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Curvelo Magdaniel, Flavia; den Heijer, Alexandra; Arkesteijn, Monique

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Flavia Curvelo Magdaniel
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Lessons from universities of technology

by

Flavia Curvelo Magdaniel
Alexandra den Heijer
Monique Arkesteijn

TU Delft

October 2019

Colophon

This book "The European Campus: Management and Information" follows "The European Campus: Heritage and Challenges" published in 2014, and comprises a study of 14 European universities of technology, which was conducted in the period June 2017 and February 2019 by members of TU Delft's Campus Research Team.

Authors:

dr. ir. Flavia Curvelo Magdaniel, post-doctoral researcher 'The European Campus' project, specialisation: campus development

prof. dr. ir. Alexandra den Heijer, leading researcher "Campus Research Team", professor of Public Real Estate, specialisation: (managing) university campuses

ir. Monique Arkesteijn MBA, project manager, assistant professor of Real Estate Management, specialisation: design and decision support

All authors are members of the Campus Research Team and are affiliated to the academic department of Management in the Built Environment (MBE) of TU Delft's Faculty of Architecture and the Built Environment, contact address: a.c.denheijer@tudelft.nl

More background information about this book and related research can be found at www.managingtheuniversitycampus.nl

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Preface

The European campus is not only a crucial enabler - or disabler - for the future of universities, but also for the future of Europe. In 2014, this proposition triggered a comprehensive research project that explored university campuses in 28 European Union (EU) member states, resulting in the first book in this series: "The European campus - heritage and challenges". As the title suggested, it highlighted the (academic) history of European universities and their buildings, in their urban setting, and the difficult campus management task they are collectively facing.

Ever since, TU Delft's Campus Research Team has studied various perspectives on (managing) the European university campus, from governance issues and workplace trend scenarios to energy-efficient strategies and smart tools. Results were published as journal papers and policy reports. Nonetheless, we wanted to merge the collective results and combine them with new empirical data, to support and inspire European campus managers.

This second book "The European Campus: management and information" (2019) contains case studies of 14 universities of technology, to illustrate similarities as well as differences in legacy, context and strategies. It is relevant for presidents, university board members and higher education policy makers (from university to European Commission members), but also for (future) students and staff who want to learn more about their working and studying environment.

Meanwhile, similar trends emerged in (other) public real estate, ranging from government buildings to hospitals. Striving at resource-efficiency while safeguarding public goals is on the agenda of many public and semi-public organisations. Universities do not seem to be unique in this complex decision-making context. Lessons for and from other sectors are the next step in public real estate research.

With knowledge sharing being the foundation of our research, we are very grateful for the participation of the universities of technology. Thanks to their effort and openness, we have campus management insights to share. We hope this is the starting point of a third phase in European campus research, which unites country organisations, university networks and individual organisations in the decision-making process towards the European campus of the future.

prof. dr. ir. Alexandra den Heijer
Professor of Public Real Estate
Delft University of Technology (TU Delft)
Delft, June 2019

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Management summary

The European Campus is a research project conducted at TU Delft that aims to outline the crucial role of universities and their campuses in the contemporary European agenda. This project has delivered two important research reports with information and recommendations for campus management researchers and practitioners:

1. The European Campus: Heritage and Challenges (Den Heijer & Tzovlas, 2014) set the agenda of the project by collecting evidence from over 800 European universities.
2. The European Campus: management and information draws lessons from 14 European universities of technology (UTs) and the contemporary context in which they operate.

The European Campus: management and information

This research continues mapping the readiness of Europe's higher education infrastructure to engage global competition. In doing so, it provides a descriptive approach of the information collected. Accordingly, the results of this research are twofold. Firstly, this research found more evidence (management information) that builds on some of the former propositions (Nr.1 and Nr.2) and secondly, it adds new propositions (Nr.3 to Nr.13) that pin-point key areas to improve campus management.

1) The European campus is an asset for Europe's knowledge economy: an 'enabler' for Europe 2020.

Figure i. Proposition of the European campus as an enabler of Europe 2020 (Den Heijer and Tzovlas, 2014)

Half of European universities are historic and mature institutions, therefore the researchers in 2014 estimated that a large share of universities buildings have a cultural/ heritage status that can be used to their advantage to attract talented students and staff. Therefore, the researchers suggested campus strategies with synergy between European campuses and cities such as:

- Consider using existing building before adding new buildings and preserve/ intensify the use of heritage buildings
- Use space more flexible, reduce footprint and invest in quality of space
- Use less territorial- and more shared space, intensify its use including public space

This book presents more evidence to support the following:

1.a Universities as growth engines – place matters

- The clustering via mergers in one location and/or co-location is a campus trend adopted by universities to consolidate their regional presence as economic engines (Section 2.4.2)
- 93% of the UTs participating in this research focus on competitive advantage in their organisational strategies and nearly half of them focus on economic growth by stating their ambition to collaborate with local and regional parties (Section 5.2)

1.b. European knowledge economy is accommodated in cultural heritage buildings

- The adaptive re-use of heritage buildings and campus landmarks is a campus trend used by universities to support image and identity as well as to promote sustainability (Section 2.4.2)
- 57% of the participant UTs are Mature or Historic universities with campuses in the inner-city (Section 4.2 and 5.3.1)

1.c. European univer-cities are considered attractive places to live, work, be

- The integration of campus' