main research question in three parts; the information needed for universities to become more sustainable, the tools needed for universities to assess its progress in becoming more sustainable, and the approach guiding universities to move forward towards sustainability.

7.2.1. Information for universities to become more sustainable

This research has offered universities in Saudi Arabia and elsewhere important information to advance their efforts towards sustainability. Information was provided through a) reviewing literature, b) assessing cases of study, and c) developing an approach that can help improve sustainability in colleges and campuses.

The study started by mapping the related literature of four domains: (1) university campus planning and design, (2) managing the university campus, (3) sustainability in university campuses, and (4) higher education in Saudi Arabia. The first domain presents key information on planning and designing university campuses. 'Teaching, learning and a vast array of academic activities need space to be performed in or through. Therefore, the built environment is as important as the activities it facilitates' (Alghamdi 2015, 1020). The most important piece of information derived from this domain was planning for higher education facilities taking the youth population projections and enrolment into account (Dober 1963). This is extremely significant given that the census data projected a huge fluctuation in the youth population in Saudi Arabia. This calls for urgent measure to be taken in order to avoid oversupply of space in university campuses in the future.

The second domain highlights important information on how university campus can be managed. It shows 'the integrated approach to managing the campus, which takes into account all the stakeholders, weighing benefits and costs, covering strategic goals, user demands and of course the physical aspects of the campus' Alghamdi (2014, 611). Scholars, such as Den Heijer (2011), have underlined the fact that changing functional needs in university campuses require a more flexible and adaptable approach. 'That is considering partnership (for sharing use, ownership or management of the campus as a whole or just specific parts). This can include, but is not limited to, academic functions (research laboratories), residential functions (student housing), related business functions (incubators), retail and leisure functions (restaurant and sport facilities) and finally the infrastructure functions (accessibility and parking)' (Alghamdi 2014, 612).

The third domain displays essential information on sustainability in university campuses. It shows definitions and aspects of sustainable campus. This study, Alghamdi (2018a, 115), defines sustainable university as:

> *'When thinking about a 'sustainable university', its campus has to consider the implementation of sustainable practices (environmentally, economically, socially, and educationally) through its campus life cycle (planning, constructing, operating, maintaining, and retrofitting) through all management directions (top-down as well as bottom-up approaches) on all levels of campus (from classrooms to laboratories, transportation, procurement, housing and other services) in many ways (e.g. energy saving, water conservation, air quality, social equity, waste reduction, walkability, well-being and health) or in many different shapes and forms (e.g. flexibility, multi-functionality, optimal space utilisation).'*

The key information provided in the last domain shows facts and figures about the system of higher education in the Kingdom, quantitatively and qualitatively. It shows the stakeholders involved in higher education in Saudi Arabia (students, faculty, staff, facility and managers, top management, rectorate, board members...etc.). This domain summarises the historical development in tertiary-level education in the Kingdom and how to improve. Success in higher education as Larry & Abouammoh (2013, 4) suggest 'cannot be achieved unless the necessary human and physical resources, administrative infrastructure, technology systems and collaborative networks are in place.'

This research has also mapped the literature of sustainable campuses. This study has found that in order to operationalise the notion of sustainability in university campuses there is a need to express such concepts in such context in five aspects. These five aspects are management, academia, engagement, environment, and innovation (Alghamdi et al. 2017). Each aspect is represented by many distinct variables. Figure 7.1 is a representation of mapping sustainable campus, where visual illustration displays the five aspects and some of their variables.

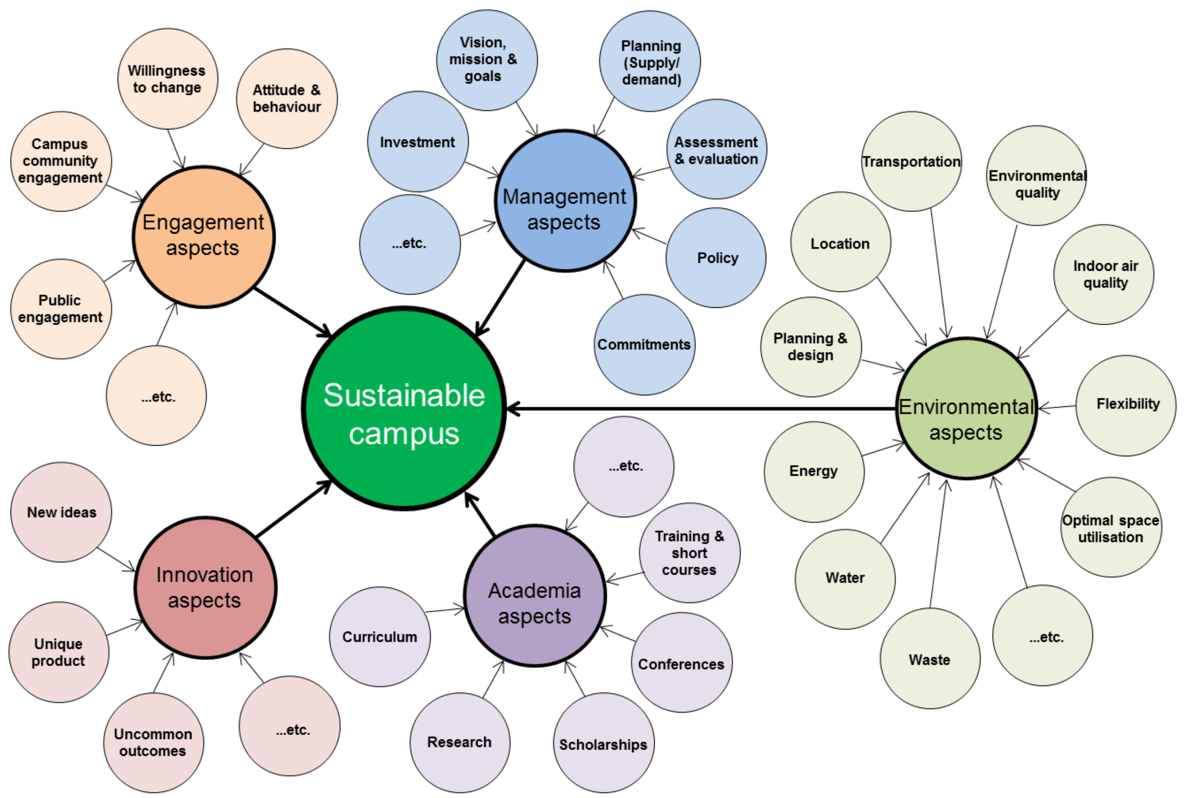

Figure 7.1: Mapping the field of sustainable campus

This study has assessed some aspects of sustainability in some of Saudi Arabian public universities. It has focused on certain areas of sustainability including:

- Management aspects
  (Vision, policy, planning, and commitments)
- Engagement aspects
  (Attitude, knowledge, and awareness of sustainability and willingness to change)
- Environment aspects
  (Location and physical accessibility, flexibility, climate considerations, and space utilisation)

The same sustainability aspects were assessed and analysed in two institutions known for their advanced leadership in sustainability, namely Arizona State University and University of South Florida. The process of assessing, analysing, and reporting the Saudi and American cases results in providing valuable information, especially for universities that are still at early stage of implementing sustainability.

7.2.2. Tools for universities to become more sustainable

This research has reviewed 12 sustainability assessment tools in universities. The study has developed a tool that helps translating ‘the theoretical concept of a sustainable university into more measurable variables to support practitioners and academics in assessing sustainability in universities’ (Alghamdi et al. 2017, 84). In this tool, shown in figure 7.2, there are five benchmarking aspects essential in measuring sustainability: management, academia, engagement, environment, and innovation. This tool assists in forming a holistic framework to advance sustainability performance in higher education institutions. This tool can be regarded as:

'a means for any higher education institution to develop its own instrument to advance its progress and to measure its efforts towards sustainability. As each university is faced with different challenges, universities can tailor their own tool based on the proposed framework. In this way, individual universities can be helped – contrary to the "one-size-fits-all" approach of conventional mainstream assessment tools. This is not to disregard the existing tools, but to empower higher education institutions to decide for themselves the development of their own processes. Once this has been established, institutions should use assessment tools not only for guiding or assessing but also for comparing and reporting and hence making sure that universities are heading in the right direction' (Ibid, 107).

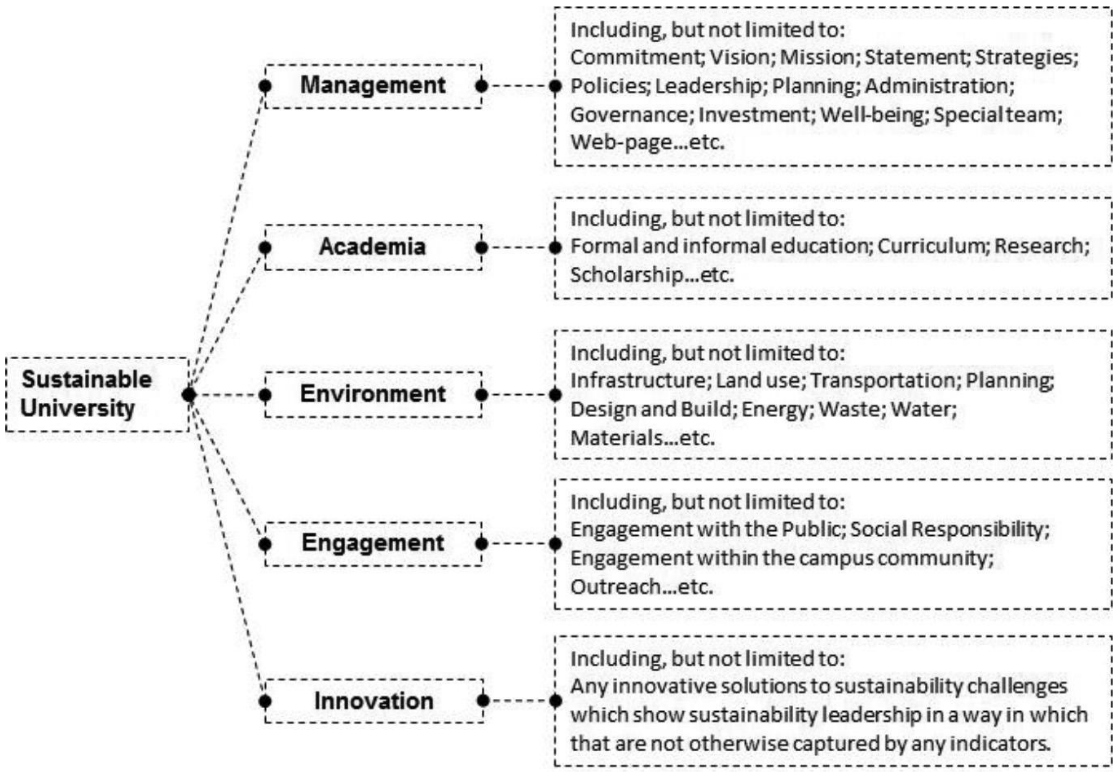

Figure 7.2: Benchmarking tool for assessing sustainability in universities (Alghamdi et al. 2017, 108)

7.2.3. An approach for universities to become more sustainable

One of the most important outputs of this research is the proposed sustainability approach for universities. The approach consists of six steps: commit, evaluate, plan, implement, track, and review. Figure 7.3 shows the six steps recommended to approach sustainability in university campuses. These steps are designed for universities at early stage of planning and implementing sustainability. However, other advanced universities in implementing sustainability can also be benefited from such steps. The six steps are as follows:

1. **Commit**: It is recommended for universities to commit to institutionalising sustainability through showing leadership in approaching sustainability holistically in the university.
2. **Evaluate**: It is recommended for universities to start by assessing the existing sustainability initiatives and programs. They could also document these practices and operations for the purpose of further improvement. This can be undertaken by using a metrics baseline, which acts as a baseline measurement to evaluate the progress made since the start.

3. **Plan**: It is recommended for universities to approach sustainability comprehensively. This means addressing all aspects of sustainability in the university: academia, management, environment, engagement, and innovation. Planning would be of great impact if policies are in place with clear and achievable targets.
4. **Implement**: It is recommended for universities to implement their sustainability plan. To do so, there could be a set of actions to be taken by each stakeholder. Taking responsibility and showing accountability would be important in order to implement sustainability practices and operations.
5. **Track**: It is recommended that universities track their progress in advancing and implementing sustainability initiatives and programs. Assessment tools can be of great help in undertaking such step. Reporting the progress is also important and it can be undertaken on a regular base for a comparison reason, among others.
6. **Review**: It is recommended for universities to revise their sustainability policies, plans, and initiatives periodically. To do so, representative stakeholders along with internal and external experts could be involved in the process of reassessment and improvement.

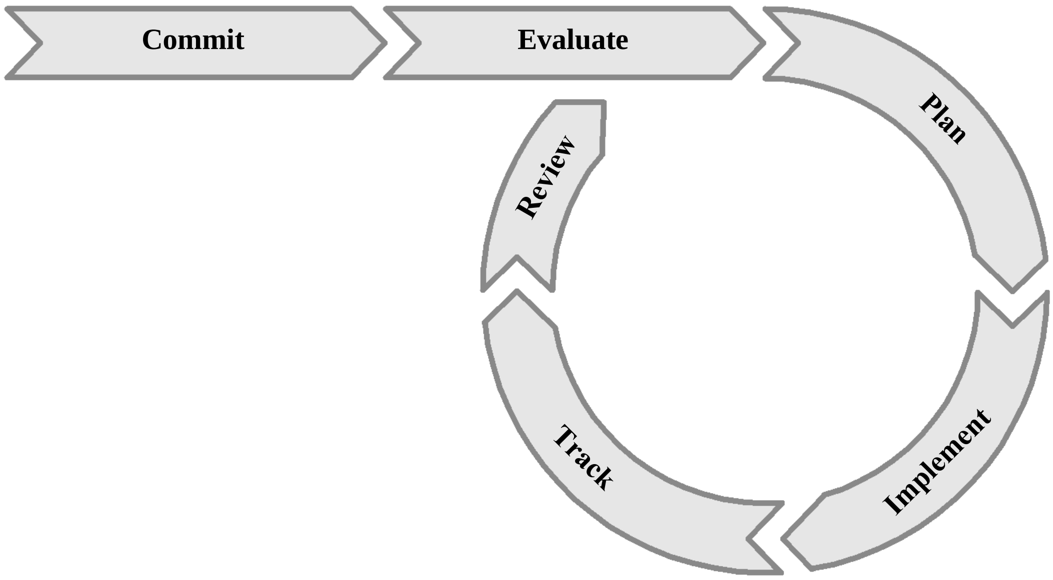

Figure 7.3: The 6-step comprehensive approach to sustainable university campus

The following table, table 7.1, shows more details about the way in which sustainability can be approached, especially for universities that are still at early stage of implementation. The table sums up the steps, strategies to be used, actions to be taken, actors responsible for execution, and the timeframe expected for each step. The latter is suggested to be as follows: short-term (1 year), medium-term (1-5 years), and long-term (5-15 years).

Table 7.1: Steps, actions, actors responsible, and timeframe to advance sustainability in campuses

Step	Strategies, actions, and responsible actors	Time
No. 1 **Commit**	● Show leadership in institutionalising sustainability in the university ● Establish Office of Sustainability (assemble a team; representatives and experts) ● Identify and involve stakeholders (students, faculty and staff members) ● Declare a sustainability commitment ● Sign sustainability declarations/charters/treaties/agreements **Actors: University rectorate and top management**	Short-term
No. 2 **Evaluate**	● Identify existing sustainability initiatives, policies, and schemes ● Use a metrics baseline acting as a measurement to evaluate the progress to be made ● Gather data, analyse, and document current sustainability practices and operations ● Define existing personnel capability ● Identify funding sources **Actors: Office of Sustainability**	Short-term
No. 3 **Plan**	● Systematically plan for sustainability (well begun is half done) ● Place sustainability knowledge and awareness top of the agenda (make it a priority) ● Formulate a clear and achievable vision for sustainability ● Establish sustainability goals (e.g. climate neutrality target) ● Mainstream sustainability in campus planning (e.g. Campus Master Plan) ● Create sustainability knowledge and awareness among students and staff ● Match the supply and demand for space (m2) ● Increase campus density and diversity to make it liveable and dynamic ● Design buildings using green principles (e.g. BREEAM and LEED) to address issues such as energy, water, waste, transport, flexibility, utilisation, occupants' well-being and comfort **Actors: Office of Sustainability & other university's departments & agencies**	Short-term and Medium-term
No. 4 **Implement (living lab)**	● Assess students' sustainability knowledge and awareness periodically ● Integrate sustainability into the university curriculums ● Offer under- and post-graduate degrees in sustainability ● Train university faculty members in sustainability practices ● Outline roles, responsibilities, and accountability procedures of stakeholders ● Form partnerships to address sustainability challenges (e.g. technical issues) ● Join sustainability networks to learn and share experience and knowledge ● Attend/hold sustainability conferences to highlight latest developments ● Establish fund to support sustainability initiatives and practices ● Publicise sustainability news, and events through appropriate communication channels ● Introduce incentives and rewards to promote sustainability practices and operations ● Integrate teaching, learning, and research with campus planning and operations ● Operate and maintain facilities using green building principles (e.g. BREEAM and LEED) to address issues such as energy, water, waste, transport...etc. ● Mobilise campus as a living lab (use campus facilities and infrastructure as a lab) **Actors: Office of Sustainability & other university's departments & agencies**	Short-term, Medium-term, and Long-term
No. 5 **Track**	● Utilise sustainability assessment tools to evaluate progress ● Use the assessment tools as a broad guide to achieve sustainability ● Prepare sustainability progress reports ● Compare university sustainability progress with national and international benchmarks **Actors: Office of Sustainability & other university's departments & agencies**	Short-, Medium- and Long-term
No. 6 **Review**	● Re-assess and revise sustainability policies, plans, programs, and initiatives ● Engage stakeholders and in-house specialists in the process of revision ● Involve external partners to gain important insights ● Re-orient towards a more sustainable approach ● Celebrate achievement (recognise and reward involved parties to keep them committed) **Actors: Office of Sustainability & other university's departments & agencies**	Short-, Medium- and Long-term

7.3. Research contributions

Saudi Arabia is experiencing rapid and major developments in its higher education sector with 70% of its universities currently being designed and built. The need for this research is based on both significant values:

7.3.1. Societal contribution (Empirical output)

This research is to focus on solutions or, put differently, implementations of sustainability aspects. This research offers planning guidelines, implementation steps, and an approach to sustainable university campuses. Such an approach has been especially designed to serve colleges and universities that are still at early stage of sustainability implementation. However, other advanced universities can be also aided by utilising the proposed approach. Therefore, not only do the empirical outputs of this research benefit Saudi Arabia, but also other countries with similar conditions (e.g. climate, transportation modes, and campus planning and design).

7.3.2. Scientific contribution (Theoretical output)

This study makes two scientific contributions to research on sustainability in universities. First, there is considerable research on sustainability tools that measure and report the advancement of sustainability in universities such as Shriberg (2002), Cole (2003), Alshuwaikhat and Abubakar (2008), Leal Filho et al. (2009), Disterheft et al. (2012), Lozano et al. (2013), Kamal and Asmuss (2013), and Gómez et al. (2014). Such studies have reviewed a number of tools giving background information and show the strengths and weaknesses of each tool. However, very little is known about the indicators through which sustainability in universities can be assessed. Consequently, this research bridges this scientific gap in operationalising sustainability tools for universities; ensuring that these tools are more intelligible, primarily through highlighting indicators, so that they clearly communicate the essential information. In doing so, this research identifies five criteria that can be grouped into a holistic framework, comprising aspects of management, academia, environment, engagement, and innovation. Therefore, the research contribution to the body of knowledge is by simplifying and detailing the structure and contents of existing sustainability tools, which enables universities to recognise key issues and ultimately improve their sustainability policies. In this way, universities, in Saudi Arabia and elsewhere, are helped through utilising the existing assessment tools or maybe developing new tailored tools. The latter is because universities face a variety of challenges and they might lack the ability to measure their sustainability policies and practices. Second, despite the importance of sustainability in university campuses, very little attention has been given to such a topic in Saudi Arabia. A number of studies were carried out on specific areas of sustainability in some Saudi Arabian public and private universities such as Alhefnawy (2014), Abanomi (2014), Alshuwaikhat et al. (2016), Almufadi & Irfan (2016), Abubakar et al. (2016), Adenle & Alshuwaikhat (2017), and Alshuwaikhat et al. (2017). However, the vast majority of these studies do not address sustainability inclusively. In fact, much of the previous research indicates a need for a comprehensive investigation of sustainability in public universities. Therefore, this research fills in this vacuum and provides an extensive study using scholarly literature and a best practices review combined with a field work including 38 expert interviews, 1,901 questionnaires, and 12-site observations. This study provides the body of knowledge with information, tools, and an approach through which sustainability aspects can be evaluated and advanced.

7.4. Reflections on the quality of the research

The journey of conducting this research has come to its end. The only issues remain to highlight are the essential principles and foundations of scientific research. Although characterised as overlapping, Miles et al. (2014, 311) suggests five categories or standards which help determining the quality of any research:

- Objectivity/confirmability
- Reliability/dependability/auditability
- Internal validity/credibility/authenticity
- External validity/transferability/fittingness
- Utilisation/application/action orientation.

This research acknowledges the fact that 'getting it all right' might be almost impossible. It should be, as Wolcott (1990) puts it, trying to 'not get it all wrong'. As a result, the following standards for the quality of research address this particular issue:

7.4.1. Objectivity/confirmability

In order to deal with the issues of impartiality and prejudice, this study has described - in great detail - its research approach, methods, and data collection techniques. Chapter three, in particular, presents the research methodology in which it shows how the data was collected, processed, analysed, and reported. This is to illustrate how each conclusion was drawn.

7.4.2. Reliability/dependability/auditability

This research has been striving for consistent approach throughout the process of undertaking this study. The effort and time given to each task in each stage were proportionately compatible.

The research results show significant correspondence between different data sources. For example, when reviewing the issue of highlighting climate change and addressing sustainability in public universities in Saudi Arabia, the findings show that most public universities have not clearly stated in their strategic plans, the aims, and commitments to achieve sustainability and hence failed to engage with the great challenge of climate change (Alghamdi 2018b). This result was confirmed after analysing 19 interviews with decision makers at eight public universities. The findings show that some Saudi universities lack expertise in sustainability and the majority of decision makers in these universities have limited knowledge of recent development in the area of sustainability (Ibid). This example shows not only consistency, but also accuracy.

This research has acknowledged the fact that it has a number of data sources. In chapter six, for instance, this study proposed the planning guidelines which consist of policies and actions to advance sustainability in public universities in Saudi Arabia. These proposed policies were not only grounded principally on evidence-based results derived from this research, but also on policies emulated from well-known best practices worldwide. This means that some policies were developed based on scientific findings of this study. Other policies, however, were adopted from supplementary literature of local, regional, and international cases. The latter is a measure that has been taken to alleviate the risk against reliability of data sources and to ensure accuracy and usefulness.

In order to ensure quality and integrity, this research has followed the same protocol during the course of data collection stages. This research involved field work through which a number of data collection techniques were used such as conducting face-to-fact interviews, distributing questionnaires, and undertaking direct observations. These techniques were all used in every university campus visited in Saudi Arabia. One week was spent in each university. The same people (with the same job titles) were approached to be interviewed. One hour was allocated for each interview. The context of the questionnaire was identical. The same goes for the interview questions, except that different positions required different set of questions.

Data quality has been made to check for bias and deceit. For instance, when space utilisation rate was calculated, the overall rate was astonishingly very low (22%). These findings were confirmed after analysing questionnaires completed by 1,901 participants. They indicated that ‘65% of teaching rooms in the five college buildings were [either] half-filled or have plenty of seats available’ (Alghamdi 2018c). The comparison between the two findings indicates impartiality, soundness, and objectivity of the data collected from different sources.

7.4.3. Internal validity/credibility/authenticity

To ensure the ‘truth value’ of this research (Groat & Wang 2002), this study has meaningfully described its context. This was done through explicit definitions and detailed examples. Chapter one, in particular, presents key definitions so that it describes the main terms used, the purpose, and the focus in this research.

The methods to collect data in this research was based on desk study and field work. The former includes scholarly literature review and professional documents review (campus master plans and college buildings floor plans, sustainability plans, sustainability reports...etc.), whereas the latter includes conducting face-to-fact interviews, distributing questionnaires, and undertaking direct observations. Using different techniques referred to as triangulation technique; ‘looking in from different angles and vantage points... think small but drill deep, using different methods and drilling from different directions’ (Thomas 2011, 68). Triangulation has greatly facilitated the internally validating this study.

Another way to ensure internal authenticity is whether or not the data is well-linked to the existing or emerging theory. For example, in chapter four, the analysis of the questionnaires suggested that ‘the more you know about sustainable development, the more you are willing to act sustainably... the question to be raised... is will the knowledge be enough to behave more sustainably’ (Alghamdi 2018a, 123). This question was answered by Heeren et al. (2016, 628) in which they indicate that ‘one should not assume that more knowledge about sustainability will necessarily translate into changes in behaviour’. They believe that it depends on other factors such as the social norms, attitudes towards sustainable behaviours, and the perceived behavioural control. This example resembles a number of internal validations including that ‘measures reflect the constructs at work... areas of uncertainty have been identified... rival explanations have been actively considered’ (Miles et al. 2014, 313).

7.4.4. External validity/transferability/fittingness

To confirm external validation, the findings of this research have been reviewed by experts from different countries (Saudi Arabia and United States). For example, in chapter six, interviews were conducted with specialists so that the proposed guidelines can be examined. The received feedbacks from the eleven professionals interviewed have helped to sharpen the proposed planning guidelines and to define the six-step implementation plan.

According to Miles et al. (2014), the issue of transferability can be addressed through ‘thick description’. The following points describe how this research has transferred some of the sustainability policies found in the supplementary literature of other cases. This study emulates some of the policies mentioned in the literature which being implemented in many campuses around the world. Dolowitz & Marsh (1996) explain that transferring a policy can be made in many ways and one of which is by emulation. Rose (1991, 21) defines emulation as ‘reject[s] coping in every detail, [but] accepts that a particular program elsewhere provides the best standard for designing legislation at home’. Therefore, some policies proposed in the planning guidelines are adopted, redesigned, and mobilised to help advancing environmental sustainability aspects in the Saudi cases. As a result, the policies are either informed strategies based on empirical study or recommended strategies based on existing body of knowledge. Furthermore, despite the fact that university campuses are different, they share, to a large extent, common planning characteristics. Sinclair (2008, 4) points out that:

> *‘While each campus has been undeniably shaped by local geography, culture, traditions and conditions, there were many similarities in the principles and policies developed to guide design and planning. Concerns about energy, air quality, water conservation, waste reduction, social quality, student experience, liveability and walkability, ethical procurement, multi-modal of transportation, health and wellness, to name but a few, were pervasive.’*

One of the remaining questions to be dealt with is what makes the proposed policies successful or unsuccessful. To answer this query, there is a need to highlight some of the factors that play a key role in leading to policies ‘success’ or ‘failure’. It is known that successful policies implemented in one country might not be successful in another. Dolowitz and Marsh (2000, 17) suggest three factors effecting policy failure:

- *‘First, the borrowing country may have insufficient information about the policy/institution and how it operates in the country from which it is transferred*
- *Second, although transfer has occurred, crucial elements of what made the policy or institutional structure a success in the originating country may not be transferred, leading to failure*
- *Third, insufficient attention may be paid to the differences between the economic, social, political, and ideological contexts in the transferring and the borrowing country.’*

Therefore, in order to deal with these important three factors that determine the success or failure of policies, Dolowitz & Marsh (2000) point out that there are a number of issues to be addressed, including:

- Thorough and complete analysis of the proposed policies through which advantages and disadvantages can be realised. This research has examined the extent to which the borrowed policies can be of help to Saudi Arabian situation.
- Making sure that tasks and responsibilities are assigned clearly for each individual or team (who should do what) (stakeholders involve including Rectorate, Directors, Deans, Office of Sustainability, School/College of Sustainability, project and facility managers, university’s faculty members, researchers, supporting staff/employees, and students). This was clearly indicated in the planning guidelines and the 6-step approach.
- Implementing the proposed policies must be phased in so that if there is any difficulty in execution of policies, possible risk can be mitigated by making necessary changes (the six-step implementation plan with its actions).
- Each policy has its own goal and hence when adapting any policy, its goal should be maintained. This is to avoid changing the focus of the policy, which otherwise leads to a problem in the implementation.

The other question to address is to what extent the findings of this research can be generalisable? Yin (2014, 21) states clearly that 'case studies, like experiments, are generalisable to theoretical propositions and not to populations or universes.' Walton (1992, 129) believes that "case studies are likely to produce the best theory". Those authors, among others for example (Lipset et al. 1956), have been in favour of the opinion that even a single case study can be used for generalising its outcomes.

However, Thomas (2011, 17) argues that 'case study is not good for generalising from'. He, among others for instance (Ragin & Becker, 1992), believes that what case study is good at is uniqueness (particular features in their variety and their completeness) and for giving a rich picture about the case studied (many kinds of insights coming from different angles and different kinds of information). Thomas (2011, 23) believes that 'We do not always want or need to generalise and some of the most inspired and insightful research, of any kind, has come about as a result of case studies.'

With the above mentioned in mind, it can be said that both opinions do hold water. Although generalisation from case study seems debatable, the fact that what is desired from the inquiry process is what always does matter. Flyvbjerg (2006, 227) succinctly addresses this saying that:

> *'A purely descriptive, phenomenological case study without any attempt to generalize can certainly be of value in this process and has often helped cut a path toward scientific innovation... The case study is useful for both generating and testing of hypotheses but is not limited to these research activities alone.'*

On one hand, parts of study can be generalisable. For instance, the sustainability knowledge and awareness rates were reported after analysing almost two thousand questionnaires, coming from nine public universities. This can be generalisable given that the sample is statistically significant and is representative of the population of public higher education institutions in Saudi Arabia.

On the other hand, based on the approach in this study which is case study, the conclusion drawn from it may not be generalisable since the focus is to deeply understand some cases of Saudi campuses through getting a rich picture and gaining analytical insights. For example, the space utilisation rates – which were calculated based on analysing only 150 classrooms in five different college buildings from five different universities – are subject to certain limitations. The small sample size does not help generalising the space utilisation study's findings.

Taken together, this research is studying a few cases in depth which may allow us to develop a logical generalisation from rich evidence produced. This research has highlighted all the limitations on sample selection and has censoriously evaluated the capacity to generalise from the sample.

7.4.5. Utilisation/application/action orientation

The last question to address is what this study can offer 'for its participants – researchers and researched – and for its consumers' (Miles et al. 2014, 314). This section presents some of the potential applications of this research.

This research ultimately proposes a six-step approach for universities to become more sustainable. Each step consists of a set of actions to be taken, actors responsible and accountable for executing in a timeframe. This research offers planning guidelines covering a range of issues from management to engagement to environment. The guidelines are composed of policies that were based on scholarly literature and best practices available.

This research has attempted to improve people's knowledge and awareness of sustainability in higher education, particularly in Saudi Arabia. For example, the aims of distributing 3,500 questionnaires in nine public universities, which is one-third of public universities in Saudi Arabia, was not only to investigate the environmental awareness and sustainable behaviour in public universities in Saudi Arabia, but to provide an insight into the attitude, knowledge, and awareness of sustainability. Although the completed questionnaires were 1,901 forms, the main purpose of conducting such task was to highlight the gaps between current policy and practice. The same goes for interviewing over 30 policy- and decision-makers in universities and in the Ministry of Education. It is expected that the participants have been informed about some of the latest developments, practices, and operations that help universities to become more sustainable. This might be of great intellectual help for students, faculty, staff, and policy- and decision-makers at the university level and at the ministerial level.

This research offers potential solutions for some of the environmental/physical aspects of university campuses. The findings are believed to provide insightful policies that can advance sustainability aspects in higher education institutions in Saudi Arabia and elsewhere. These policies are considered as recommendations to universities and to the Ministry of Education. These policies might be of great benefit if taken into account, given that they were based on recent best practices in sustainability in campuses.

The findings of this research will be made available through all means. The book will be accessible, both physically and digitally, to potential users.

7.5. Limitations of research

This section highlights the limitations of the present study. Thonney (2012, 309) believes that writers indicate these limitations '*to accomplish four rhetorical moves*:

> *(1) to establish a territory and occupy a niche*
> *(2) to introduce previous research into the conversation*
> *(3) to recommend further research, and*
> *(4) to acknowledge limitations.*'

This research was set to assess, analyse, document, and report how sustainable university campuses in Saudi Arabia are. It then developed an approach to advance sustainability aspects by drawing some lessons from best practices available. However, the reader should bear in mind that this study has some limitations:

- This study focused on certain aspects of sustainability. According to Alghamdi et al. (2017), there are five aspects of sustainability: management, academia, engagement, environment and innovation. This research has dealt with aspects including management, engagement, and environment. However, it did not cover aspects such as academia and innovation.
- This study was limited by the numbers of performance indicators it explored in each aspect of sustainability. For example, in the environmental aspect, this research has studied only five indicators (location, physical accessibility, flexibility, climate

considerations, and space utilisation). However, other indicators, including but not limited to, energy, water, waste are all beyond the scope of this research.

- This study was mainly concentrating on recently established public universities in Saudi Arabia. There are 28 public universities in the Kingdom; eight are well-established (1957-1998), whereas 20 are recently founded (2003-2014). However, the sample in this study consisted of only one old university (King Saud University) and six new universities (Al Baha University, Jazan University, Najran University, University of Hail, University of Hafr Al Batin, and Prince Sattam bin Abdulaziz University). Furthermore, a private university was included given its distinctive campus planning and design (King Abdullah University for Science and Technology). This means that the sample was made of seven public uncivilities which count for a quarter of public universities in the Kingdom.
- Almost all public universities in Saudi Arabia have two campuses; male and female. This study focused on the male campus in each university, given the easy access to conduct the research. According to the Saudi Centre for Higher Education Statistics, almost 52% of students in public universities are female (CHES 2017). Therefore, this study was limited by the absence of female students and their campuses.
- Methodologically, the plan was to collect first-hand information through both desk study (reviewing scholarly literature and professional documents) as well as field work (undertaking interviews, distributing questionnaires, and site visit observations). Although this was the case with Saudi Arabian university campuses, visiting the two cases in the United States - namely Arizona State University (Tempe Campus) and University of South Florida (Tampa Campus) - was not possible given the inability to acquire a US visiting Visa. The research acknowledges the drawback of not being able to visit these leading universities in order to investigate how sustainability works there. Rose (2002, 13) indicates clearly that ‘To understand how a programme works in another country it is necessary to go there in order to learn what printed documents leave out... Investigating a programme on the ground enables a visitor to see how it looks from the inside rather than from a distance.’

7.6. Further research

The findings of this research provide opportunities for future research. The latter is needed so that it can help close the knowledge gap in sustainability in university campuses in Saudi Arabia and beyond. This study, therefore, calls for more research in the following areas:

- **University campuses planning and design in Saudi Arabia**. As far as it is known, the first extensive research for the Saudi Arabian university campuses planning and design was undertaken by Mousalli in 1979 (PhD Thesis at University of Cambridge). In his research, he dealt with the first generation of university campuses in Saudi Arabia (well-established institutions including King Saud University, King Abdulaziz University, King Fahd University for Petroleum and Minerals, and Umm Al Qura University). Ever since, there has been some research looking at certain aspects of planning and design (Al-Tassan 2005; Al-Jwair 2007; Aldegheishem 2013; Abanomi 2014), but not as comprehensive as Mousalli (1979). Therefore, there is a need to research further into this matter.
- **Sustainability aspects in higher education institutions in Saudi Arabia**. This research has investigated some sustainability aspects (management, engagement, and environment) in Saudi University. Other aspects, however, such as academia and innovation, require further studies to be carried out in order to evaluate all aspects of sustainability in colleges and universities. Furthermore, every aspect has many performance indicators that can be used for measuring improvement. This study has

looked at some indicators in each aspect of sustainability. Consequently, further experimental investigations are needed.

- **Sustainability assessment tools and performance indicators**. This research has undertaken an analytical review on existing and well-known assessment tools for sustainability in colleges and universities (Alghamdi et al. 2017). However, one of the recommendations was the need to move ‘from proposing more tools... to practically detailing and operationalising the core of these tools, which is indicators... Tools ought to develop indicators in easily measurable ways, clearly defined and agreed upon’ (Ibid, 112). As a result, further studies regarding these performance indicators would be worthwhile.
- **Sustainability knowledge and awareness assessment**. This study has evaluated the level of sustainability knowledge and awareness among male students in Saudi Arabian public universities (Alghamdi 2018a). There are two issues to be underlined here. First, is the fact that ‘the behaviours of participants in this research were not observed, but rather self-reported through questionnaires. Therefore, research on observed behaviours is required to reflect the reality’ (Ibid, 124). Second, is the fact that ‘the research questionnaires were only distributed in male campuses’ given the easy access to conduct such research (Ibid). Hence, additional research is needed to cover both genders.
- **Climate change in Saudi Arabian higher education institutions**. This research has briefly reviewed the extent to which the challenge of climate change was addressed in higher education institutions in Saudi Arabia (Alghamdi 2018b). Further extensive investigation into how public universities in the Kingdom have been dealing with climate change is strongly recommended. The investigation can be in terms of climate change policies and implementation (practices and operations).
- **Space utilisation beyond teaching space**. This research has carried out an examination of a small sample of teaching space (150 classrooms in five different college buildings from five different universities) (Alghamdi 2018c). There are two issues to be highlighted here. First is the need for more research to enlarge the sample to cover more classrooms from many institutions so that the utilisation rate of facilities can be representative. Second is the fact that ‘general purpose teaching space is the most common type of space to be surveyed’ (SMG 2006, 07). However, less common spaces that are surveyed deserve much needed attention, since these spaces account for a substantial proportion of each college building. Consequently, more research is required to determine the utilisation of other spaces than just the teaching rooms. Special teaching space (theatres/auditoriums), research areas (research laboratories), offices (for both academic and staff), and support space (libraries, meeting rooms, exhibition areas, conference rooms, staff rooms, and leisure rooms) are all cases in point (Alghamdi 2018c).

7.7. Concluding remarks

The aim of this research was to propose a sustainability approach that can help colleges and universities in Saudi Arabia and elsewhere to become more environmentally sustainable. This approach was based on planning guidelines consisting of a set of policies and actions to advance universities efforts towards being more environmentally friendly. The research has recommended a six-step implementation plan which clearly indicates the strategies, actions, actors, and the timeframe needed for each step.

The current campus policies in Saudi Arabia have not considered sustainability aspects as they should be. Therefore, what has been proposed can help bridge the gap, scientifically and societally. Failing to adopt such sustainable planning guidelines may result in keeping Saudi universities lagging behind.

This research intends to look at the bigger picture of sustainability in university campuses in Saudi Arabia and elsewhere. Yet, some examinations were undertaken in certain aspects of sustainability aiming at both a) deep understanding and explanations and b) building evidence-based solutions. The gist of this present study is that before diving into exploring specific aspects of environmental sustainability such as water, energy, transport, or waste, it is of vital importance to know how sustainability aspects can be addressed holistically in universities. Approaching sustainability holistically can be far more effective and influential. In order to do so, sustainability needs to be institutionalised. To do just that, this requires a leadership combined with commitment, vision, plans, targets, and tools to measure and report progress.

The government of Saudi Arabia will soon privatise a number of sectors including higher education. All public universities possibly have to deal with many issues, including funding. This goes in line with the country's Vision 2030 in which it indicates, among others, that public sectors should find other sources of income. In order to continue providing education, research, and community services, higher education institutions have not only to plan strategically, but also to operate sustainably. This implies a necessary modification in a) the business model and b) the way the university functions. The physical plant of any university is the second most valuable and expensive asset (after its people). Such asset requires looking after efficiently and effectively for the sake of thriving, or otherwise declining. In his research, the 21st-Century Campus, Haggans (2016, 2) argues that:

> *'We have just begun to see institutional mergers and rising economic pressures leading to business model transformations. As we go forward it will become clear that the legacy costs of brick and-mortar campuses will either contribute to an institution's value or to its decline.'*

Saudi Arabia has adopted a long-term vision known as Saudi Vision 2030. It invests massively in the higher education sector. The Kingdom's tertiary education is expanding rapidly. By 2030, studies show that the share of 25-34 year-olds with a tertiary degree across OECD and G20 countries could reach '300 million' of which '3%' would be from Saudi Arabia alone (similar to Japan and bigger than South Korea, Canada, United Kingdom, Germany, France, Spain, and Turkey) (OECD 2015, 2). This indicates that there is a shift in the distribution of the global talent pool among nations.

As a final point, public universities in Saudi Arabia should know what other public universities have achieved by adopting a more sustainable approach. This research attempts to do just that; informing public universities, in Saudi Arabia and elsewhere, about what similar universities across the world have accomplished for their institutions and their campuses. Informing these institutions of what they are missing may result in a dramatic change. Bennett (1991, 43) points out that 'fears of being left behind on an important public issue can trigger attention. The cumulative effect of action elsewhere may translate into a feeling of insecurity about being the odd-man-out'. Knowledge and awareness certainly act as a push factor. The recent development in the Kingdom's economy and the adaptation of Vision 2030 also acts as another drive factor (Saudi Vision 2030, 2017). Living in the desert of the Arabian Peninsula for their entire life means that the Saudi Arabian people can survive the hardship, given that they have the determination, patience, and ambition to go around every challenge the desert throws at them. The Saudi Arabian public universities can certainly turn the corner and improve all the sustainability aspects in their campuses and beyond, given their capacity and competence.

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The 1,901 completed research questionnaires

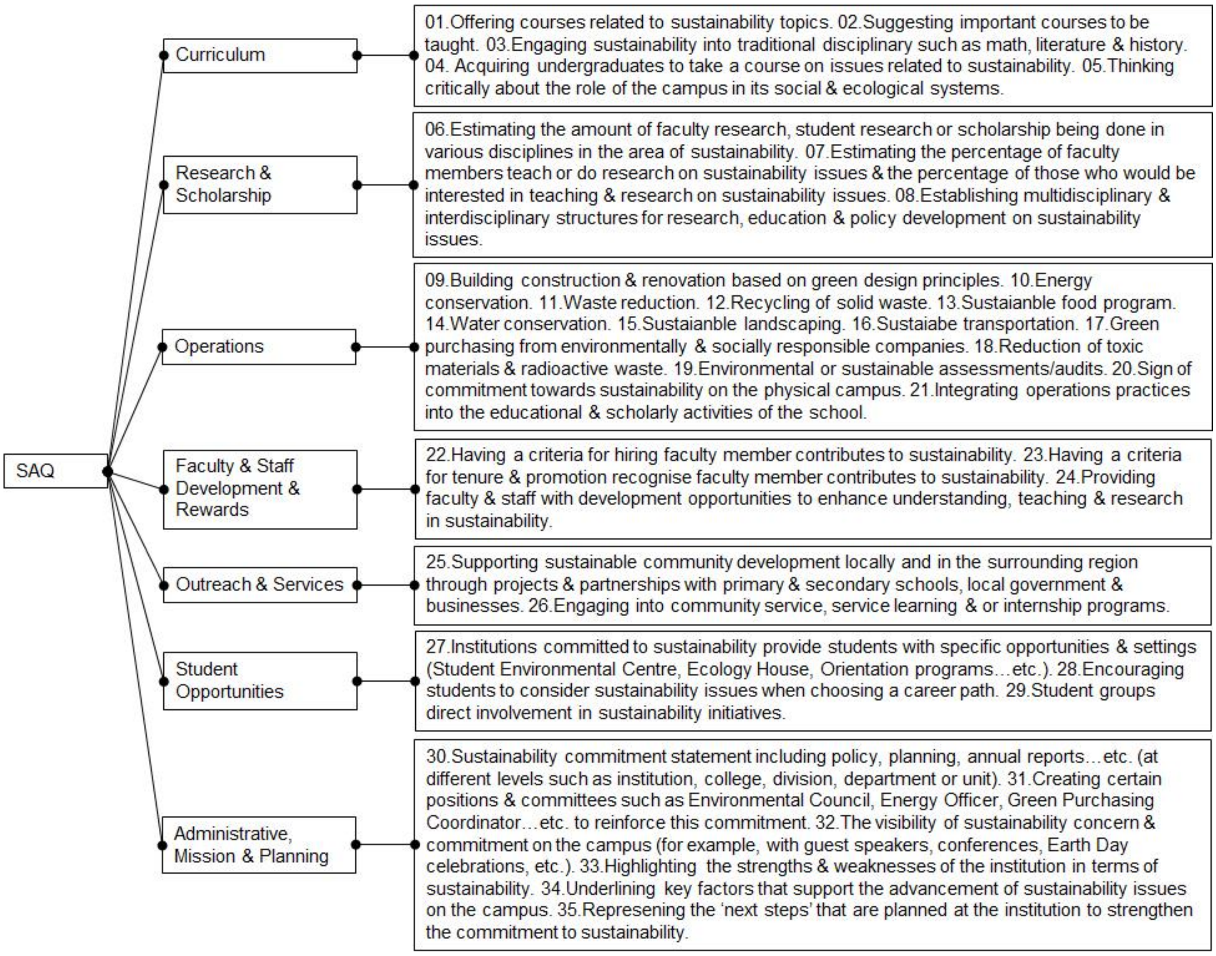
Appendices

Appendix A

Appendix A: Sustainability assessment tools in universities

Sustainability assessment questionnaire (SAQ)

● **Background**: The sustainability assessment questionnaire (SAQ) was designed by the Association of University Leaders for a Sustainable Future’s (ULSF). This association is the secretariat for signatories of the Talloires Declaration 1990. According to the ULSF, the SAQ for colleges and universities was developed between 1999 and 2001. Appendix A.1 shows a summary of key information about the SAQ.



Appendix A.1: A summary of the SAQ

● **Purpose**: The SAQ is a largely “qualitative teaching tool” aiming to “raise consciousness and encourage debate about what sustainability means for higher education, practically and philosophically; provide a snapshot of the state of sustainability on your campus and finally, promote discussion on the next steps for your institution” (ULSF 2009).

● **Criteria and indicators**: The survey requires that the campus representatives provide information about their institution on specific criteria (curriculum; research and scholarship; operations; faculty and staff development and rewards; outreach and service; student opportunities; administrative, mission and planning). There are 35 indicators in the format of a questionnaire. The levels of hierarchy are three, and thus, there are no sub-criteria.

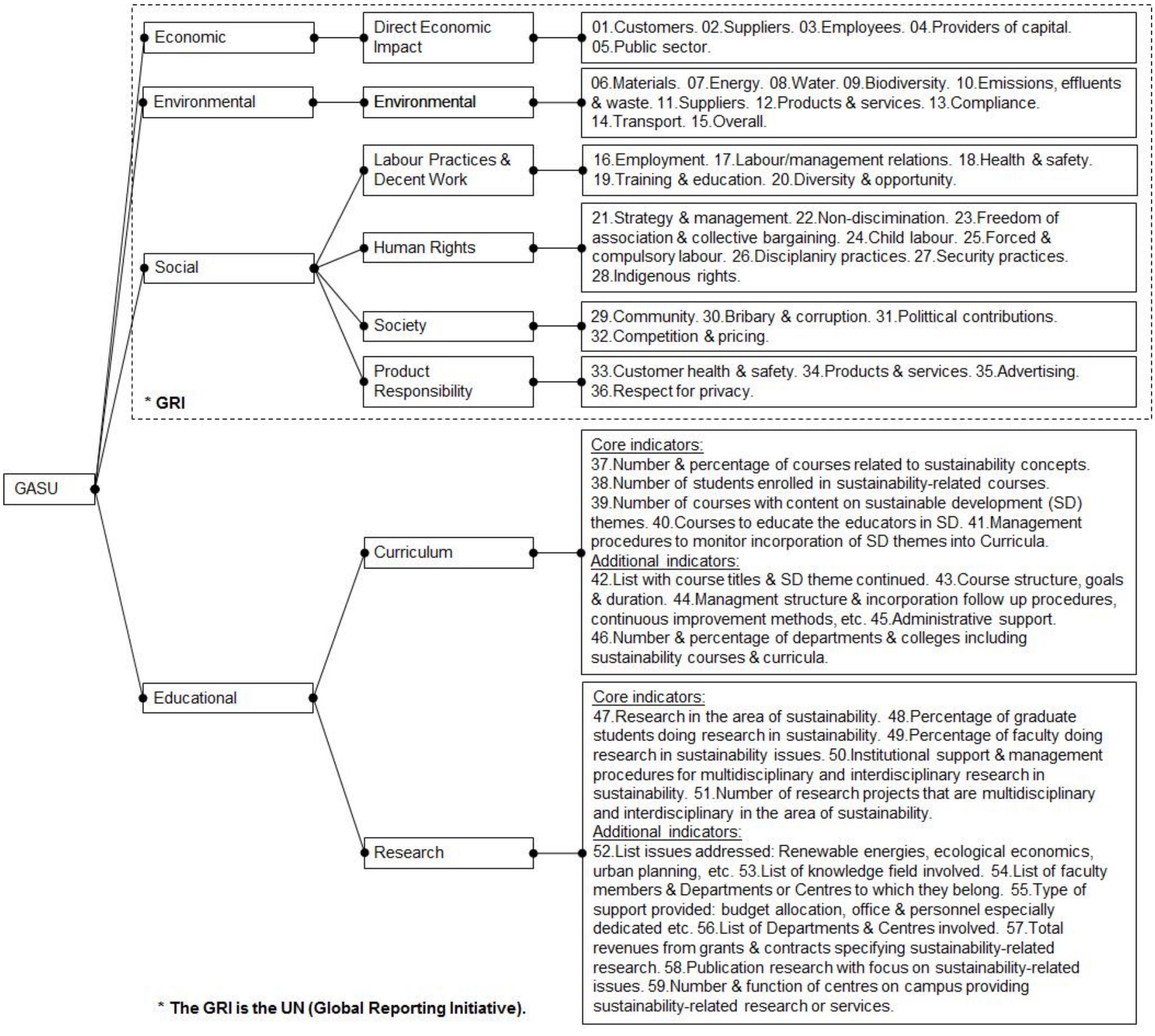
● **Design approach**: It consists of forming a representative sample of 10-15 individuals drawn from students, faculty, staff and the university administration; and introducing the purpose, the objectives, the definitions in advance and facilitation of the discussion throughout the exercise. Each participant should take 30 min to fill out the questionnaire. It may take 2-3 h or so (ULSF 2009).

● **Potential use**: It consists of addressing the idea of sustainability in university campus by "generating discussion and reporting progress" (Kamal & Asmuss 2013, 455). The SAQ is a useful tool to frame sustainability on campus along with helping to design more detailed evaluation tools for each campus (Beringer et al. 2008).

● **Tool structure**: Levels of hierarchy: three; main criteria: seven; sub-criteria: zero; indicators: 35.

Graphical assessment of sustainability in university (GASU)

● **Background**: The Graphical assessment of sustainability in university (GASU) was developed based on the Global Report Initiative (GRI). The GRI model was developed to assess sustainability in corporations. It has three dimensions of sustainability: social, environmental and economic (GRI 2002). The GASU framework modified the GRI by adding another dimension, the educational, to be applicable for colleges and universities (Lozano 2006). Appendix A.2 illustrates a summary of key information about the GASU.



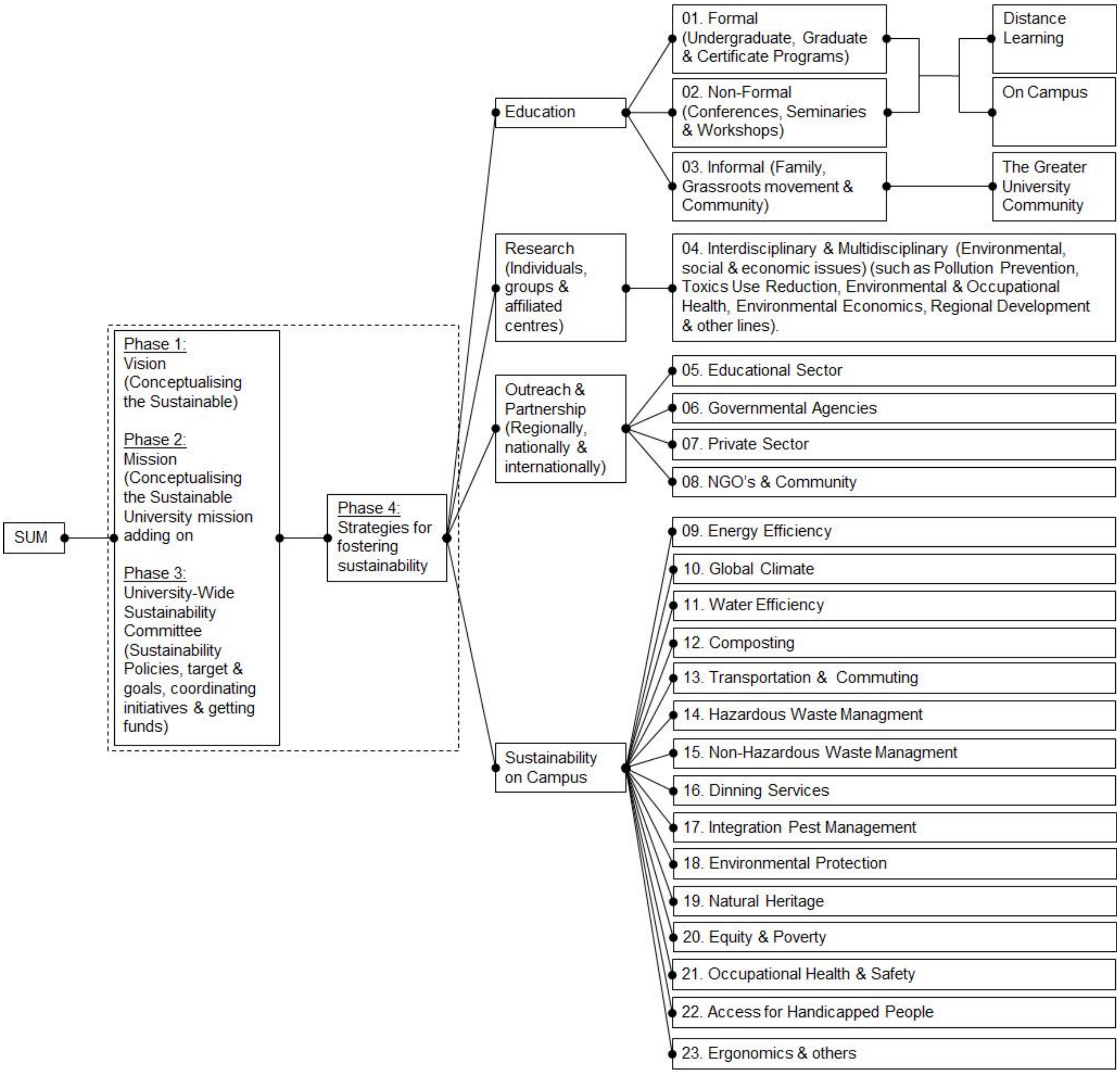
Appendix A.2: A summary of the GASU

● **Purpose**: The main aim was to establish a tool that helps measuring and reporting higher education institution's sustainability efforts within and among other institutions. It also "facilitates the analysis, longitudinal comparison and benchmarking of universities' sustainability efforts and achievement" (Lozano 2006, 963).
Criteria and indicators: The GRI (2002) has three criteria and 36 indicators. In the GASU model (Lozano 2006), however, Lozano adds additional criteria, and hence, there were 59 indicators in total. The levels of hierarchy are four, and hence, sub-criteria are eight (direct economic impact; environmental; labour practices and decent work; human rights; society; product responsibility; curriculum; and research) (Lozano 2006).
● **Design approach**: The GASU uses the AMOEBA-type diagram to facilitate comparisons of university's efforts towards sustainability and its benchmarking against other universities. The idea is to grade each indicator on a scale of 0-4; 0 indicates lack of information, whereas 4 indicates that the information given has an excellent performance. Then, the GASU automatically generates nine charts (general chart; economic chart; environmental chart; educational chart; and five charts for social dimension). The charts could then be used to investigate the current situation of the institution to pinpoint the exact dimensions or criteria which need to be addressed (Lozano 2006).
● **Potential use**: The GASU gives the institution a visual illustration of sustainability dimensions. Therefore, it is easier to compare and contrast the university's efforts towards sustainability within and among other universities.
● **Tool structure**: Levels of hierarchy: four; main criteria: four; sub-criteria: eight; indicators: 59.

Sustainable university model (SUM)
● **Background**: The sustainable university model (SUM) model was created by Luis Velazques in 2006. Soon after, it was tested using empirical data from around 80 universities across the world. The model offers a structured framework for visualising and achieving a sustainable university system. Appendix A.3 demonstrates a summary of key information about the SUM.
● **Purpose**: The SUM gives a clear perspective about "how people responsible for sustainability initiatives achieve their initial momentum to progress to advanced steps in the process to become a sustainable university" (Velazques et al. 2006, 810).
● **Criteria and indicators**: The SUM has four diverse phases (developing a sustainability vision for the university; the mission; sustainability committee; and sustainability strategies). The strategies have four criteria (education; research; outreach and partnership; and sustainability on campus).
● **Design approach**: The SUM represents a clear orientation on exactly how to be a sustainable university. The systematic analysis designed to assist higher education institution personnel understands the concept of sustainability through executing the four steps incrementally:

> *'The implementation of the model must not be a static process for generating particular initiatives. Therefore, the four phases of the model are a series of iterations that are designed to work continuously to improve the sustainability of the institution'* (Velazques et al. 2006, 817).

● **Potential use**: It is clear that this model is more likely to be used as an internal impetus through which the university personnel can advance the institution's strategies for becoming sustainable.
● **Tool structure**: Levels of hierarchy: four; main criteria: four; sub-criteria: zero; indicators: 23.



Appendix A.3: A summary of the SUM

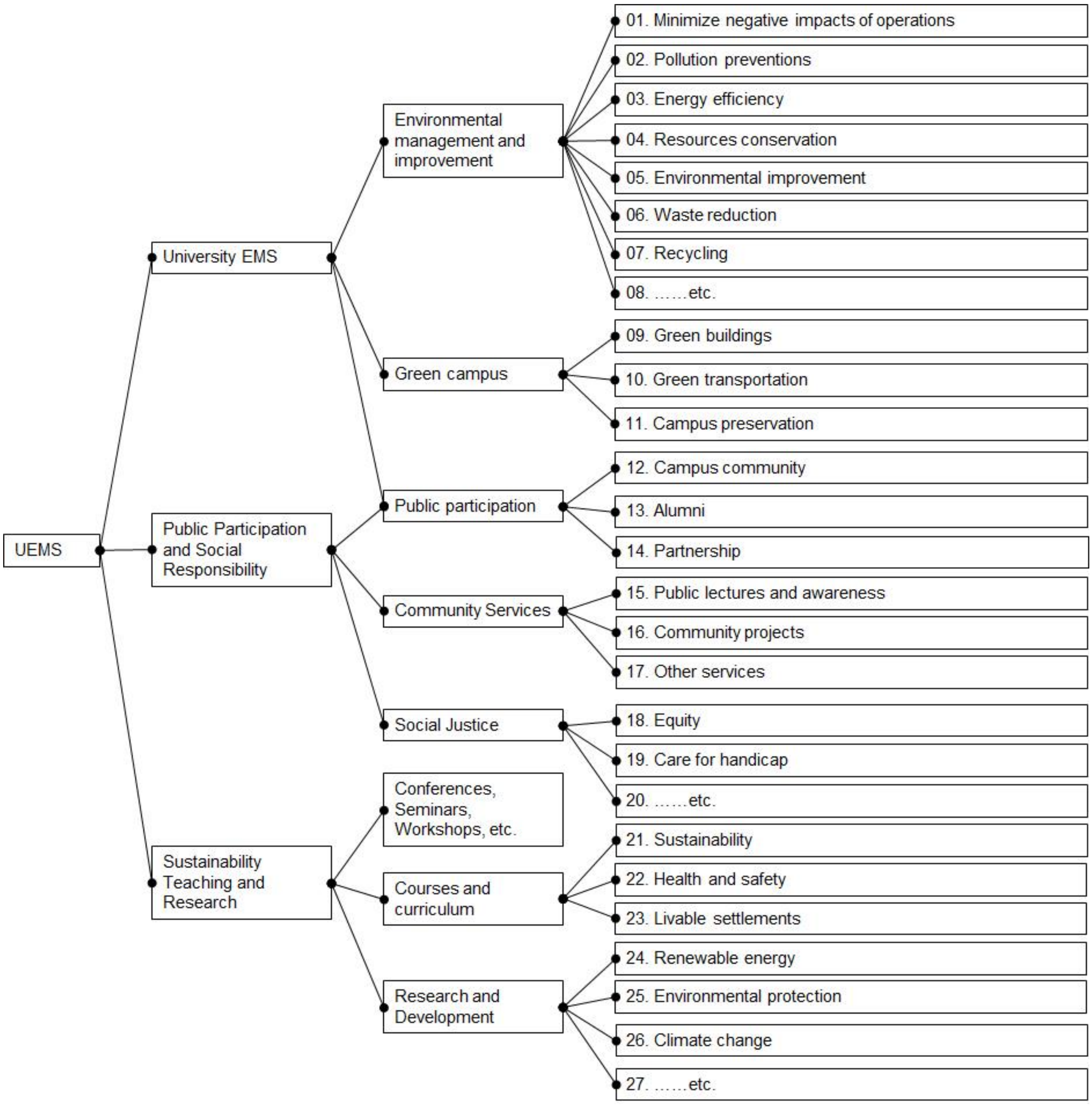
University environmental management system (UEMS)

● **Background**: In 2008, Alshuwaikhat and Abubakar proposed the university environmental management system (UEMS) framework to achieve campus sustainability through overcoming the lack of environmental management practices for higher education institutions. The system ensures more sustainability through the integration of three strategies: university Environmental management system; public participation and social responsibility; and promoting sustainability through education and research. Appendix A.4 exhibits a summary of key information about the UEMS.

● **Purpose**: The reason to propose the UEMS framework is to develop sustainability in university by directing its efforts in a systematic way in which the three strategies mentioned above can be accomplished by undertaking a range of initiatives.

● **Criteria and indicators**: The UEMS has three strategies (criteria) and eight initiatives (sub-criteria), namely, environmental management and improvement; green campus; public participation; community services; social justice; conferences, seminars or workshops;

courses and curriculum; and research and development. Alshuwaikhat and Abubakar (2008) suggest 27 indicators through which the initiatives can be completed successfully.



Appendix A.4: A summary of the UEMS

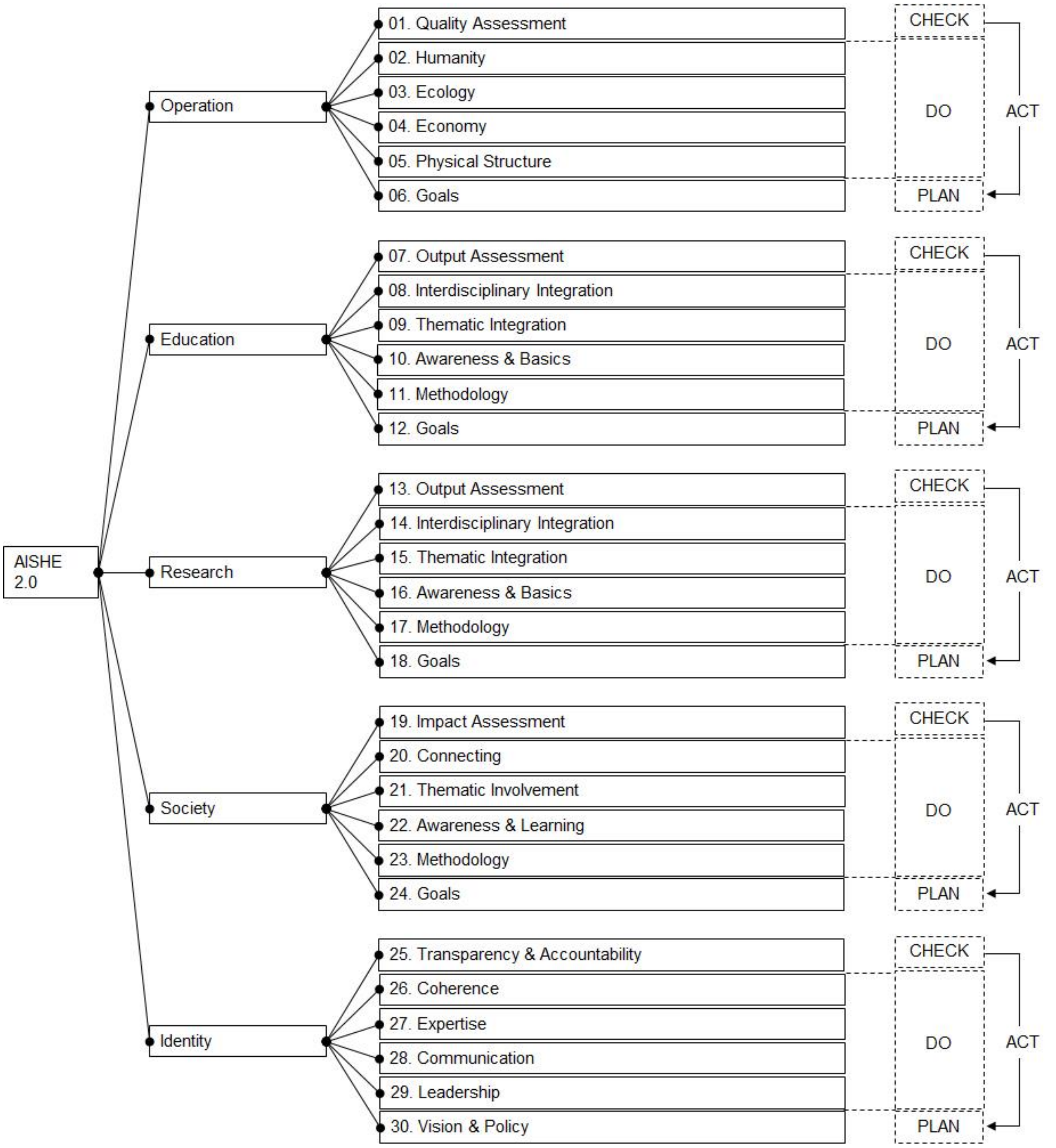
● **Design approach**: The UEMS measures sustainability by addressing the main aspects of sustainability in university campus and beyond. The integrated approach recommends adopting the three aforementioned strategies. Each strategy has initiatives which can lead to achieving the sustainability mission of the institution. Moreover, higher education institution ought to establish an organisational structure, in a format of either a committee or a department, along with providing the necessary resources to accomplish the sustainability vision (Alshuwaikhat & Abubakar 2008).
● **Potential use**: The UEMS can be used by colleges and universities to broadly guide their efforts towards sustainability. This framework can be used internally, meaning that a

university can develop its vision and mission to become sustainable by following the three strategies and the eight initiatives proposed by this model.
● **Tool structure**: Levels of hierarchy: four; main criteria: three; sub-criteria: eight; indicators: 27.

Assessment instrument for sustainability in higher education (AISHE)
● **Background**: The assessment instrument for sustainability in higher education (AISHE) was established by a Dutch group called the Dutch Foundation for Sustainable Development, led by Niko Roorda. The first version of AISHE was developed and validated between 2000 and 2001. AISHE 1.0 has been used by many universities across the world to assess sustainability in their institutions. The first version was criticised, as it focused too heavily on the educational dimension of sustainability. However, the second version of AISHE was developed and launched in 2009. The expanded version, AISHE 2.0, covers social and environmental and educational aspects. In 2012, the AISHE was reviewed by Hobéon, a consultancy company focusing on Dutch higher education system, to update it and make it more accessible (Boer 2013). Appendix A.5 displays a summary of key information about the AISHE 2.0.
● **Purpose**: The major aims of this tool are to offer a framework that audits sustainability internally and externally; to measure the accomplishment in campus implementation of sustainability; and to create a mechanism through which motivations and experience can be exchanged between higher education institutions (Roorda 2002).
● **Criteria and indicators**: The expanded AISHE 2.0 consists of five modules (criteria), namely, operation, education, research, society and identity. Each criterion has six indicators. The idea of continuous improvement is the core of the AISHE structure. This process called "Deming Cycle" or "PDCA Cycle" (Deming 1986). It has four steps: plan, do, check and act. This means that once the process is completed, it starts again in a never-ending cycle.
● **Design approach**: The framework was categorised in five distinctive modules (criteria), reflecting the main aspects of any university. Each can be used and applied individually. The result of the assessment can be represented through a reporting tool to give an explicit overall assessment of sustainability efforts. This assessment then can indicate whether the university, or certain areas, qualifies for certification (Roorda et al. 2009).
● **Potential use**: This framework is appropriately applicable for the whole university, but it also can be used at a campus, a college, a school, a department or even a single research or education centre. What adds value to the model is that it is specifically designed to incorporate only the most significant criteria and not necessarily the whole framework.
● **Tool structure**: Levels of hierarchy: three; main criteria: five; sub-criteria: zero; indicators: 30.

Benchmark indicator questions – alternative university appraisal (BIQ-AUA)
● **Background**: The alternative university appraisal (AUA) is a project launched in 2009 by an Asia-Pacific academic alliance named ProSPER.Net (promotion of sustainability in postgraduate education and research network). It is made up of 28 universities, including its 19 founding members from Australia, India, Japan, Korea, Malaysia, Thailand and the UN. The ambition was to promote education for sustainable development (ESD) under the sponsorship of the United Nations University Institute of Advanced Studies. Appendix A.6 shows a summary of key information about the BIQ-AUA (BIQ – benchmark indicator questions).
● **Purpose**: The central aim is to help higher education institutions planning to introduce or advance ESD activities. It is also aiming to create "a learning community, in which HEIs can

identify their own strengths and weaknesses, learn from one another and share good ESD practices in their own areas of interest” (AUA 2012, 4).



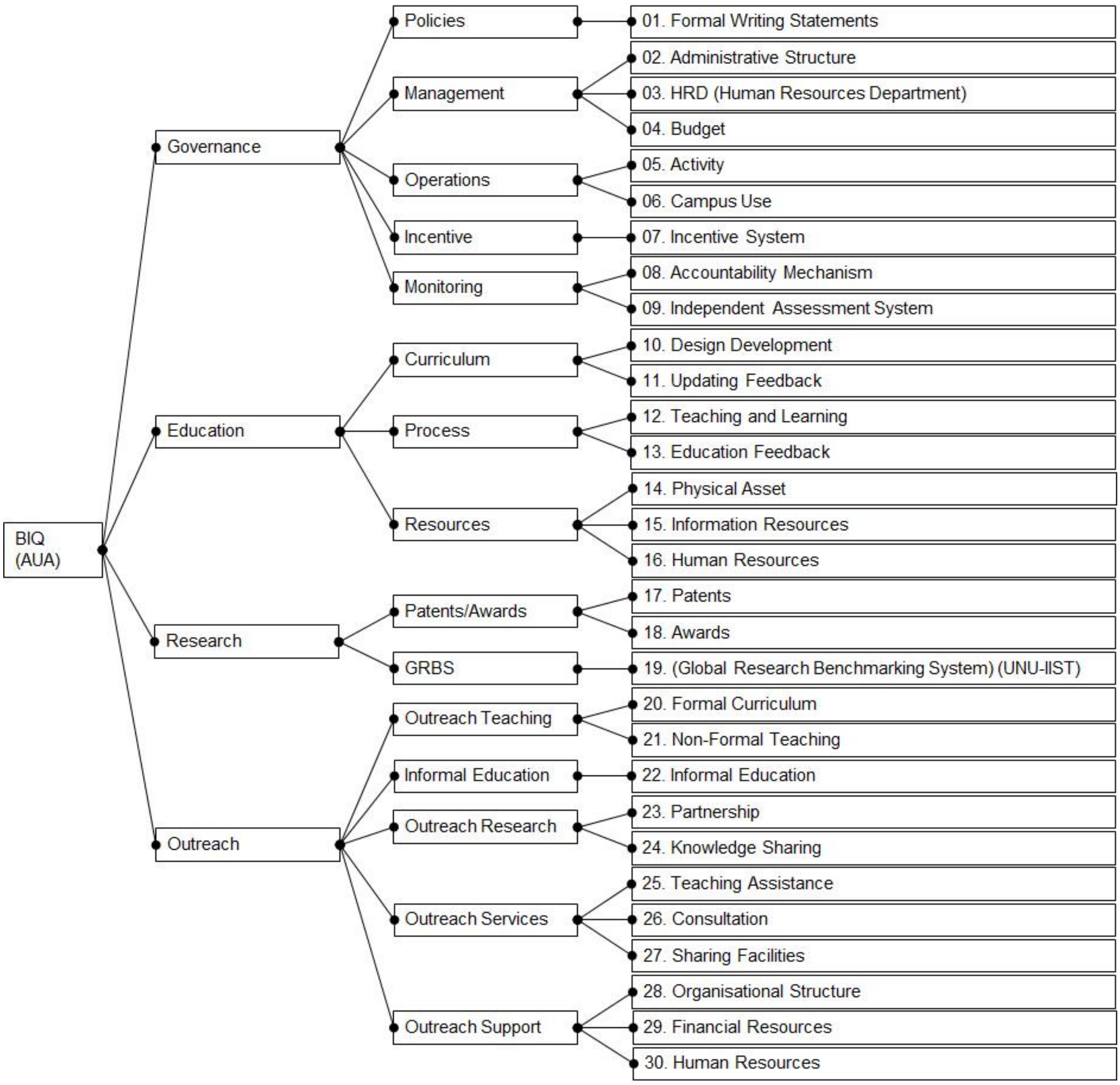
Appendix A.5: A summary of the AISHE 2.0

● **Criteria and indicators**: The BIQ has four criteria (governance, education, research and outreach) and 13 sub-criteria (policies, management, operations, incentive, monitoring, curriculum, process, resources, patents/awards, global research benchmarking system, outreach teaching, informal education, outreach research, outreach services and outreach support). These sub-criteria represent 30 indicators and 50 questions.
● **Design approach**: The ProSPER.Net approach is developing the BIQ model among others: sustainability assessment questionnaire (SAQ); dialogue; and the BIQ. The BIQ is a useful tool to look at, because it is indicator-based. The BIQ is a set of quantitative questions about

the overall maturity of the university's efforts towards sustainability. The method is to form a group that represents all users such as administrative staff; faculty staff and members; academics; and students to answer the 50 questions raised in the BIQ. The group can also include individuals from alumni associations, non-profit organisations, non-governmental organisations or related communities.

● **Potential use**: The BIQ can be used to allow the institution to reorient itself towards a sustainable future and assist universities to acknowledge areas to be recognised, addressed and hence improved.

● **Tool structure**: Levels of hierarchy: four; main criteria: four; sub-criteria: 13; indicators: 30.

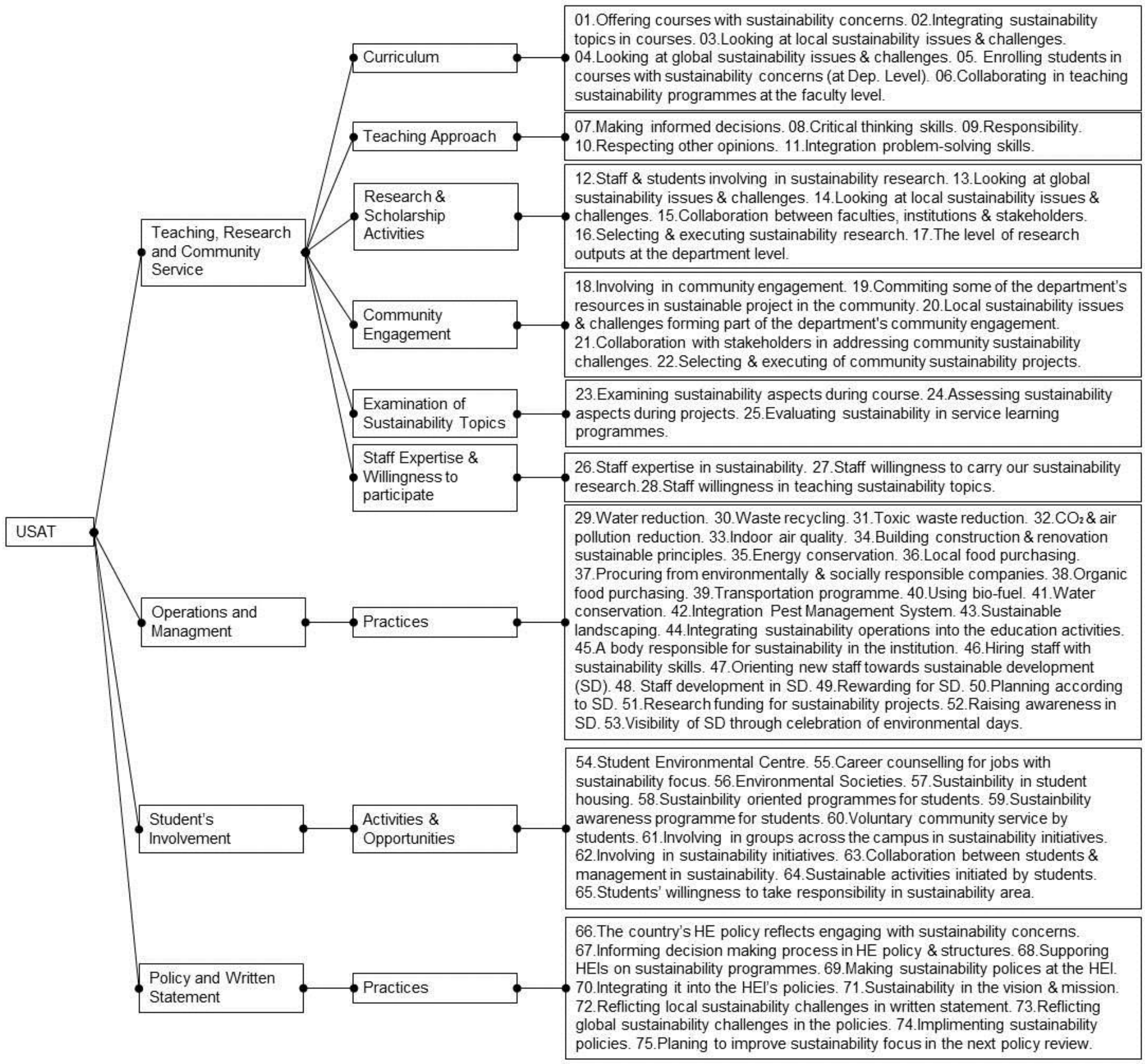


Appendix A.6: A summary of the BIQ-AUA

Unit-based sustainability assessment tool (USAT)

● **Background**: The unit-based sustainability assessment tool (USAT) is a tool developed to be used in the Swedish/Africa International Training Programme. The programme was on Education for Sustainable Development in Higher Education, supported by the United

Nations Environmental Programme (UNEP) and Mainstreaming Environment and Sustainability into African Universities. The tool "was developed through the PhD research of Muchaiteyi Togo, supervised and supported by Heila Lotz-Sisitka at Rhodes University, South Africa" (PSPE 2012b). Appendix A.7 illustrations a summary of key information about the USAT.



Appendix A.7: A summary of the USAT

● **Purpose**: The main aim of developing this framework is not only to be a guide for educating and aiding university towards sustainability but also to be a flexible tool used at the departmental, faculty and unit level (Togo & Lotz-Sisitka 2013). So, the idea is to be used individually and independently by different departments, faculties or units at the same institution.
● **Criteria and indicators**: The USAT is divided into four areas (criteria), nine sub-criteria and 75 indicators. The four criteria are: teaching, research and community services; operations and management; student's involvement; and policy and written statement.
● **Design approach**: The USAT was developed based on reviewing three well-known frameworks, namely, SAQ, AISHE and GASU. These frameworks were used as a foundation

for developing and proposing indicators for a unit-based audit tool: Though the USAT is designed to be used at departmental/institutional unit level, the results representing the performance of various departments can be averaged to get the overall performance of the institution. Not all the teaching departments or institutional units at a university need necessarily to be included in the survey, though it is important to have all faculties represented if the results are to represent overall university sustainability performance (Togo & Lotz-Sisitka 2009, 8).

● **Potential use**: This tool can be mainly used to facilitate a quick identification of a university department's efforts towards sustainability. It can also detect areas (indicators) in which a department is leading or lagging.

● **Tool structure**: Levels of hierarchy: four; main criteria: four; sub-criteria: nine; indicators: 75.

The Green Plan

● **Background**: The Green Plan (or the CPU-CGE Green Plan Framework) was initially developed in France and drawn up by the French Conference of University Presidents (CPU), the French Conference of Grands Ecoles (CGE) and the French Ministry of Ecology. The first version of the Plan was launched in 2010 with four levels (criteria), whereas the 2012 version was built on five continuous improvement levels. Appendix A.8 depicts a summary of key information about the Plan.

● **Purpose**: The Green Plan system, which was mainly designed and developed for colleges and universities, is aiming to assist them in drawing up their own sustainability plans. It is designed to be operational and can be suitably adapted at different stages in the implementations of sustainability. The Framework can:

> *'... assess the progress made; analyse and diagnose its strong points and weak points; define a sustainable development strategy that is consist with its general policy; draw up its plan of action; implement the plan of action defined; assess and develop a process for continuous improvement and progress'* (Green Plan 2010).

● **Criteria and indicators**: The Framework covers five fields (criteria): strategy and governance; teaching and training; research; environmental management; and social policy and regional presence. There are 18 sub-criteria in total and 44 indicators.

● **Design approach**: The Green Plan outline helps to highlight the institution's sustainable development policy, whereas the Green Plan Framework assesses implementation of the sustainable development policy. The Framework table is organised in a way in which it can be completed easily, clearly and succinctly. It includes definitions, indicators, supporting documents, action plan and five levels (categories) for each indicator explaining (awareness, initiation, conformity of green plan scheme targets, control and leadership).

● **Potential use**: The Green Plan Framework makes it possible to measure and assess the sustainability performance of the institution in relation to laws, standards and voluntary initiatives; compare the sustainability performance of the institution over a period of time; and compare several institutions in terms of their sustainability performance (Green Plan 2010).

● **Tool structure**: Levels of hierarchy: four; main criteria: five; sub-criteria: eight; indicators: 44.

Sustainable campus assessment system (SCAS)

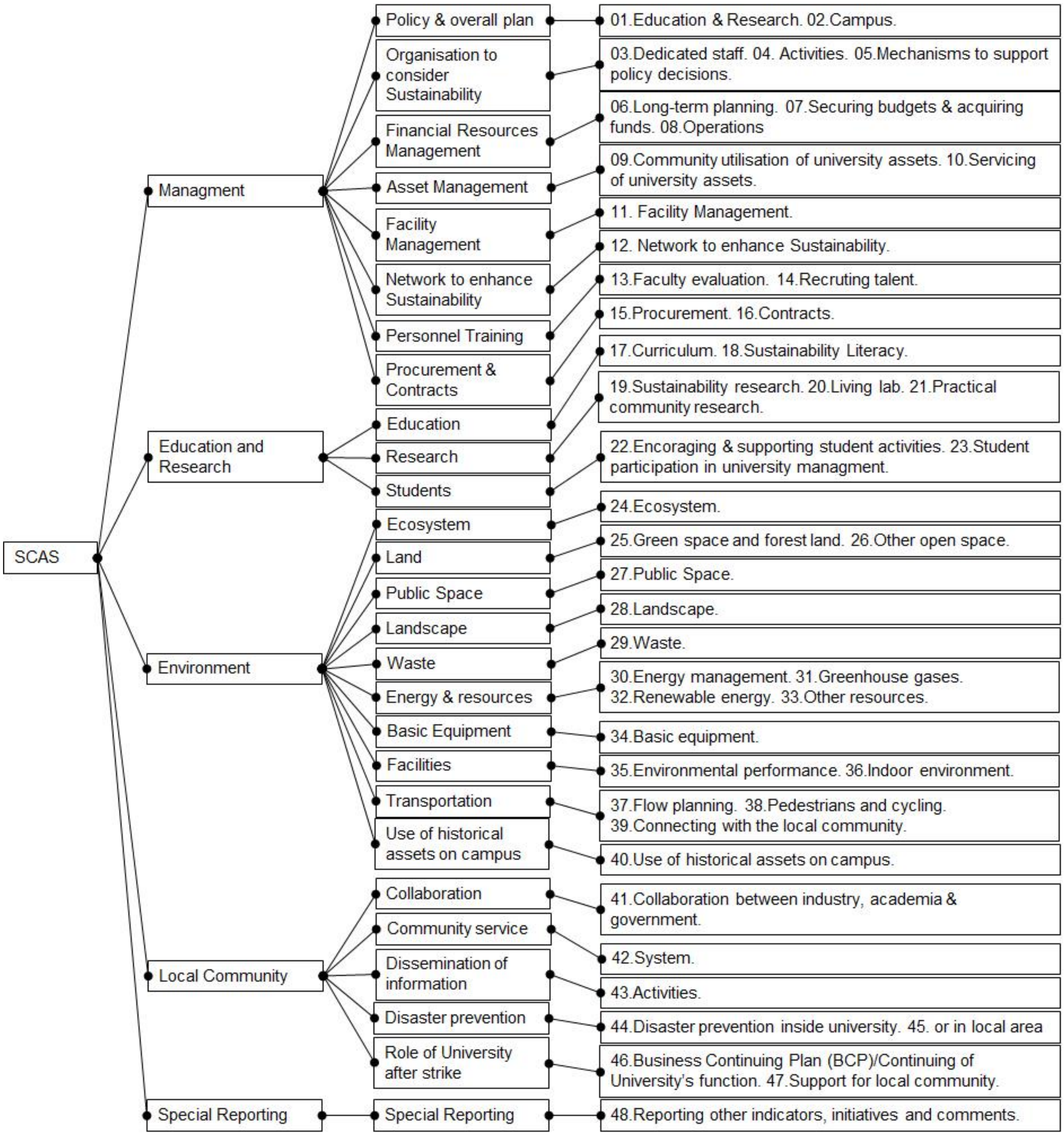
● **Background**: The sustainable campus assessment system (SCAS) was developed by the Office for a Sustainable Campus in Hokkaido University, Japan. In 2013, the system was approved by Hokkaido University. It is the first instrument to assess sustainability in higher education institutions in Japan (PSPE 2012a). The updated version of 2014 is very detailed and contains well-explained criteria. Appendix A.9 represents a summary of key information about the SCAS.

Appendix A.8: A summary of the Green Plan

● **Purpose**: The system has been developed aiming to evaluate sustainability aspects in higher education institutions. The assessment system's result will inform each institution of its strengths and weaknesses in terms of sustainability. The tool can offer relative comparison to other institutions (SCAS 2014).

● **Criteria and indicators**: The 2014 version of SCAS has 5 criteria and 27 sub-criteria. It has 48 categories represented by 174 questions. What is noticeable in this framework is that it offers slightly unusual sub-criteria. Disaster prevention and the role of university after a calamity are examples of this odd collection. This is understandable given the fact that Japan and other Asian-Pacific countries should be prepared in advance for disasters such as earthquakes and tsunamis. The SCAS covers a wide range of issues, and the 27 sub-criteria bear witness to such diversity and richness.

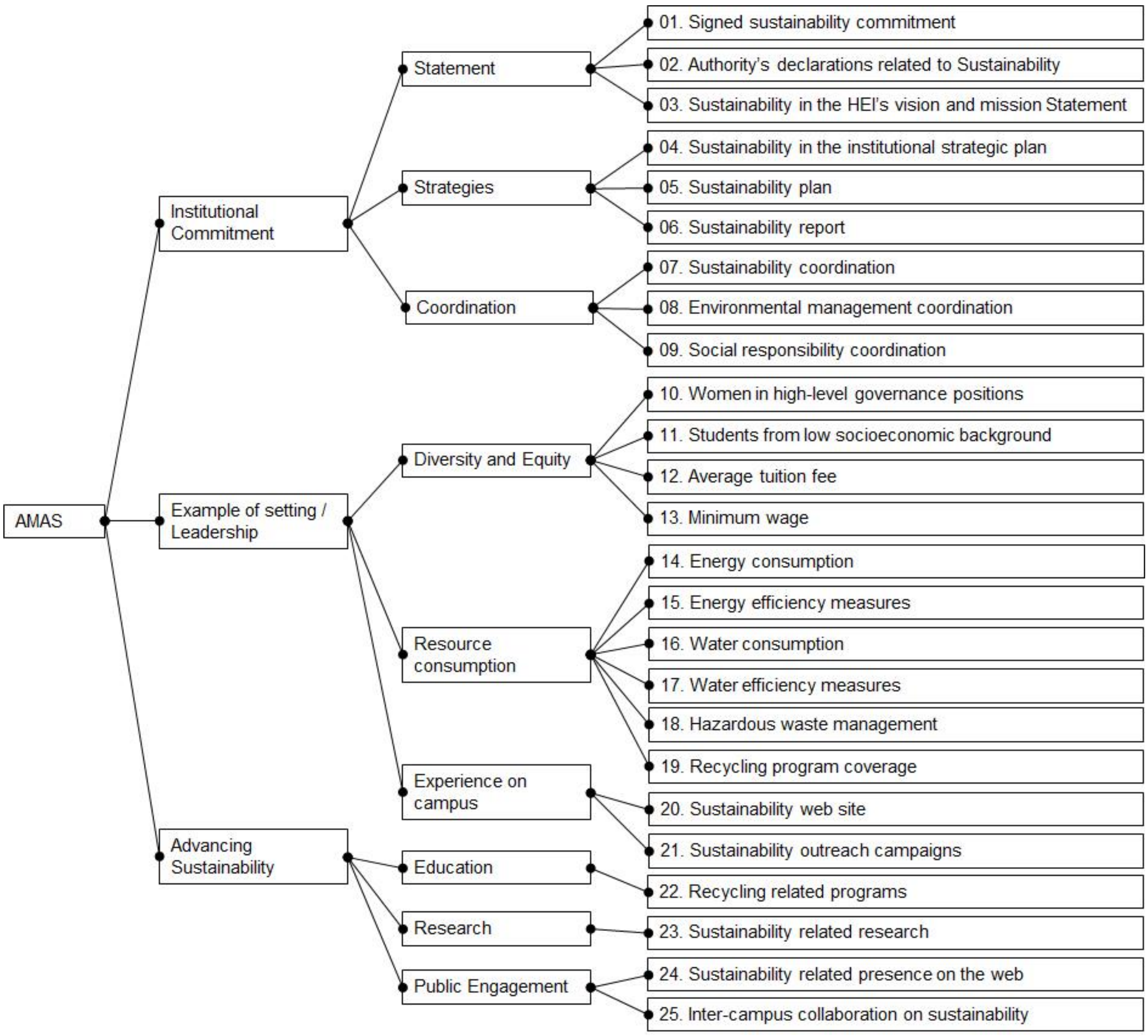
● **Design approach**: The 28-page online survey is designed to be a self-assessment. In the survey, the assessment criteria are defined and examples are given. A score is allocated to each question. The survey is bilingual, written in both Japanese and English.
● **Potential use**: The SCAS could potentially help each institution to make a decision of their strategies for their sustainable future based on an assessment that covers a wide range of aspects of sustainability. The SCAS is a particularly useful model for countries that experience earthquakes and tsunamis.
● **Tool structure**: Levels of hierarchy: four; main criteria: five; sub-criteria: 27; indicators: (48 categories – 174 questions).



Appendix A.9: A summary of the SCAS

Adaptable model for assessing sustainability in higher education (AMAS)

● **Background**: The adaptable model for assessing sustainability in higher education (AMAS) was initially developed during Gómez's master's degree research under the supervision of Sáez-Navarrete (Gómez 2013). They then, among others, launched the AMAS model in 2014. The model was designed to be based on deep understanding of earlier experience in sustainability in universities, taking into consideration international declarations and other models. Appendix A.10 displays a summary of key information about the AMAS.



Appendix A.10: A summary of the AMAS

● **Purpose**: The goal of AMAS is:

> *'... to introduce an Adaptable Model for Assessing Sustainability into higher education institutions that enable the assessment of sustainability within different implementation stages and data availability scenarios'* (Gómez et al. 2014, 01).

● **Criteria and indicators**: The AMAS framework has been structured based on three interrelated criteria: institutional commitment; example of setting/leadership; and advancing sustainability. These three categories then have nine sub-criteria: statement; strategies; coordination; diversity and equity; resource consumption; experience on campus; education;

research; and public engagement. The model proposes 25 indicators to help assess sustainability aspects in higher education institutions.

● **Design approach**: Unlike many assessment tools, the AMAS was constructed based on clear justification, as all the stages of building the model were presented in the research. To calculate the 25 indicators, both qualitative and quantitative data are required; 15 indicators need quantitative data (60 per cent), whereas just 10 need qualitative data (40 per cent).

● **Potential use**: This model is flexible in terms of adding and removing indicators based on the context of the institution, without losing common ground criteria. Hence, this model "enables the assessment of sustainability within different contexts while maintaining a universal methodological approach". Additionally, it:

> *'... allows for comparison within a cluster of institutions with similar contexts. The assessment model could be used to improve other assessment tools by following the same process used to build the model, facilitating the participation of stakeholders and experts'* (Gómez et al. 2015, 475).

● **Tool structure**: Levels of hierarchy: four; main criteria: three; sub-criteria: nine; indicators: 25.

Sustainability tracking, assessment, and rating system (STARS)

● **Background**: The sustainability tracking, assessment and rating system (STARS) is a voluntary self-reporting system developed by the AASHE. It was initially developed in 2010 as one of the initiatives towards sustainable higher education institutions in the USA and Canada. It is not only an assessment instrument but also a rating framework adding more value to the system as a comparison tool. STARS, therefore, has recently become one of the most popular frameworks (Gómez et al. 2015; Saadatian & Salleh 2011). Appendix A.11 demonstrations a summary of key information about the STARS.

● **Purpose**: According to the STARS's 2.0, the main goals are to:

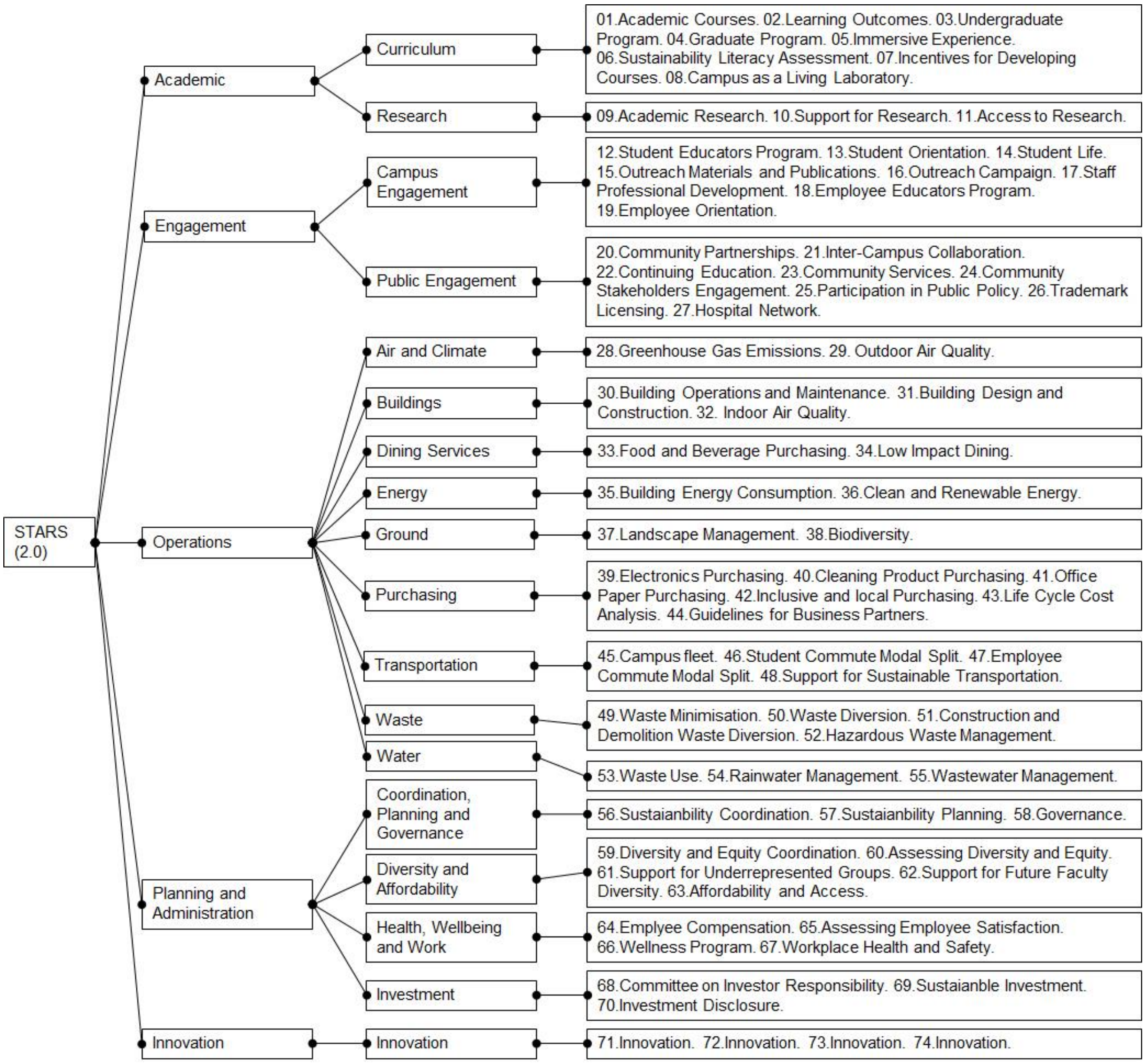
> *'... provide a framework for understanding sustainability in all sectors of higher education; to enable meaningful comparisons over time and across institutions using a common set of measurements developed with broad participation from the campus sustainability community; to create incentives for continual improvement towards sustainability; to facilitate information sharing about higher education sustainability practices and performance and finally to build a stronger, more diverse campus sustainability community'* (2014, 9).

● **Criteria and indicators**: Unlike the first version of STARS, which was divided into three criteria, the 2014 STARS version was categorised into five areas: academic; engagement; operations; planning and administration; and innovation. The STARS has 74 indicators (including four innovation credits scored separately) in 18 sub-criteria: curriculum; research; campus engagement; public engagement; air and climate; building; dining services; energy; ground; purchasing; transportation; waste; water; coordination, planning and governance; diversity and affordability; health, well-being and work; and investment and innovation.

● **Design approach**: The STARS is an online credit-based survey based on four categories along with the innovation one. Hence, there are five levels of rating (with minimum score required for each level): bronze (25 credits); silver (45 credits); gold (65 credits); platinum (85 credits); and reporting (participating but not considering to be rated).

● **Potential use**: The STARS can be used as a road map for developing a sustainable plan for higher education institutions that are taking first steps towards sustainability or those who already advanced.

● **Tool structure**: Levels of hierarchy: four; main criteria: five; sub-criteria: 18; indicators: 74.



Appendix A.11: A summary of the STARS 2.0

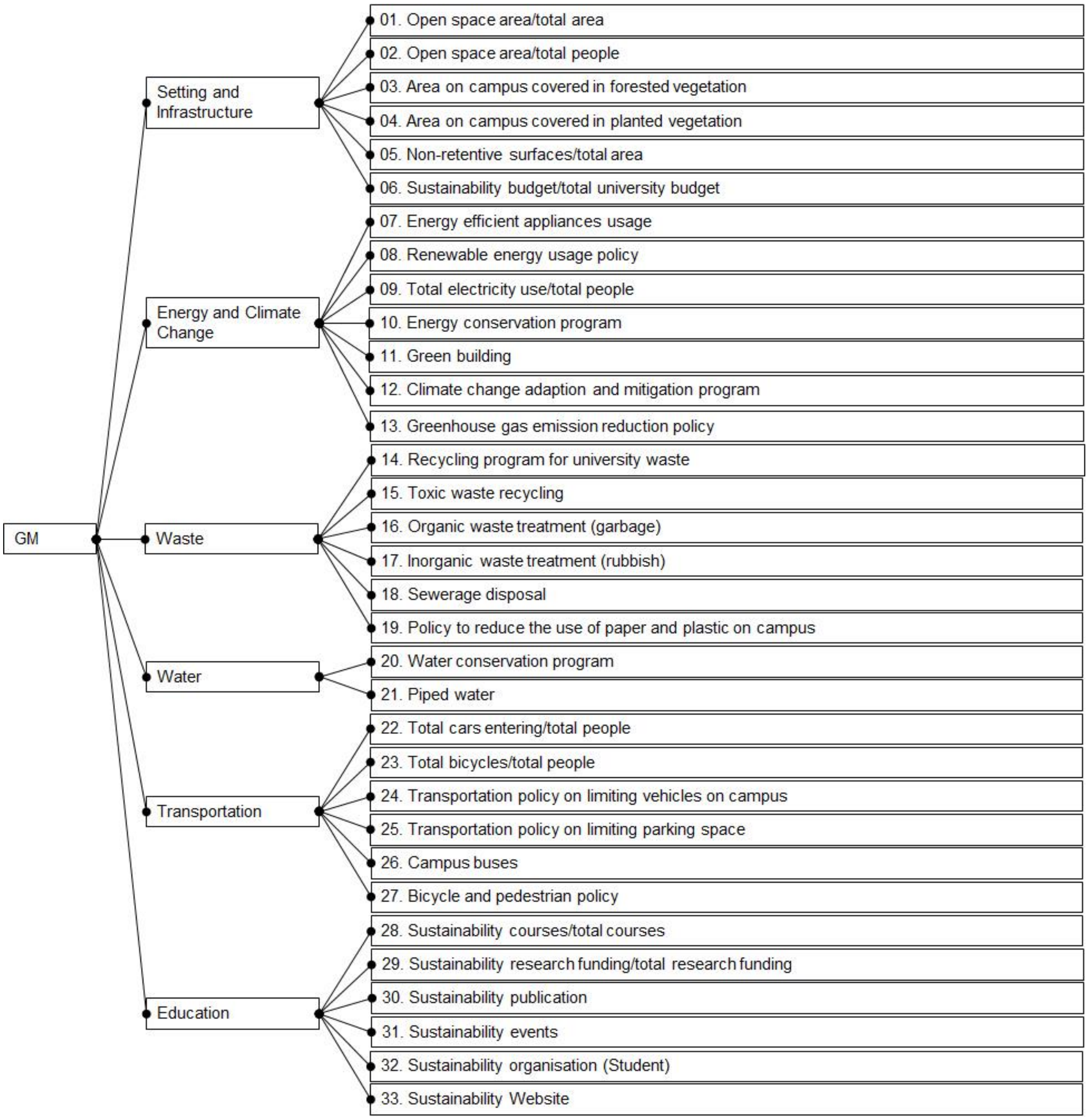
Green metric (UI's GreenMetric university sustainability ranking)

● **Background**: The Green metric (GM) or (UI's GM) is a world university ranking system for universities to assess and compare campus efforts towards sustainability. The tool was based on a broad philosophy that encompasses the three E's: environment; economics; and equity and education. It was developed by the Universitas Indonesia (University of Indonesia), Indonesia, in 2010. The updated version of the GM was released in 2014. Appendix A.12 shows a summary of key information about the GM.

● **Purpose**: The main aim of this framework (or this ranking) is to be open to every and each higher education institution to participate; to be accessible to all universities in both the developed and developing world; to contribute to the body of knowledge on sustainability in education and the greening of campuses; and to promote university-led social change with regards to sustainability goals (GM 2014).

● **Criteria and indicators**: The GM was divided into six dimensions (criteria): setting and infrastructure; energy and climate change; waste; water; transportation; and education. The tool has no sub-criteria and has a total of 33 indicators.

● **Design approach**: The free GM system collects its data through an online survey covering six categories mentioned above. These criteria are assessed and then added up. Each specific indicator within each criterion is assessed based on a points system of awarding.
● **Potential use**: The system can be potentially used for measuring sustainability in higher education institutions through its ranking system and, hence, benchmarking campus sustainability best practices from all over the world.
● **Tool structure**: Levels of hierarchy: three; main criteria: six; sub-criteria: zero; indicators: 33.



Appendix A.12: A summary of the GM

Appendix B
Appendix B: Research questionnaire

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Assessing Environmental Sustainability
A Study of the planning and design of higher education facilities in Saudi Arabia

Introduction: Saudi Arabia is investing heavily in higher education sector specifically in its physical facilities. The Kingdom is building over 20 new campuses for 20 recently established universities. The construction began with PHASE I by building a couple of colleges in each university. PHASE II, in which other college buildings will be constructed, will be carried out in the near future. This study is part of an ongoing PhD that research focuses on environmental sustainability in university campuses in Saudi Arabia. This evaluation will be conducted in 9 public universities with the goal of assessing and addressing environmental issues in Saudi universities.

Aims: The research aims to i) learn more about environmental sustainability in the first phase of college buildings and university campuses, ii) develop sustainable planning principles as a guidance to aid improvement of these facilities, and hence iii) help make new college buildings, to a large extent, future-proof.

Importance: Your input is an opportunity to make your voice heard to influence decision making for planning better and sustainable colleges and campuses; saving resources and helping yourself as well as the future generations to learn, study and do research in a healthier, smarter and greener environment.

Instructions: Based on the research focus, the questionnaire is divided into 4 parts: sustainability awareness, university site, college building and educational spaces. Please answer each question separately. Responses will be anonymised. The entire survey may take between 10 to 15 minutes.

General Information:

1. University: ....
2. College: ....
3. Department: ....
4. Category of work: (*Please tick*)

   ☐ Student (*Please circle which* year: 1st - 2nd - 3rd - 4th - 5th- 6th - 7th) ☐ Academics ☐ Admin staff

5. Level of education - the degree you have already obtained: (*Please tick*)

   ☐ Post-graduate degree (Master's or Doctoral)
   ☐ Undergraduate degree (Bachelor's)
   ☐ Associate degree (community colleges or technical colleges)
   ☐ General education (High or Secondary school)
   ☐ Less than high school (Intermediate education/school)

Part 1: Environmental Awareness and Sustainable Behaviour

6. Attitude, knowledge, and awareness of sustainability

The World Commission on the Environment and Development (1987) defined Sustainable Development as "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*".

6.1. Did you know about the definition of "Sustainable Development" mentioned above? (*Please tick*)

☐ Yes ☐ No

6.2. When thinking about a "sustainable university", its campus has to consider the implementation of sustainable practices (environmentally, economically, socially and educationally) through its campus life cycle (planning, constructing, maintaining, and retrofitting) through all management directions (top-down as well as bottom-up approaches) on all levels of campus (from classrooms to laboratories, transportation, procurement, housing and other services) in many ways (e.g. energy saving, water conservation, air quality, social equity, waste reduction, walkability, students experience, well-being and health) or in many different shapes and forms (e.g. flexibility, multi-functionality, optimal space utilisation). What do you consider are the most important sustainability issues in university campus?

....
....
....

1 of 4

6.3. Please indicate which of the following statements best describes your level of interest in sustainability:
- ☐ I have a passion for sustainability
- ☐ I have considerable interest in sustainability
- ☐ I am neither interested nor disinterested in sustainability (neutral)
- ☐ I have little interest in sustainability
- ☐ I have no interest in sustainability

6.4. Does your university have facilities for renewable energy? (e.g. solar panels, wind turbines, geothermal plant etc.)
☐ Yes ☐ No If yes, please give more information: ....

6.5. Does your university have separate collection bins for different types of waste e.g. glass, paper, plastic, etc.?
☐ Yes ☐ No

6.6. Would you be willing to use the separate collection bins for different types of waste if available?
☐ Yes ☐ No If not, why? ....

6.7. Which issues act as barriers preventing you living a more sustainable lifestyle at university and home?
(*Please tick all that applies to you*)
- ☐ Unsure what I should be doing
- ☐ Too difficult
- ☐ Too time consuming
- ☐ Too costly
- ☐ Lack of collective action to make a difference
- ☐ Lack of support within my community
- ☐ Lack of support at my university (no Student Group's)
- ☐ Not a high priority
- ☐ Other: ....

7. Sustainable behaviour

7.1. Please tick if you:
- ☐ Refill water bottles
- ☐ Recycle (treat or process used or waste materials so as to make suitable for reuse)
- ☐ Engage in energy reduction practices (e.g. turn off heat/A.C./ lights, high efficiency lightbulbs)
- ☐ Donate unwanted possessions
- ☐ Purchase sustainable products (e.g. recycled paper notebooks)
- ☐ Have conversations outside of class with faculty, staff, or friends about sustainability issues
- ☐ Perform research on a sustainability topic
- ☐ Take a module/course on sustainability subjects from your program of study
- ☐ Attend a program/event related to sustainability (e.g. events off campus)
- ☐ Attend lectures focused on sustainability (e.g. open and public lectures)
- ☐ Participate in student organizations focused on sustainability

Part 2: University Site Characteristics

8. Geographical situation (work-home distance/proximity**)**

8.1. Is the university close to your place of living? (*Please tick*)
☐ Yes ☐ No How far in kilometres approximately?..

8.2. Do you live in the university campus (Student Dormitories, Staff Housing…etc.)?
☐ Yes ☐ No

8.3. Would you prefer to live on campus instead of off campus?
☐ Yes ☐ No If Yes or No, please state why?..

9. Accessibility (mobility**)**

9.1. How do you come to the university?
☐ Train/Bus (campus fleet) ☐ Own car ☐ Carpooling ☐ Cycling ☐ Walking ☐ Other: ……….......

9.2. In minutes, how long is usually your commuting time to your college?
☐ 10 ☐ 15 ☐ 20 ☐ 30 ☐ 45 ☐ 60 or more

9.3. How do you assess the number of car parking spaces in the university?
☐ Far too little ☐ Too little ☐ About right ☐ Too much ☐ Far too much

2 of 4

9.4. Overall, how do you assess the traffic infrastructure (motorways, capacity, & traffic density) on your way to and from the university? (*Please tick*)

☐ Very poor ☐ Poor ☐ Fair ☐ Good ☐ Very good

9.5. Are you willing to use public transport, university shuttle or sharing a car instead of your own car to the university?

☐ Yes ☐ No If not, why? ……………………………………………………………………………

9.6. Does your university develop actions to reduce the need to travel? (using e.g. tele-education, tele-working or flexible schedules-working hours etc.)

☐ Yes ☐ No ☐ Not sure

Part 3: College Building Characteristics

10. Types of space

10.1. In an average week, how much time do you spend in the following types of space?
(*Please calculate and write down the hours underneath each type of space*)

Types of Space	Lecture halls		Laboratory / workshop / studio		Library		Office		Café, Cafeteria, Prayer hall		Other (*Please state*): …………………		**Total**
Hours per week	………..	+	………..	+	………..	+	………..	+	………..	+	………..	=	………..

11. Indoor Environmental Quality (IEQ):

The quality ensures that the building provides safe, healthy, and productive spaces for the campus community. The IEQ encompasses the conditions inside a building (air quality, lighting, temperature, ergonomics) and their effects on occupants or residents.

11.1. Please rate the quality of the following spaces using a scale of 1 to 5 where:

(1) Very poor (2) Poor (3) Fair (4) Good (5) Very good

Types of Space	Lecture halls	Laboratory / workshop / studio	Library	Office	Café, Cafeteria, Prayer hall	Other (*Please state*): …………………	**Overall**
Rate	………..	………..	………..	………..	………..	………..	………..

12. Feeling and experience

12.1. Do you prefer doing your study, work, research or project at your college?

☐ Yes ☐ No If not, please state why?…………………………………………………………

12.2. Where do you usually do your study, work or research (e.g. college, library, home, coffee shop on/off campus)?

……………………………………………………………………………………………………

……………………………………………………………………………………………………

12.3.1 Your most favourite place or spot in your college building is ……………………………… because ………………………………

12.3.2 Your least favourite place or spot in your college building is ……………………………… because ………………………………

13. Flexibility (Time, Space & Furniture**)**

13.1. Would you be willing to come to attend classes in the evening period (between 5 pm and 9 pm)?

☐ Yes ☐ No If yes, would you prefer to attend in the evening?………………………………

13.2. Which of the following flexibility properties does exist in your college building? (*Please tick*)

☐ opportunities to use spaces for multiple purposes (Versatility)
☐ easiness of adapting spaces for new functions (Convertibility)
☐ easiness of expansion and/or contraction of the educational space (Scalability)
☐ easiness of personalising spaces (Modifiability)

13.3. Can the furniture in any classroom in your college be easily reorganised in any of these multiple configurations: linear (lecture, presentation, and video), horizontal (class discussion), cluster (small group discussion and activities), and network (decentralized instruction)?

☐ Yes ☐ No ☐ Not sure

3 of 4

14. Space utilisation

14.1. How do you assess the proportion of the size of classrooms compared to the number of students in your college over the academic year?

☐ Very congested ☐ Congested ☐ Half filled ☐ Uncrowded ☐ Plenty of seats available

14.2. How satisfied are you with the overall size of classrooms in your college building?

☐ Very satisfied ☐ Satisfied ☐ Unsure ☐ Dissatisfied ☐ Very Dissatisfied

Part 4: Specific Space Characteristics

(This specific part of the evaluation focuses on specific types of space e.g. classroom, lab, library, office, theatre etc.).

15. Please state in which type of space are you in now: ………………………………………………………………...........…........

16. Air quality

16.1. What is the impact of quality of the air in this part of the building on your work performance?

☐ Very negative ☐ Negative ☐ Neutral ☐ Positive ☐ Very positive

16.2. Do you have control over the natural and mechanical ventilation systems?

☐ Yes ☐ No ☐ Not sure

16.3. Does this room have air quality detectors (monitoring CO2, humidity and temperature) to automatically decentralise the ventilation system ensuring optimal air quality without unnecessary energy loss?

☐ Yes ☐ No ☐ Not sure

17. Temperature (thermal conditions**)**

17.1. What is the impact of temperature in this part of the building on your work performance?

☐ Very negative ☐ Negative ☐ Neutral ☐ Positive ☐ Very positive

17.2. Do you have control over heating and/or cooling systems?

☐ Yes ☐ No ☐ Not sure

18. Light

18.1. What is the impact of quality of light in this part of the building on your work performance?

☐ Very negative ☐ Negative ☐ Neutral ☐ Positive ☐ Very positive

18.2. Do you have control over the natural and artificial lighting systems?

☐ Yes ☐ No ☐ Not sure

18.3. Does this room have lighting controls (motion sensor) to automatically turn lights on and off as needed?

☐ Yes ☐ No ☐ Not sure

19. Acoustics

19.1. What is the impact of sound quality in this part of the building on your work performance?

☐ Very negative ☐ Negative ☐ Neutral ☐ Positive ☐ Very positive

20) Please add any additional comments to improve sustainability in your building and campus:

....

....

....

21) Please indicate your interest in the following: *(please tick)*

☐ I am available for follow-up questions if needed

☐ I would like a copy of the summary of findings from this assessment

(**Name**:…………………………………..…….. / **Email**: ………………………………………………………..........……………..)

Thank you very much for taking part in this questionnaire

I acknowledge Delft University of Technology as well as the Saudi Ministry of Education (Higher Education) for the help and support and King Saud University for sponsoring the research project. For more information about the research, please do not hesitate to contact me: Naif Alghamdi, Faculty of Architecture and Planning, King Saud University, Riyadh, Saudi Arabia, e-mail: naag@ksu.edu.sa | T: +966114677144 | M: +966555774436.

Appendix C

Appendix C: Main interview questions

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Interview Questions

Part 1: General information

Name:
Position:
Responsibilities:
Years of experience (in general):
Years of experience (in position):
Level of education:
Qualification (Major):

Part 2: Main interview questions

01) What are the university's overall goals in general and in managing the university campus in particular?
02) What is the university's vision in general and what is it for managing the university campus?
03) What is the university policy to implement sustainability aspects?
04) What is the university commitment to sustainability? Put differently, as a university, what measures do you take to advance sustainability? (e.g. Office of Sustainability, Environmental Council, Environmental Coordinator, Director of Sustainability Programs, Energy Officer, Green Purchasing Coordinator, Institutional Declaration/Statement of Commitment to Sustainability/Environmental Responsibility, Orientation programs on sustainability for faculty and staff, Socially responsible investment practices and policies, Regularly conducted environmental audits...etc.)
05) How do your university assess sustainability aspects?
06) How can you describe integrating flexibility in the campus facilities? (Flexibility can be defined as e.g. easiness of expanding or contracting the space, easiness of adapting new functions, or allowing for multiple purposes)
07) How would you improve or ease the accessibility (mobility) to the university?
08) How do your university manage space provision and space utilisation?
09) What would the university do if the enrolment has fallen because of a shrinking youth population? How can your university campus with its facilities serve another function after they have served their original purpose (teaching, learning and doing research activities)?
10) Last decade (between 2005 and 2015) was the 'United Nations Decade of Education for Sustainable Development'. What is the university policy during this decade for such an important issue?
11) What prevents your university from planning and design the future proposed facilities to be certified by any green-building certification scheme mentioned earlier (e.g. BREEAM UK, LEED US, GREEN STAR AU, & DIGNB GR)?
12) There are many sustainability developments happening in university campuses around the world. I would like to ask if your institution has taken part or involved in or at least considered participating in:
    - The international declarations to advance all aspects of sustainability in higher education institutions e.g. Stockholm, Talloires, Halifax, Tokyo, and the UN
    - The Environmental Management Systems (EMS) such as ISO 14001 Standard and the EMAS Regulation
    - The specialised conferences held annually to address sustainability in universities and discuss the latest developments in the field e.g. ISCN, EMSU and AASHE
    - The sustainability assessment tools and frameworks e.g. SAQ, SUM, BIQ-AUA, USAT, and AMAS
    - The sustainability ranking systems for universities e.g. Green Matric, Green League, and STARS
    - The professional bodies or associations of campus facilities and college buildings e.g. SCUP and APPA
    - Events that have happened in the past years which show your institution's concern and commitment to sustainability in your campus (guest speakers, conferences, Earth Day celebrations, training course, workshop, etc.)

Appendix D (Space utilisation tables of five college buildings)

Appendix D.1: College of Languages and Translation at King Saud University

													Sunday								Monday								Tuesday								Wednesday								Thursday							
NO.	Department	Space Code	Space Type	Planned capacity	Planned space/user	Space Size (m2)	Space Per User	Current Capacity	Count	Sum	Frequency %	Occupancy %	Utilisation %	9	10	11	12	13	14	15	16	9	10	11	12	13	14	15	16	9	10	11	12	13	14	15	16	9	10	11	12	13	14	15	16	9	10	11	12	13	14	15	16
1	Common	G050	Lecture	25	1.7	42	1.4	30	16	424	40%	88%	**35%**	0	24	24	0	0	0	21	21	31	24	24	0	39	39	29	29	0	19	19	0	0	0	0	0	34	31	0	0	0	0	0	0	16	0	0	0	0	0	0	0
2	French	G004	Lecture	70	1.3	91	1.8	50	23	671	58%	58%	**34%**	0	8	8	0	23	23	0	0	51	51	51	0	25	25	0	0	0	33	33	0	19	19	0	0	49	50	50	0	18	18	8	8	50	33	0	0	18	0	0	0
3	Spanish	G024	Lecture	70	1.3	91	2.6	35	21	395	53%	54%	**28%**	0	0	0	0	9	9	9	9	32	32	32	0	11	11	0	0	29	29	0	0	9	9	9	9	32	32	32	0	11	11	0	0	29	0	0	0	0	0	0	0
4	French	G073	Computer lab	33	2.6	85	1.7	50	21	491	53%	47%	**25%**	50	51	51	0	0	0	29	29	21	4	4	0	0	0	0	0	0	19	19	0	0	0	23	23	12	27	27	0	21	21	14	14	0	0	0	0	0	0	16	16
5	Common	1014	Lecture	70	1.3	90	2.0	44	26	672	65%	59%	**38%**	31	31	31	0	0	0	21	0	43	46	46	0	21	21	2	2	46	43	43	0	0	0	21	21	0	43	0	0	3	3	0	21	29	46	0	0	5	5	24	24
6	Common	1001	Lecture	42	1.6	68	1.9	35	21	541	53%	74%	**39%**	22	36	36	0	21	21	30	0	29	31	31	0	0	0	0	0	29	28	28	0	9	9	0	0	0	28	0	0	30	30	0	0	30	29	0	0	17	17	0	0
7	French	1003	Lecture	40	1.5	60	1.7	35	24	391	60%	47%	**28%**	0	18	18	0	14	14	1	1	22	31	31	0	16	16	0	0	17	0	18	0	13	13	0	0	32	0	0	0	20	20	0	0	0	18	18	0	18	18	2	2
8	Common	1012	Lecture	70	1.3	91	2.6	35	26	672	65%	74%	**48%**	30	36	36	0	23	23	0	27	32	24	24	0	31	31	27	27	27	26	26	0	0	0	2	2	0	26	0	0	27	27	27	0	22	27	0	0	31	31	0	0
9	Common	1013	Lecture	70	1.3	91	2.6	35	26	581	65%	64%	**42%**	30	15	15	0	9	9	13	0	30	28	28	0	18	18	22	22	29	31	31	0	29	29	13	13	0	31	0	0	0	0	0	18	29	29	0	0	0	0	21	21
10	Common	1014	Lecture	70	1.3	91	2.1	44	26	672	65%	59%	**38%**	31	31	31	0	0	0	21	0	43	46	46	0	21	21	2	2	46	43	43	0	0	0	21	21	0	43	0	0	3	3	0	21	29	46	0	0	5	5	24	24
11	Common	1004	Lecture	70	1.3	91	2.3	40	20	493	50%	62%	**31%**	45	21	21	0	0	0	0	28	35	38	38	0	18	18	8	8	0	0	0	0	30	30	0	0	22	17	17	0	28	28	8	0	35	0	0	0	0	0	0	0
12	Common	1006	Lecture	25	1.7	42	1.7	25	16	104	40%	26%	**10%**	4	0	0	0	2	2	0	0	2	2	2	0	0	0	2	0	0	21	21	0	2	2	0	0	30	0	0	0	0	0	2	2	0	4	4	0	0	0	0	0
13	English	1008	Lecture	35	1.5	51	1.7	30	17	278	43%	55%	**23%**	0	4	4	0	0	0	28	0	6	3	3	0	0	0	5	5	0	0	0	0	0	0	0	0	16	1	1	0	28	28	0	0	0	46	46	0	27	27	0	0
14	Spanish	1009	Lecture	25	1.7	42	1.4	30	15	99	38%	22%	**8%**	9	6	6	0	0	0	0	0	10	0	0	0	2	2	0	0	0	0	0	0	0	0	2	2	0	13	13	0	0	0	0	0	10	10	10	0	2	2	0	0
15	Spanish	1011	Lecture	25	1.7	42	1.4	30	15	124	38%	28%	**10%**	0	8	8	0	11	11	0	0	6	2	2	0	0	0	0	0	6	0	0	0	12	12	0	0	6	0	0	0	0	0	13	13	0	0	0	0	7	7	0	0
16	Common	1015	Lecture	25	1.7	42	1.4	30	14	94	35%	22%	**8%**	4	5	5	0	0	0	4	4	0	0	16	0	0	0	0	0	16	0	0	0	8	8	0	0	8	4	4	0	0	0	4	4	0	0	0	0	0	0	0	0
17	Common	1016	Lecture	25	1.7	42	1.4	30	17	86	43%	17%	**7%**	13	1	1	0	0	0	0	0	0	1	1	0	2	2	0	0	4	0	0	0	9	9	0	0	23	7	7	0	1	1	2	0	2	0	0	0	0	0	0	0
18	Common	1017	Lecture	36	1.4	51	1.7	30	27	299	68%	37%	**25%**	1	18	18	0	0	11	11	0	12	10	10	0	15	15	12	12	2	26	26	0	0	0	12	12	2	0	10	0	13	13	0	0	13	10	10	0	2	1	2	0
19	Common	1018	Lecture	20	1.7	33	1.7	20	7	55	18%	39%	**7%**	7	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	7	0	0	0	0	0	8	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0
20	Common	1019	Lecture	16	1.6	26	1.6	16	16	58	40%	23%	**9%**	3	0	0	0	0	0	4	4	3	3	3	0	0	0	0	0	0	0	0	0	0	0	4	4	0	4	4	0	0	0	4	4	3	3	0	0	0	0	4	4
21	Common	1033	Lecture	25	1.7	42	1.4	30	12	282	30%	78%	**24%**	28	23	23	0	34	34	0	0	29	17	17	0	0	0	0	0	0	0	0	0	0	0	0	0	21	14	14	0	0	0	0	0	28	0	0	0	0	0	0	0
22	Common	1070	Lecture	35	1.5	51	1.7	30	11	334	28%	101%	**28%**	33	30	30	0	0	0	0	0	0	29	29	0	0	0	0	0	0	36	36	0	0	0	0	0	30	29	0	0	0	0	0	0	16	0	36	0	0	0	0	0
23	Common	1074	Lecture	35	1.5	51	1.7	30	16	543	40%	113%	**45%**	30	31	31	0	33	33	0	0	0	31	31	0	0	0	0	0	0	38	38	0	33	0	0	0	31	31	0	0	38	38	0	0	0	0	38	0	38	0	0	0
24	Hebrew	G002	Lecture	25	1.7	42	1.7	25	24	141	60%	24%	**14%**	0	6	6	0	4	4	0	0	0	9	9	0	3	3	5	10	9	7	7	0	5	5	3	0	7	3	3	0	10	10	0	0	6	0	3	0	4	0	0	0
25	Hebrew	G003	Lecture	35	1.5	51	1.7	30	25	360	63%	48%	**30%**	26	23	23	0	3	3	4	4	25	27	27	0	3	0	3	3	26	27	27	0	4	4	0	0	25	23	23	0	3	8	0	0	0	0	0	0	8	8	0	0
26	Persian	G005	Lecture	35	1.5	51	1.7	30	27	175	68%	22%	**15%**	11	3	3	0	0	0	16	16	0	0	0	0	5	5	9	9	1	1	1	0	5	5	7	9	7	0	0	0	5	5	7	7	0	6	6	0	6	6	7	7
27	Spanish	G024	Lecture	70	1.3	91	2.6	35	22	424	55%	55%	**30%**	0	0	0	0	9	9	9	9	32	32	32	0	11	11	0	0	29	29	29	0	9	9	9	9	32	32	32	0	11	11	0	0	29	0	0	0	0	0	0	0
28	French	G025	Lecture	70	1.3	91	1.8	50	22	480	55%	44%	**24%**	41	45	45	0	1	1	0	0	46	44	44	0	2	2	4	4	0	9	9	0	0	0	2	2	43	45	45	0	1	1	0	0	44	0	0	0	0	0	0	0
29	English	G035	Lecture	35	1.5	51	1.5	35	12	172	30%	41%	**12%**	0	0	0	0	0	0	0	0	0	0	0	0	17	17	0	0	0	2	2	0	12	12	0	0	0	17	17	0	13	13	17	0	33	0	0	0	0	0	0	0
30	Russian	G055	Lecture	25	1.7	42	1.4	30	12	220	30%	61%	**18%**	24	24	24	0	0	0	0	0	18	20	20	0	0	0	0	0	24	0	0	0	4	4	0	0	18	20	20	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix D.2: College of Science at University of Hail

													Sunday								Monday								Tuesday								Wednesday								Thursday							
NO.	Department	Space Code	Space Type	Planned capacity	Planned space/user	Space Size (m2)	Space Per User	Current Capacity	Count	Sum	Frequency %	Occupancy %	Utilisation %	9	10	11	12	13	14	15	16	9	10	11	12	13	14	15	16	9	10	11	12	13	14	15	16	9	10	11	12	13	14	15	16	9	10	11	12	13	14	15	16
31	Biology	F112	Lecture	35	1.2	43	1.2	35	14	330	35%	67%	**24%**	36	30	34	0	0	0	0	18	36	30	34	8	0	0	0	0	0	1	0	0	0	0	0	0	36	30	34	1	0	2	0	0	0	0	0	0	0	0	0	0
32	Chemistry	F080	Lecture	35	1.2	43	1.0	41	26	377	65%	35%	**23%**	39	7	7	30	30	12	12	0	39	5	5	0	0	0	5	5	0	12	12	9	0	7	0	6	39	3	3	0	18	18	0	4	39	0	0	5	6	0	0	0
33	Mathletics	F072	Lecture	35	1.2	41	1.0	40	15	301	38%	50%	**19%**	0	37	0	0	0	21	21	2	0	37	0	11	0	0	0	5	6	21	21	0	20	0	23	2	0	37	0	0	0	0	0	0	0	37	0	0	0	0	0	0
34	Physics	S057	Lecture	45	2.3	103	2.9	35	26	601	65%	66%	**43%**	35	0	0	0	0	38	38	3	35	11	11	0	47	47	0	0	18	18	5	0	23	23	2	3	35	27	27	30	30	0	0	0	40	23	0	0	7	7	18	0
35	English	F051	Lecture	25	1.3	32	0.8	40	24	333	60%	35%	**21%**	0	6	3	31	0	0	22	0	20	7	0	2	2	6	0	0	12	6	3	21	21	0	0	0	37	33	33	2	2	0	14	10	31	6	3	0	0	0	0	0
36	Physics	F097	Lecture	35	1.2	43	1.1	40	21	274	53%	33%	**17%**	37	10	10	3	5	5	0	0	37	17	17	14	14	0	0	0	3	0	3	0	0	0	0	0	37	5	5	17	0	0	0	0	0	5	14	0	8	8	0	0
37	Tourism	F063	Lecture	84	1.5	122	3.5	35	20	628	50%	90%	**45%**	31	30	0	39	0	0	0	0	33	0	0	32	32	33	33	0	31	30	0	39	0	0	0	0	2	33	33	32	32	0	33	0	31	30	0	39	0	0	0	0
38	Archaeology	F055	Lecture	25	1.3	32	1.3	25	15	166	38%	44%	**17%**	5	43	31	0	0	9	0	0	27	0	6	6	1	0	0	6	5	0	0	0	0	9	0	0	0	0	6	6	1	0	0	0	5	0	0	0	0	0	0	0
39	Tourism	F062	Lecture	35	1.2	43	1.7	25	12	198	30%	66%	**20%**	10	0	36	0	0	0	0	0	0	0	18	9	0	3	0	0	10	0	36	0	0	0	0	0	0	0	18	9	0	3	0	0	10	0	36	0	0	0	0	0
40	English	S060	Lecture	25	2.7	67	2.2	30	18	407	45%	75%	**34%**	0	19	19	20	20	0	0	0	0	34	34	0	0	2	0	0	49	19	19	20	20	0	0	0	4	34	34	0	0	2	0	0	0	0	0	0	29	29	0	0
41	Common	F052	Lecture	25	1.3	32	0.8	40	20	419	50%	52%	**26%**	0	33	6	6	6	0	0	10	14	8	0	0	18	18	0	0	0	29	29	0	0	0	0	10	0	8	0	43	43	31	31	0	0	33	33	0	0	0	0	10
42	Common	F061	Lecture	35	1.2	43	1.2	35	18	159	45%	25%	**11%**	0	16	10	0	0	1	0	0	0	0	10	10	9	1	0	0	0	16	10	0	0	1	0	0	0	18	10	10	9	1	0	0	0	16	10	0	0	1	0	0
43	Common	F066	Lecture	35	1.3	44	1.3	35	23	199	58%	25%	**14%**	7	0	2	5	5	0	0	0	0	18	18	0	0	3	3	5	7	2	5	5	0	0	0	0	0	0	28	0	0	3	3	5	7	0	2	5	5	28	28	0
44	Common	F071	Lecture	25	1.3	32	1.3	25	25	262	63%	42%	**26%**	6	13	5	10	5	0	0	0	0	0	17	28	11	3	0	0	6	13	5	10	5	0	0	0	0	0	17	28	11	3	0	0	6	13	0	7	7	7	13	13
45	Common	F090	Lecture	35	1.1	40	1.3	30	23	180	58%	26%	**15%**	7	0	20	0	12	12	3	3	2	0	20	3	0	3	3	0	7	9	9	5	5	0	0	0	2	0	20	0	2	2	0	0	7	12	12	0	0	0	0	0
46	Common	F091	Lecture	40	1.6	65	1.6	40	23	538	58%	58%	**34%**	0	5	5	0	0	31	31	0	34	27	27	1	1	18	18	0	0	31	31	0	0	37	37	0	14	18	18	0	0	34	34	0	24	31	31	0	0	0	0	0
47	Common	F098	Lecture	35	1.2	43	1.7	25	20	217	50%	43%	**22%**	0	14	14	0	10	10	0	0	4	1	0	5	5	12	12	0	0	11	11	0	4	22	22	8	0	0	0	0	0	0	0	8	0	10	0	17	17	0	0	0
48	Common	F100	Lecture	45	1.8	82	2.1	40	18	528	45%	73%	**33%**	0	0	0	0	5	5	0	0	15	47	47	37	37	0	34	0	0	0	0	34	34	33	33	0	37	0	0	15	15	0	0	0	34	33	33	0	0	0	0	0
49	Common	F128	Lecture	45	1.5	69	1.7	40	17	547	43%	80%	**34%**	0	2	2	0	0	0	0	0	0	31	0	44	44	0	0	0	40	0	0	24	24	0	0	0	44	30	0	47	47	0	0	0	16	36	36	40	40	0	0	0
50	Common	F131	Lecture	60	1.7	102	2.3	45	11	281	28%	57%	**16%**	0	0	0	0	0	0	0	0	0	34	0	0	0	0	0	0	0	44	0	7	7	0	0	0	0	0	0	0	34	34	0	0	7	13	13	0	44	44	0	0
51	Physics	G061	Lab	20	4.7	94	4.7	20	37	546	93%	74%	**68%**	15	15	17	17	17	19	19	19	14	14	0	0	0	16	16	16	16	16	14	14	14	14	14	14	18	18	12	12	12	11	11	11	18	18	12	12	12	13	13	13
52	Physics	G067	Lab	20	4.7	93	4.7	20	32	544	80%	85%	**68%**	15	15	21	21	21	20	20	20	0	0	0	0	0	15	15	15	16	16	18	18	18	15	15	15	18	18	15	15	15	17	17	17	19	19	0	0	0	15	15	15
53	Physics	G068	Lab	15	4.4	66	4.4	15	33	533	83%	108%	**89%**	15	15	17	17	17	14	14	14	0	0	15	15	15	20	20	20	0	0	20	20	20	12	12	12	19	19	17	17	17	0	0	0	18	18	14	14	14	14	14	14
54	Chemistry	G086	Lab	20	4.4	87	4.4	20	19	336	48%	88%	**42%**	0	0	26	26	26	0	22	22	3	3	0	0	0	0	0	0	0	0	0	0	0	0	16	16	0	0	20	20	20	0	12	12	0	0	20	20	20	0	16	16
55	Chemistry	G087	Lab	25	3.8	94	3.8	25	24	316	60%	53%	**32%**	3	3	10	10	0	19	19	19	0	0	0	0	0	0	0	12	7	7	0	2	0	21	21	21	0	0	0	0	0	19	19	19	10	0	20	20	20	5	5	5
56	Chemistry	G092	Lab	25	3.8	94	3.8	25	26	391	65%	60%	**39%**	0	0	20	20	20	0	3	3	20	20	3	3	3	21	21	21	0	0	0	0	0	24	24	24	8	8	0	14	14	14	19	19	0	0	15	15	15	0	0	0
57	Common	S054	Lecture	45	2.4	109	2.7	40	20	697	50%	87%	**44%**	0	0	0	0	0	0	0	0	37	0	0	0	40	40	39	0	33	64	0	32	32	63	31	13	39	40	0	0	0	0	37	0	2	31	31	31	31	31	0	0
58	Common	S058	Lecture	25	2.0	50	1.3	40	14	466	35%	83%	**29%**	0	39	39	46	46	0	0	12	55	0	0	41	41	0	0	0	52	0	0	0	0	0	0	0	0	6	6	0	0	38	38	7	0	0	0	0	0	0	0	0
59	Common	S059	Lecture	60	3.3	198	5.0	40	20	402	50%	50%	**25%**	0	0	14	46	0	0	0	0	8	8	15	15	30	30	41	0	0	7	14	46	0	0	30	0	8	8	15	15	0	11	11	0	30	0	0	0	0	0	0	0
60	Common	S061	Lecture	45	3.5	159	4.0	40	22	528	55%	60%	**33%**	4	4	0	0	0	0	0	0	30	37	37	25	25	0	0	0	4	4	0	0	20	20	0	0	41	47	0	25	25	37	38	38	11	20	0	0	18	18	0	0

Appendix D.3: College of Engineering at University of Najran

NO.	Department	Space Code	Space Type	Planned capacity	Planned space/user	Space Size (m2)	Space Per User	Current Capacity	Count	Sum	Frequency %	Occupancy %	Utilisation %	Sunday								Monday								Tuesday								Wednesday								Thursday							
														9	10	11	12	13	14	15	16	9	10	11	12	13	14	15	16	9	10	11	12	13	14	15	16	9	10	11	12	13	14	15	16	9	10	11	12	13	14	15	16
61	Civil	CE212	Lecture	32	1.3	43	1.4	30	8	114	20%	48%	**10%**	0	0	0	0	0	0	0	0	0	19	0	0	0	0	19	19	0	0	0	0	0	0	0	0	0	19	0	0	0	0	17	17	0	0	0	0	2	2	0	0
62	Civil	CE214	Lecture	32	1.7	53	1.3	40	12	162	30%	34%	**10%**	0	16	16	0	0	0	0	0	0	16	16	0	0	0	0	0	0	16	0	0	0	0	17	17	0	16	0	0	0	0	10	10	0	0	0	0	0	0	6	6
63	Civil	CE206	Lecture	29	1.1	31	1.0	30	8	156	20%	65%	**13%**	0	13	0	0	0	0	0	0	0	0	0	0	26	26	26	0	0	13	13	13	0	0	0	0	0	0	0	0	26	0	0	0	0	0	0	0	0	0	0	0
64	Civil	CE213	Lecture	31	1.4	44.7	1.5	30	10	98	25%	33%	**8%**	0	9	9	0	17	17	0	0	0	5	0	0	0	0	0	0	0	9	0	0	17	0	0	0	0	5	5	5	0	0	0	0	0	0	0	0	0	0	0	0
65	Civil	CE225	Studio	60	1.9	111	1.9	60	5	209	13%	70%	**9%**	0	0	0	0	61	0	0	0	0	0	0	29	29	0	0	0	0	0	0	0	61	0	0	0	0	0	0	29	0	0	0	0	0	0	0	0	0	0	0	0
66	Electrical	EE216	Lecture	36	1.5	53	2.1	25	8	109	20%	55%	**11%**	24	14	14	0	0	0	0	0	13	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	10	0
67	Electrical	EE212	Lecture	32	1.3	43	1.7	25	13	172	33%	53%	**17%**	19	7	7	0	0	0	0	0	0	17	17	0	17	17	10	10	0	7	0	0	0	0	0	0	0	17	0	0	17	0	10	0	0	0	0	0	0	0	0	0
68	Electrical	EE211	Lecture	32	1.3	43	1.7	25	8	65	20%	33%	**7%**	0	0	0	0	0	0	15	15	13	1	1	0	0	0	0	0	0	0	0	0	0	0	15	0	0	1	0	0	0	0	4	0	0	0	0	0	0	0	0	0
69	Architecture	ARE221	Lecture	42	1.3	56	1.9	30	10	126	25%	42%	**11%**	0	0	0	0	0	0	0	0	12	12	0	0	13	13	0	0	0	0	0	0	0	0	0	0	12	12	13	13	13	13	0	0	0	0	0	0	0	0	0	0
70	Electrical	EE213	Lecture	32	1.6	52	2.1	25	9	113	23%	50%	**11%**	9	17	17	0	0	0	0	0	0	17	17	0	0	0	0	0	0	17	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	1	1	0	0
71	Architecture	ARE203	Lecture	20	1.7	33	1.7	20	9	51	23%	28%	**6%**	0	0	0	0	0	0	0	0	5	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5	5	7	7	7	0	0	0	0	0	0	0	0	0	0
72	Civil	CE216	Lecture	36	1.5	53	1.8	30	12	22	30%	6%	**2%**	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	3	3	3	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
73	Civil	CE211	Lecture	32	1.3	43	1.4	30	11	61	28%	18%	**5%**	1	1	0	0	0	0	0	0	0	0	0	0	0	0	18	18	3	3	0	0	0	0	0	0	0	0	0	0	5	5	0	0	0	0	0	0	2	2	3	0
74	Civil	CE209	Lab	30	2.9	86	2.9	30	3	66	8%	73%	**6%**	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
75	Civil	CE204	Lecture	29	1.1	31	1.0	30	8	144	20%	60%	**12%**	0	0	0	0	13	13	23	23	0	0	0	0	0	0	0	0	0	0	0	0	13	13	23	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
76	Civil	CE202	Lecture	29	1.1	32	1.1	30	6	84	15%	47%	**7%**	0	0	0	0	0	0	0	0	0	14	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	14	14	14	0	0	0	0	0	0	0	0	0	0	0
77	Civil	CE205	Lecture	30	1.0	31	1.0	30	4	20	10%	17%	**2%**	0	0	0	0	0	0	0	0	5	5	0	0	0	0	0	0	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
78	Electrical	EE201	Studio	70	1.6	110	1.8	60	5	175	13%	58%	**7%**	0	0	0	0	35	35	35	0	0	0	0	0	0	0	0	0	0	0	0	0	35	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
79	Architecture	ARE228	Studio	90	3.8	342	5.7	60	5	147	13%	49%	**6%**	0	0	0	0	0	0	0	0	0	0	0	0	0	18	18	37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37	37	0	0	0	0	0	0	0	0
80	Civil	CE201	Studio	70	1.6	110	1.8	60	8	259	20%	54%	**11%**	0	41	14	14	0	0	0	0	0	0	0	0	0	0	0	0	0	41	41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36	36	36	0	0	0	0
81	Electrical	EE225	Lecture	32	1.7	53	1.8	30	2	20	5%	33%	**2%**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0
82	Electrical	EE218	Lecture	36	1.4	51	2.0	25	10	102	25%	41%	**10%**	0	0	0	0	0	0	0	0	0	13	13	13	0	0	0	0	0	0	0	0	0	0	0	0	0	13	13	13	0	0	0	0	0	0	0	0	6	6	6	6
83	Architecture	ARE201	Studio	32	3.4	109	3.6	30	13	195	33%	50%	**16%**	15	15	15	15	0	0	0	0	0	0	0	0	18	18	0	0	15	15	15	15	0	13	13	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
84	Architecture	ARE214	Lecture	30	1.4	41	1.4	30	9	72	23%	27%	**6%**	8	8	8	0	0	0	0	0	0	0	0	0	0	0	0	0	8	8	8	0	0	0	0	0	0	0	8	8	8	0	0	0	0	0	0	0	0	0	0	0
85	Architecture	ARE213	Lecture	36	1.6	56	1.9	30	14	86	35%	20%	**7%**	0	7	7	7	7	6	6	6	0	0	4	4	4	0	0	0	7	7	7	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
86	Architecture	ARE222	Lecture	42	1.3	56	1.9	30	12	78	30%	22%	**7%**	0	0	0	0	8	8	8	0	0	0	0	0	0	5	5	5	0	0	0	0	8	8	8	0	0	5	5	5	0	0	0	0	0	0	0	0	0	0	0	0
87	Architecture	ARE207	Computer lab	30	2.9	86	2.9	30	8	84	20%	35%	**7%**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	9	9	9	0	0	0	0	12	12	12	12
88	Architecture	ARE212	Lecture	36	1.5	54	1.8	30	7	28	18%	13%	**2%**	0	0	0	0	0	0	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	4	4	4	0	0	0
89	Architecture	ARE210	Lecture	36	1.4	52	1.7	30	16	113	40%	24%	**9%**	7	7	7	0	15	15	15	0	2	2	2	2	0	0	0	0	7	7	7	0	6	6	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
90	Architecture	ARE220	Lecture	20	1.4	27	0.9	30	4	24	10%	20%	**2%**	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6	0	0	0	0	0	0	0	0	0

Appendix D.4: College of Science and Humanities at Prince Sattam University

NO.	Department	Space Code	Space Type	Planned capacity	Planned space/user	Space Size (m2)	Space Per User	Current Capacity	Count	Sum	Frequency %	Occupancy %	Utilisation %	Sunday								Monday								Tuesday								Wednesday								Thursday							
														9	10	11	12	13	14	15	16	9	10	11	12	13	14	15	16	9	10	11	12	13	14	15	16	9	10	11	12	13	14	15	16	9	10	11	12	13	14	15	16
91	Common	2M1	Lecture	45	1.5	69	1.7	40	18	645	45%	90%	**40%**	0	34	34	33	39	39	29	29	0	39	39	0	38	38	38	0	0	32	32	33	43	43	0	0	0	0	0	0	0	0	0	0	0	0	0	33	0	0	0	0
92	Common	2B9	Lecture	84	1.5	122	4.1	30	14	395	35%	94%	**33%**	25	27	30	0	0	0	0	0	0	22	22	0	0	0	0	0	31	27	30	0	0	0	0	0	25	31	31	0	0	0	0	0	32	32	30	0	0	0	0	0
93	Common	2B4	Lecture	35	1.1	40	1.3	30	20	560	50%	93%	**47%**	35	33	31	0	0	0	0	0	28	24	24	0	21	21	0	0	35	33	31	0	0	0	0	0	28	24	24	0	32	32	0	5	35	33	31	0	0	0	0	0
94	Common	2C1	Lecture	25	1.2	31	1.0	30	23	327	58%	47%	**27%**	28	18	8	0	11	0	0	3	16	18	18	0	0	0	8	8	28	18	8	0	11	0	0	3	28	0	0	0	0	0	14	8	28	18	8	0	11	0	0	8
95	Common	2D4	Lecture	25	1.3	32	1.1	30	27	416	68%	51%	**35%**	28	18	8	0	11	0	0	3	16	18	18	0	25	25	0	15	28	28	18	8	0	11	5	0	28	0	0	0	0	5	14	8	28	18	8	0	11	0	5	8
96	Common	2W4	Lecture	45	2.1	95	3.2	30	13	438	33%	112%	**37%**	0	15	0	0	0	42	0	0	31	34	34	0	0	0	0	0	31	0	0	0	0	42	0	0	31	34	34	0	0	0	0	0	0	34	34	0	0	42	0	0
97	Common	2M5	Lecture	35	1.3	44	1.5	30	14	345	35%	82%	**29%**	7	31	31	0	0	0	38	0	12	0	0	0	0	0	0	0	7	31	31	0	0	0	38	0	12	0	0	0	0	0	0	0	7	31	31	0	0	0	38	0
98	Common	2B5	Lecture	40	1.6	65	2.2	30	16	277	40%	58%	**23%**	22	9	13	0	20	13	0	0	24	20	20	0	0	0	0	0	22	9	13	0	0	0	0	0	0	16	16	0	0	0	0	0	22	25	13	0	0	0	0	0
99	Common	2B2	Lecture	25	1.3	32	1.1	30	15	283	38%	63%	**24%**	25	0	16	0	23	0	0	0	11	10	0	0	0	0	0	0	25	0	0	0	23	0	0	0	20	22	22	0	11	11	0	0	25	16	0	0	23	0	0	0
100	Common	B10	Lecture	45	1.8	82	2.7	30	17	607	43%	119%	**51%**	35	35	34	0	0	0	0	0	35	35	30	0	0	0	51	51	35	35	34	0	0	0	0	0	33	30	30	0	0	0	0	0	35	35	34	0	0	0	0	0
101	English	2B1	Lecture	25	1.0	26	0.9	30	15	458	38%	102%	**38%**	35	33	31	0	0	0	0	0	0	0	0	0	0	0	25	0	35	33	31	0	0	25	0	0	24	31	31	0	0	0	0	0	35	33	31	0	0	0	25	0
102	Common	2B3	Lecture	35	1.2	41	1.4	30	16	305	40%	64%	**25%**	25	0	16	0	23	0	0	0	11	16	0	0	0	0	0	0	16	25	0	0	23	0	0	0	20	22	22	0	11	11	0	0	25	16	0	0	23	0	0	0
103	Common	2B6	Lecture	50	1.7	84	1.7	50	17	606	43%	71%	**30%**	32	43	38	0	0	0	0	0	32	43	38	0	0	0	0	0	32	38	38	0	0	0	0	0	38	43	43	0	31	31	0	0	27	27	32	0	0	0	0	0
104	English	2B8	Lecture	35	1.2	43	1.4	30	14	406	35%	97%	**34%**	31	27	34	0	26	0	0	0	0	26	26	0	0	0	0	0	31	27	34	0	0	0	0	0	0	26	26	0	0	0	0	0	31	27	34	0	0	0	0	0
105	Mathematics	2C3	Lecture	35	1.2	41	1.4	30	4	68	10%	57%	**6%**	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	17	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
106	Mathematics	2C4	Lecture	35	1.1	40	1.3	30	25	331	63%	44%	**28%**	6	8	16	0	0	15	20	0	12	8	8	0	0	0	15	15	6	8	16	0	0	15	20	0	6	16	16	0	20	20	0	0	6	8	16	0	0	15	20	0
107	Mathematics	2C7	Lecture	35	1.2	43	1.4	30	17	508	43%	100%	**42%**	32	23	29	0	0	0	0	0	32	29	29	0	0	0	0	0	32	23	29	0	0	0	0	0	23	34	39	0	0	0	0	0	32	23	29	0	35	35	0	0
108	Common	2D1	Lecture	25	1.2	31	1.0	30	14	352	35%	84%	**29%**	27	24	0	0	27	0	0	0	24	27	27	0	0	0	0	0	27	24	0	0	27	0	0	0	0	20	20	0	0	0	0	0	27	24	0	0	27	0	0	0
109	Common	2D10	Lecture	35	1.3	44	1.5	30	18	404	45%	75%	**34%**	20	0	17	0	37	0	0	0	0	17	17	0	0	0	15	15	20	0	17	0	37	0	0	0	20	12	12	0	0	0	37	37	20	0	17	0	37	0	0	0
110	Common	2D11	Lecture	35	1.2	43	1.4	30	18	196	45%	36%	**16%**	9	14	0	0	10	10	0	0	10	0	0	0	14	14	0	0	9	14	0	0	10	10	0	0	9	0	0	0	10	10	0	0	9	14	0	0	10	10	0	0
111	Physics	2D5	Lecture	25	1.3	32	1.1	30	16	194	40%	40%	**16%**	16	10	10	0	0	0	0	0	10	16	16	0	0	0	0	0	16	10	10	0	0	12	12	0	0	10	10	0	0	0	0	0	16	10	10	0	0	0	0	0
112	Common	2D8	Lecture	35	1.2	43	1.4	30	18	402	45%	74%	**34%**	24	18	29	0	10	0	18	18	29	0	0	0	28	28	0	0	24	18	29	0	10	0	0	0	0	0	0	0	24	24	0	0	24	18	29	0	0	0	0	0
113	Common	2D9	Lecture	84	1.5	122	4.1	30	19	408	48%	72%	**34%**	18	25	24	0	19	0	0	0	0	0	0	0	25	25	0	0	18	25	24	0	19	0	0	0	24	0	0	0	18	18	0	0	18	25	24	0	19	20	20	0
114	Common	2M7	Lecture	35	1.3	44	1.1	40	23	622	58%	68%	**39%**	34	31	31	0	26	26	26	0	0	22	22	0	36	36	36	0	25	26	26	0	31	31	31	0	27	27	27	0	0	0	0	0	15	15	15	0	0	0	0	0
115	Common	2W1	Lecture	45	2.4	108	2.7	40	21	660	53%	79%	**41%**	16	29	37	0	34	34	0	0	33	40	28	0	0	0	0	0	33	29	37	0	34	34	0	0	33	40	28	0	0	0	0	0	16	29	28	0	34	34	0	0
116	Common	2W2	Lecture	45	2.3	103	2.6	40	21	638	53%	76%	**40%**	0	30	30	0	38	38	29	29	30	23	20	0	0	0	0	0	23	28	35	0	38	38	0	0	32	23	20	0	0	0	0	0	30	28	0	0	38	38	0	0
117	Common	3W1	Lecture	45	2.4	109	2.7	40	28	1136	70%	101%	**71%**	34	34	42	34	38	38	0	0	46	46	42	0	50	40	0	0	37	37	42	43	39	39	0	0	46	46	42	0	50	40	0	0	39	39	24	43	43	43	0	0
118	Common	3W2	Lecture	35	2.1	73	2.4	30	20	733	50%	122%	**61%**	43	36	35	0	0	42	0	0	40	30	24	0	39	39	0	0	43	36	35	0	0	42	0	0	0	30	24	0	39	0	0	0	43	36	35	0	0	42	0	0
119	Common	3W3	Lecture	35	2.1	73	2.4	30	25	805	63%	107%	**67%**	42	0	25	0	35	29	29	0	24	28	41	0	42	39	18	0	42	0	25	0	35	18	18	0	24	28	41	0	42	39	0	0	42	39	25	0	35	0	0	0
120	Common	3W4	Lecture	45	2.3	104	2.6	40	24	674	60%	70%	**42%**	26	0	31	0	34	0	0	0	29	27	27	0	28	22	22	0	26	33	33	0	34	0	25	0	29	27	27	0	28	22	22	0	26	31	31	0	34	0	0	0

Appendix D.5: Community College at University of Hafr Al Batin

														Sunday								Monday								Tuesday								Wednesday								Thursday							
NO.	Department	Space Code	Space Type	Planned capacity	Planned space/user	Space Size (m2)	Space Per User	Current Capacity	Count	Sum	Frequency %	Occupancy %	Utilisation %	9	10	11	12	13	14	15	16	9	10	11	12	13	14	15	16	9	10	11	12	13	14	15	16	9	10	11	12	13	14	15	16	9	10	11	12	13	14	15	16
121	Common	0602	Lecture	60	1.5	88	2.3	38	11	339	28%	81%	**22%**	52	0	29	0	0	0	0	0	52	0	29	0	0	0	0	0	52	0	29	0	0	5	5	5	0	0	0	0	0	0	0	0	52	0	29	0	0	0	0	0
122	Common	1403	Lecture	35	1.2	43	1.4	30	12	257	30%	71%	**21%**	16	31	0	0	27	0	0	0	0	31	0	0	2	0	0	0	16	31	0	0	27	0	0	0	0	0	0	0	0	0	2	0	16	31	0	0	27	0	0	0
123	Common	1312	Lecture	35	1.2	42	1.4	30	7	94	18%	45%	**8%**	0	10	17	0	0	0	0	0	0	15	0	0	0	0	0	0	0	10	17	0	0	0	0	0	0	15	0	0	0	0	0	0	0	10	0	0	0	0	0	0
124	Common	1303	Lecture	35	1.2	43	1.4	30	13	183	33%	47%	**15%**	17	13	0	0	0	0	0	0	13	15	15	0	0	12	12	0	17	13	0	0	0	0	0	0	13	15	15	0	0	0	0	0	0	13	0	0	0	0	0	0
125	Electrical	1308	Lecture	45	1.9	85	2.8	30	12	111	30%	31%	**9%**	8	6	9	14	0	0	0	0	0	0	0	0	0	0	0	0	8	6	9	14	0	0	0	0	0	0	0	0	0	0	0	0	8	6	9	14	0	0	0	0
126	Electrical	1408	Lecture	45	1.9	85	2.8	30	9	150	23%	56%	**13%**	10	17	23	0	0	0	0	0	0	0	0	0	0	0	0	0	10	17	23	0	0	0	0	0	0	0	0	0	0	0	0	0	10	17	23	0	0	0	0	0
127	Common	1311	Lecture	35	1.2	43	1.4	30	6	84	15%	47%	**7%**	15	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	13	0	0	0	0	0
128	Common	1302	Lecture	35	1.2	43	1.4	30	13	207	33%	53%	**17%**	21	0	20	0	11	0	0	0	21	5	20	0	0	0	0	0	21	0	20	0	11	0	0	0	0	5	0	0	0	0	0	0	21	0	20	0	11	0	0	0
129	Common	1304	Lecture	35	1.2	41	1.4	30	12	199	30%	55%	**17%**	19	0	0	32	0	0	0	0	0	6	9	0	0	0	0	0	19	0	8	32	0	0	0	0	0	6	9	0	0	0	0	0	19	0	8	32	0	0	0	0
130	Common	1315	Lecture	35	1.2	43	1.4	30	13	113	33%	29%	**9%**	0	15	6	0	8	0	0	0	0	0	5	0	0	0	0	0	8	15	6	0	8	0	0	0	0	0	5	0	0	0	0	0	8	15	6	0	8	0	0	0
131	Mechanical	0305	Lab	30	1.0	31	1.0	30	16	140	40%	29%	**12%**	0	0	0	0	11	11	11	11	0	0	0	0	0	0	0	0	0	0	0	0	7	7	7	7	0	0	0	0	11	11	11	11	0	0	0	0	6	6	6	6
132	Mechanical	0311	Lab	30	2.0	61	2.0	30	7	54	18%	26%	**5%**	0	0	0	0	0	0	0	0	6	6	0	0	0	0	0	6	0	0	0	0	0	0	0	9	0	0	0	0	9	9	9	0	0	0	0	0	0	0	0	0
133	Religion	1202	Lecture	35	1.2	43	1.2	35	4	84	10%	60%	**6%**	0	0	0	0	0	0	0	0	10	0	0	32	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	32	0	0	0	0	0	0	0	0	0	0	0	0
134	Common	1206	Lecture	35	1.5	53	1.8	30	6	75	15%	42%	**6%**	0	22	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	22	0	0	3	0	0	0	0	0	0	0	3	0	0	0	0	22	0	0	0	0	0	0
135	Electronics	1218	Lecture	20	1.5	30	1.0	30	6	17	15%	9%	**1%**	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	4	0	1	0	0	0	0	0	5	0	0	0	0	0	0	0
136	Common	1219	Lecture	20	1.6	31	1.0	30	6	75	15%	42%	**6%**	0	23	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	2	0	0	0	0	0
137	Computer	1310	Lecture	45	2.8	126	4.2	30	12	32	30%	9%	**3%**	0	0	0	0	3	3	3	3	0	2	0	0	0	0	0	0	0	0	0	0	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3
138	Mechanical	1314	Lecture	35	1.1	37	1.2	30	5	64	13%	43%	**5%**	0	0	10	0	0	0	0	0	0	17	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	10	0	0	0	0	0	0
139	Mechanical	1316	Lecture	35	1.2	43	1.4	30	2	14	5%	23%	**1%**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0
140	Computer	1318	Lecture	20	1.5	29	1.0	30	6	12	15%	7%	**1%**	2	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	2	1	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
141	Common	1320	Lecture	20	1.6	31	1.0	30	7	17	18%	8%	**1%**	2	2	0	0	3	0	0	0	2	2	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0
142	Computer	1410	Lecture	45	2.8	126	4.2	30	6	51	15%	28%	**4%**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	0	0	0	0	0	0	0	0	0	15	15	15	0
143	Electronics	1414	Lecture	35	1.1	37	1.2	30	9	72	23%	27%	**6%**	0	0	0	0	0	0	0	0	0	0	0	0	15	15	15	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	8	8	8	0
144	Electrical	1416	Lecture	35	1.1	38	1.3	30	6	24	15%	13%	**2%**	0	0	0	0	0	0	0	0	4	4	4	0	0	0	0	0	0	0	0	0	4	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
145	Common	1420	Lecture	20	1.6	31	1.0	30	9	24	23%	9%	**2%**	5	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	5	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	5	2	1	0	0	0	0	0
146	Electrical	1503	Lab	30	1.4	41	1.4	30	6	66	15%	37%	**6%**	0	0	0	0	0	11	11	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	11	11	0	0	0	0	0	0	0	0
147	Electrical	1528	Lab	40	2.4	97	3.2	30	9	99	23%	37%	**8%**	0	0	0	0	0	12	12	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	11	11	0	0	0	0	0	10	10	10
148	Computer	1530	Lab	45	2.8	126	4.2	30	11	22	28%	7%	**2%**	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	0
149	Electrical	1531	Lab	20	2.2	43	2.9	15	6	48	15%	53%	**8%**	0	0	0	0	0	0	0	0	0	0	0	0	0	8	8	8	0	0	0	0	0	0	0	0	0	0	0	0	0	8	8	8	0	0	0	0	0	0	0	0
150	Electrical	1533	Lab	30	2.0	61	2.0	30	6	51	15%	28%	**4%**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	14	14	0	0	0	0	3	3	3	0	0	0	0	0	0	0	0	0

Appendix E

Appendix E: Space Management Tool: Managing space provision in higher education institutions

Space Management Tool

The proposed '*Space Management Tool'* depends on a number of factors, which can greatly influence the size of the university physical plant. These factors include the following:

1. Campus population (information about the existing campus users such as students, faculty, staff...etc. and the projected population in the future).
2. Campus space program (information about the space; what is available and what should be provided in the future?).
3. Focus of the university (whether university focuses more on teaching or on research. Such difference is vital, given the difference in the facilities required).
4. Acceptance rate (such percentage is significant and it is based on the admission policy in each university).
5. Ratios of Faculty to Students and Staff to Faculty (such ratios are important for space modelling).
6. Working hours (The campus can increase its capacity if the working hours are extended and hence instead of 8 hours per day, 12 hours per day will increase the capacity by 33%).

Campus population

Appendix E.1: How to collect data on the campus population (existing and near-, short- and long-term)

Category	**Students [1]**				**Academics staff**				**Medical staff**				**Administration staff**						**Contractors [5]**				**Residents [6]**					**Total**
Sub-category	**Preparatory Year [2]**	**Undergraduate**	**Master**	**PhD Fellow**	**Faculty Members [3]**	**Researchers**	**Technicians**	**Others**	**Doctors**	**Nurses**	**Technicians**	**Others**	**Administration [4]**	**Deanships**	**Agencies**	**Colleges**	**Departments**	**Others**	**Contractor A**	**Contractor B**	**Contractor C**	**Others**	**Undergraduate**	**Graduate Students**	**Faculty Members**	**Doctors**	**Nurses**	
2015 Population **(Existing)**																												
2020 Population **(Near-term)**																												
2025 Population **(Short-term)**																												
2030 Population **(Long-term)**																												
…																												
Total																												

Notes:

1. Students are representing only the Full-Time Equivalent student numbers (FTE's).
2. Preparatory Year is a program for freshmen required by most academic programs to prepare newcomers with necessary skills that support education and learning process.
3. Faculty Members include professors, associate professors, assistant professors, lecturers, and teaching assistants.
4. Administration includes for example Rectorate Office, Vice Rectors, and University Council.
5. Contractors include contracted companies by the University to provide services such as Operation, Maintenance, Security, Catering, Cleaning...etc.
6. Residents that are only accommodated on-campus. Off-campus residents can be calculated separately.

Campus space program

Appendix E.2: How to collect data on space of university campuses (What is available and what should be provided in the future?)

Years	2015		2020		2025		2030	
University Campuses [1]	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Total Gross Floor Area (GFA) [2]								
Total Useable Floor Area (UFA) [3]								

Notes:

1. University Campuses are all campuses including the main campus and the satellite campuses. Given the gender segregation system in Saudi Arabia, the majority of universities have two campuses; one for male and one for female students.
2. Gross Floor Area (GFA) is the 'sum of fully enclosed area and unenclosed covered area' (AAPPA 2002, 04).
3. Useable Floor Area (UFA) or Net Internal Area (NIA) is the 'floor area measured from inside face of walls and deducting all the common use areas (such as corridors and toilets) and non-habitable areas (such as lifts, stairs, service ducts...etc.)' (AAPPA 2002, 04).

Standardised Inventory of Space

Appendix E.3: How to collect data on space in one campus (How many square meters are available and how many should be provided in the near-, short- and long-term?)

Campus profile (Macro level)	(For every campus including male campus and female campus)
Campus name	
Campus location	
Total area of campus land (hectares)	
Total area of campus buildings (m^2)	
Total number of buildings on-campus [1]	
Average age of buildings	

Notes:

1. If the University has other buildings off-campus, then it should be calculated separately.

e.g. Male campus zones profile								
Years	**2015**		**2020**		**2025**		**2030**	
Gross Floor Area & Useable Floor Area (GFA) & (UFA)	**GFA**	**UFA**	**GFA**	**UFA**	**GFA**	**UFA**	**GFA**	**UFA**
Academic zone [1]								
Medical zone [2]								
Sport zone [3]								
Science Park zone								
Student Housing zone								
Faculty/Staff Housing zone								
Endowment zone								
Utilities								
Total								

Notes:

1. Academic zone includes all the college buildings and the preparatory year building
2. Medical zone includes all medical college buildings, teaching hospital, outpatient facilities, and other medical centres.
3. Sport zone includes the stadium, gymnasium, and other sport facilities (Distinguish in- and out-door spaces).

e.g. College building (Micro level)	(For every college building on campus)			
Age of the building				
Number of floors				
Number of teaching rooms				
Number of lecture hall/theatres				
Number of computer rooms				
Number of workshops/studios				
Number of labs				
Number of offices				
Number of meeting rooms				
Number of conference rooms				
...etc.				
Years	**2015**	**2020**	**2025**	**2030**
Total Gross Floor Area (GFA)				
Total Useable Floor Area (UFA)				

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SAMENVATTING ONDERZOEK

Achtergrond

Het Koninkrijk Saoedi-Arabië (KSA) heeft een strategisch langetermijnplan voor het hoger onderwijs vastgesteld. Dit strategisch plan, bekend als 'The Horizon 2030', heeft tot doel een 'kennismaatschappij' op te bouwen door te investeren in menselijke kapitaal via middelbaar, beroepsgericht, technisch en hoger onderwijs. Dit plan kan worden beschouwd als onderdeel van de Saudi Vision 2030, die gericht is op een 'levendige samenleving', een 'welvarende economie' en een 'ambitieuze natie'; voorspoed zonder afhankelijk te zijn van de export van natuurlijke hulpbronnen zoals olie, gas en mineralen. De strategische dimensies van het Horizon-plan zijn: expansie, kwaliteit en diversiteit. Het plan identificeert en concentreert zich op acht hoofdgebieden, waaronder infrastructuur. De focus op fysieke voorzieningen, zoals faciliteiten, infrastructuur en terreinen, omvat zowel de planning voor de transformatie van bestaande universiteitscampussen als de bouw van nieuwe. Om een dergelijk plan te implementeren, investeert de regering van Saoedi-Arabië aanzienlijk in de onderwijssector, met speciale aandacht voor het hoger onderwijs. In de afgelopen jaren is bijna een kwart van het nationale budget besteed aan onderwijs en opleiding. Alleen al de laatste tien jaar werden 20 nieuwe universiteiten opgericht. Deze hausse in de uitbreiding van het hoger onderwijs heeft geleid tot de bouw van 20 nieuwe campussen en satellietcampussen (als toevoegingen aan reeds bestaande campussen). Om het bouwproces van deze projecten te versnellen, heeft het ministerie van Onderwijs de verantwoordelijkheid op zich genomen om de eerste fase van het plannen, ontwerpen en bouwen van de belangrijkste campussen en satellietcampussen van deze recent opgerichte universiteiten centraal aan te sturen. Deze taak werd door velen beschreven als absoluut immens. Dat komt omdat de meeste campussen werden ontworpen als een stedelijke ontwikkeling, waarbij elke campus niet alleen universiteitsgebouwen omvat, maar ook een ziekenhuis, 'science park', sport- en recreatievoorzieningen, personeelswoningen, studentenhuisvesting en andere ondersteunende faciliteiten. De bouw werd gefaseerd uitgevoerd, waarbij in elke fase een aantal universiteitsgebouwen en enkele ondersteunende faciliteiten werden gebouwd. Feiten en cijfers van pas opgerichte universiteitscampussen wijzen op een enorme investering in de infrastructuur en faciliteiten van het hoger onderwijs in het Koninkrijk. Zulke cijfers zijn een duidelijk signaal dat omwille van een duurzame toekomst uiterste behoedzaamheid nodig is bij de aanpak van deze megaprojecten.

Focus van het onderzoek

Onderzoek heeft aangetoond dat aan vijf aspecten van duurzaamheid aandacht besteed moet worden op universiteitscampussen: management, milieu, betrokkenheid, 'academia', en innovatie. Om te meten hoe duurzaam de instelling is, worden prestatie-indicatoren gebruikt om elk duurzaamheidsaspect te evalueren. Dit onderzoek toetste daarvan de volgende aspecten: management (met behulp van indicatoren zoals visie, beleid, planning en commitment), betrokkenheid (met behulp van indicatoren zoals houding, kennis, bewustzijn en veranderingsbereidheid) en milieu (met behulp van indicatoren zoals locatie, fysieke toegankelijkheid, klimaatoverwegingen, flexibiliteit en benutting en bezetting van de ruimte. Deze drie aspecten en de tien indicatoren werden gekozen met het oog op hun belang en hun gevolgen voor gebruikers en middelen, nu en in de toekomst. Dit onderzoek besteedde vooral aandacht aan recent opgerichte universiteiten, aangezien zij nog in aanbouw zijn en verbeteringen in de volgende fase nog kunnen worden geïmplementeerd.

Onderzoeksvraag en methodologie

Met dit alles in gedachten is de belangrijkste onderzoeksvraag beantwoorden in dit onderzoek: ‘Met welke informatie, hulpmiddelen en aanpak kunnen bestaande en nieuwe universiteitsgebouwen en campussen in Saoedi-Arabië duurzamer worden?' Om een dergelijke vraag te kunnen beantwoorden is er een indeling in drie onderzoeksfasen gemaakt: Verkenning, Verklaring en Conclusie. Elke fase kent zijn eigen onderzoekstechnieken. In de eerste (Verkenning) werden relevante bronnen geïdentificeerd en werd wetenschappelijke literatuur van vier domeinen in kaart gebracht, te weten campusplanning en -ontwerp; campus management; duurzame campussen; en hoger onderwijs in Saoedi-Arabië. Bij het onderzoeken van literatuur werden ook sectorspecifieke documenten betrokken, zoals bouwkundige tekeningen van universiteitsgebouwen en campussen, milieurapportages, strategische plannen van universiteiten en masterplannen van campussen. In deze onderzoeksfase zijn een conceptueel kader en een analyse hulpmiddel ontwikkeld. De volgende stap was veldonderzoek in Saudi-Arabië om acht geselecteerde casussen te bezoeken en gegevens te verzamelen via interviews, focusgroepen, vragenlijsten en observaties. Deze casussen waren Al Baha University, Jazan University, King Abdullah University for Science and Technology, King Saudi University, Najran University, Prince Sattam Bin Abdulaziz University, University of Hafr Al Batin en University of Hail. De volgende stap was om de grote hoeveelheid verzamelde gegevens te verwerken en te analyseren. Uit de Saoedische casussen kwamen veel verklaringen voor de geobserveerde feiten. Daarom werd de focus aangescherpt en werden de onderzoeksvragen scherper geformuleerd. De tweede fase (Verklaring) begon met ‘desk research’ om mogelijke casussen voor onderzoek te vinden die konden gelden als ‘best practices’ voor duurzame campussen die vergelijkbaar zijn met Saoedi-Arabië. De selectie was gebaseerd op de eerder ontwikkelde criteria, waaronder klimaat en autogebruik. Twee casussen - beide gesitueerd in de Verenigde Staten van Amerika (VS) - werden geselecteerd voor analyse, te weten de Arizona State University (Tempe Campus) en de University of South Florida (Tampa Campus). Deze stap verliep echter niet volgens plan vanwege de onmogelijkheid om een bezoekersvisum te krijgen. In plaats daarvan werden interviews op afstand afgenomen via telecommunicatiesoftware (Skype en FaceTime). Wat volgde was het verwerken en analyseren van de gegevens uit de wetenschappelijke literatuur, casusdocumentatie en uit de interviews, zodat er lessen uit getrokken konden worden. De derde en laatste fase (Conclusie) begon met het samenvatten van de onderzoeksresultaten en het ontwikkelen van planningsrichtlijnen en een implementatieaanpak om de duurzaamheid van Saoedi-Arabische universiteitscampussen te bevorderen. Om de voorlopige richtlijnen en de implementatieaanpak te beoordelen, werden interviews met duurzaamheidsexperts uit Saoedi-Arabië en de Verenigde Staten gehouden. De feedback werd gebruikt om de voorgestelde planningsrichtlijnen en de implementatieaanpak van duurzaamheid te verbeteren.

Onderzoeksresultaten

De analyse is gebaseerd op het bestuderen van tien casussen (8 uit het KSA en 2 uit de VS), 38 interviews (31 uit het KSU en 7 uit de VS), 1.901 vragenlijsten werden verzameld in het KSA en 12 campussen werden bezocht en geobserveerd in het KSA. De algemene bevindingen wijzen er op dat de universiteitscampussen van Saudi-Arabië met betrekking tot duurzaamheidsaspecten van universiteiten ver achterblijven bij hun tegenhangers in Europa en Noord-Amerika. Ondanks het feit dat deze universiteiten een gemeenschappelijke visie hebben om een leeromgeving te creëren die aantrekkelijk, ‘smart’ en duurzaam is, ontbreekt het aan een goed omschreven beleid om een dergelijke visie te realiseren. Er is een duidelijk gebrek aan leiderschap in duurzaamheid en aan een alomvattende aanpak van duurzaamheid in de overgrote meerderheid van de instellingen voor het openbare hoger onderwijs in het

Koninkrijk. De meeste universiteiten hebben geen gedocumenteerde duurzaamheidsinspanningen voor hun campussen. Ze hebben geen instrumenten ontwikkeld om hun vooruitgang op het gebied van duurzaamheid te meten, noch hebben ze bestaande instrumenten geïmplementeerd. Op nationaal niveau is er een gebrek aan strategische planning voor voorzieningen voor hoger onderwijs in termen van vraag en aanbod. Er is geen haalbaarheidsstudie uitgevoerd voor deze omvangrijke ontwikkelingen (zoals 20 nieuwe grootschalige campussen). Er is een gebrek aan vraag- en aanbodbeleid om fysieke ruimtes in instellingen voor hoger onderwijs op nationaal niveau in Saoedi-Arabië te beheren. Dit gaat gepaard met de afwezigheid van een lange-termijnstudie naar de jongerenpopulatie in het Koninkrijk. Dit is van cruciaal belang, aangezien de voorspelling door de Verenigde Naties van de jongerenpopulatie tussen 14 en 24 een ernstige fluctuatie suggereert. Het toont een toename van de jongerenpopulatie tot het jaar 2035 gevolgd door een scherpe daling in dit deel van de bevolking. De bevindingen laten ook zien dat de meerderheid van de studenten aan openbare universiteiten in Saoedi-Arabië weinig kennis heeft over duurzame ontwikkeling. Bovendien beoordeelt geen enkele openbare universiteit zijn studenten op regelmatige basis met betrekking tot hun kennis en bewustzijn van duurzaamheid. Er is een gebrek aan beleid om duurzaamheid te integreren in bestaande onderwijscurricula. Studenten toonden een gebrek aan interesse en bereidheid om deel te nemen aan een aantal duurzame initiatieven op de campus. De meeste Saudi-Arabische beleids- en besluitvormers hebben onvoldoende kennis van en bewustzijn over de recente ontwikkelingen op het gebied van duurzaamheid op universiteitscampussen. De analyse benadrukt dat een groot aantal Saoedische universiteitscampussen, vooral nieuwe, ver van hun eigen steden zijn gelegen. De overgrote meerderheid van de ondervraagde mensen gaf aan dat ze buiten de campus wonen en maar enkelen van hen wonen het liefst op de campus. Gemiddeld reizen Saoedische studenten, academici en ondersteunend personeel over een afstand van ongeveer 44 kilometer tussen hun woonplaats en hun universiteitscampus. De overgrote meerderheid van de deelnemers gebruikt zijn eigen auto om naar de universiteitscampus te komen. Dat is logisch aangezien het Koninkrijk een auto-georiënteerd land is. Andere problemen met locatie en bereikbaarheid zijn de afwezigheid van openbaar vervoer, onvoltooide infrastructuur en de uitdagende topografie van sommige terreinen, zoals rotsachtige bergen (bijv. Al Baha University), en heuvels (bijv. As Sulayyil Campus), zanderigheid (bijv. Najran University) of laag-gelegen terrein (bijv. Prince Sattam bin Abdulaziz University). Wat betreft klimaat tonen de bevindingen uit de analyses van zowel de masterplannen van nieuwe campussen als de universiteitsgebouwen aan, dat inzetten op ruimtelijke compactheid niet is overwogen. Compactheid heeft vooral voor de Saoedische context een aantal voordelen gezien het extreme klimaat. Het idee om zo min mogelijk ruimte in te nemen, werd niet gerealiseerd. In feite zijn campussen en universiteitsgebouwen groot in omvang. Dit heeft een negatieve invloed op onder andere de loopafstand buiten de gebouwen en de hoeveelheid buitengevel die aan de zon wordt blootgesteld. Er zijn problemen met de milieukwaliteit, waaronder de oriëntatie van gebouwen, schaduw en daglicht, passieve ventilatiestrategieën en andere duurzame energie voorzieningen (bijvoorbeeld zonnepanelen en windturbines). Wat betreft flexibiliteit (in termen van tijd, ruimte en meubilair), wijzen de bevindingen uit dat meer dan de helft van de academici een flexibel schema heeft en bereid is om 's avonds (tussen 17.00 en 21.00 uur) colleges te geven, terwijl ongeveer een kwart van de studenten en ondersteunend personeel de voorkeur geven aan de avondperiode in plaats van aan de ochtend. Twee derde van de deelnemers gaf aan dat de ruimtes in hun universiteitsgebouwen voor meer doeleinden kunnen worden gebruikt, terwijl een derde erop wijst dat ruimtes gemakkelijk nieuwe functies kunnen opnemen. Het gebrek aan fysieke flexibiliteit in de lay-out van universiteitsgebouwen in campussen van recent opgerichte universiteiten is als probleem aangemerkt. Dit beperkt het perspectief op aanpassingen in universiteitsgebouwen nu en in de toekomst. Meer dan een derde van de ondervraagde mensen wees erop dat het meubilair flexibel is. Wat betreft het ruimte gebruik van voorzieningen op de campus, blijkt dat volgens de ondervraagde personen meer dan twee derde van de klaslokalen in Saoedische campussen halfvol zijn of zelfs ruim voldoende zitplaatsen beschikbaar hebben. Meer dan de helft van de mensen is tevreden over de totale grootte van de klaslokalen in hun universiteitsgebouwen. De beoordeling van het gebruik van de ruimte in sommige universiteitsgebouwen aan openbare universiteiten wijst op een lage bezettingsgraad. Opvallend is dat bijna alle publieke sectoren in het Koninkrijk, inclusief het hoger onderwijs, niet bekend zijn met ruimtegebruiksstudies.

Conclusies en Aanbevelingen

Dit onderzoek besluit met het voorstellen van planningsrichtlijnen die bestaan uit beleid en acties ter bevordering van duurzaamheid van openbare universiteiten in Saoedi-Arabië. Deze voorgestelde beleidslijnen zijn niet alleen gebaseerd op ‘evidence-based’ resultaten die uit dit onderzoek zijn afgeleid, maar ook op beleid dat is overgenomen van wereldwijd bekende 'best practices'. Om universiteiten te helpen om niet alleen te praten, maar ook de daad bij het woord te voegen stelt deze studie ook een implementatieplan van zes stappen voor: vastleggen, evalueren, plannen, implementeren, volgen en beoordelen. Deze stappen kunnen worden gezet met een aantal stevige acties van de verantwoordelijke actoren, binnen het voorgestelde tijdschema, om een soepele uitvoering en alomvattende aanpak van duurzaamheidsprocessen en -praktijken op campussen en daarbuiten te garanderen.

Wetenschappelijke waarde

Dit onderzoek levert twee wetenschappelijke bijdragen aan onderzoek naar duurzaamheid in universiteiten. Ten eerste overbrugt dit onderzoek de wetenschappelijke kloof bij het operationaliseren van duurzaamheidstools voor universiteiten door ervoor te zorgen dat de bestaande instrumenten voor het beoordelen van duurzaamheid op campussen begrijpelijker zijn. Dit vond vooral plaats door duurzaamheidsindicatoren te markeren, zodat ze alleen de essentiële informatie duidelijk communiceren. Hiermee identificeert dit onderzoek vijf criteria die kunnen worden gegroepeerd in een holistisch kader, dat aspecten omvat van management, ‘academia’, milieu, betrokkenheid en innovatie. De bijdrage van het onderzoek aan het wetenschapsgebied is het vereenvoudigen en uitwerken van de structuur en inhoud van bestaande duurzaamheidstools, waardoor universiteiten belangrijke kwesties kunnen herkennen en uiteindelijk hun duurzaamheidsbeleid kunnen verbeteren. Universiteiten in Saoedi-Arabië, en elders, worden geholpen door gebruik te maken van bestaande beoordelingsinstrumenten of op basis daarvan op maat gemaakte tools te ontwikkelen. Ten tweede is er in Saoedi-Arabië, ondanks het belang van duurzaamheid van universiteitscampussen, heel weinig aandacht besteed aan dit onderwerp. Veel van het eerdere onderzoek geeft zelfs aan dat er behoefte is aan een uitgebreid onderzoek naar duurzaamheid aan openbare universiteiten. Dit onderzoek vult dit vacuüm in en biedt documentatie van wetenschappelijke literatuur en ‘best-practices’, gecombineerd met veldonderzoek. Deze studie biedt een kennisbasis, hulpmiddelen en een benadering waarmee duurzaamheidsaspecten kunnen worden geëvalueerd en vooruitgebracht. Dit is van groot belang voor een land waar twee derde van de openbare universiteitscampussen nog in aanbouw zijn.

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LIST OF PUBLICATIONS

In the course of doing this doctoral thesis, some parts of this research resulted in a number of publications. These publications are as follows:

Alghamdi, N. (2018), "Space, like time, is money: Evaluating space utilisation in Saudi Arabian universities", in Filho, W. L. (eds.), *The University Campus of the Future: Connecting the nexus energy, climate and sustainable development in university operations, World Sustainability Series*, Springer International Publishing AG, Cham, Switzerland.

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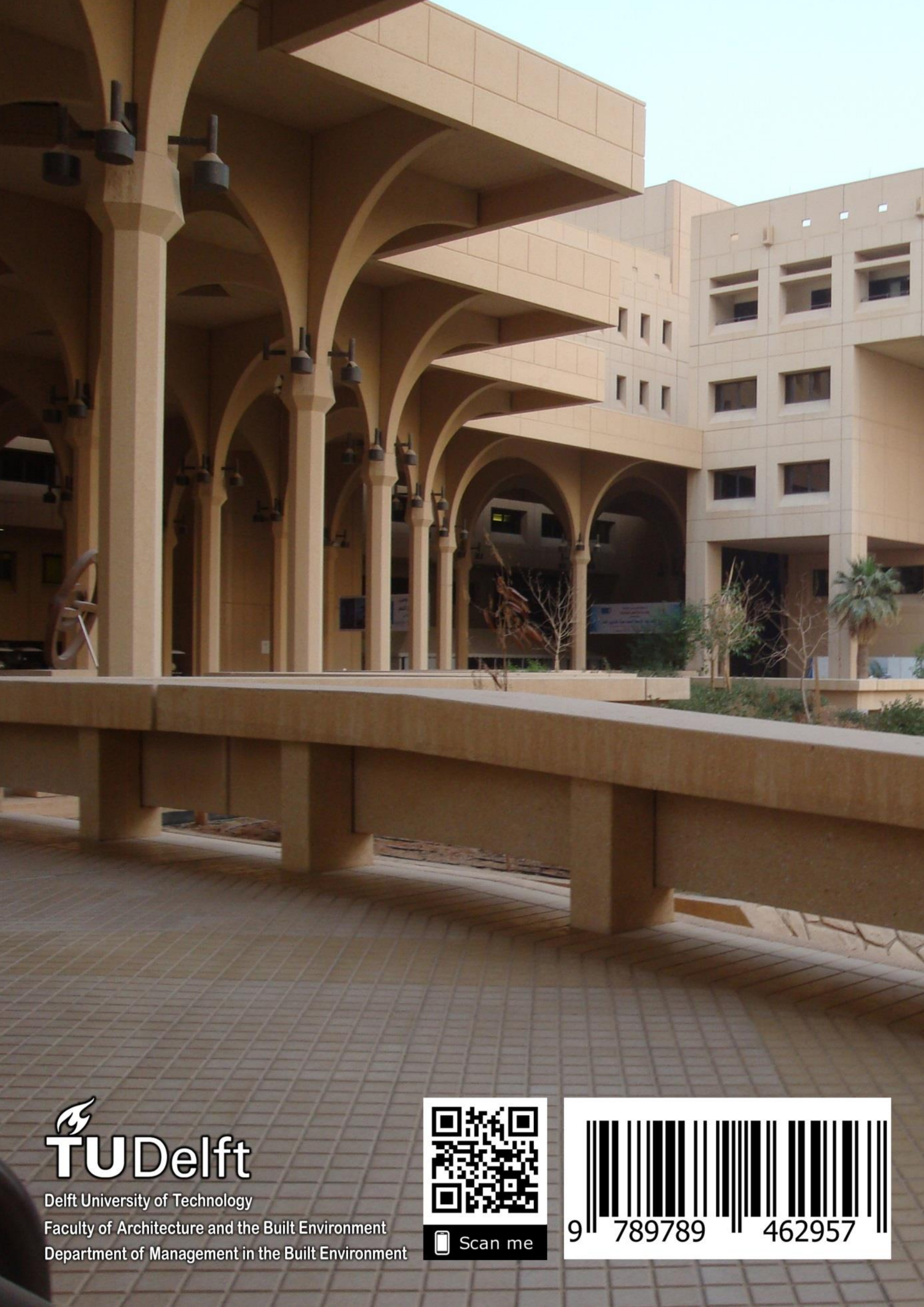

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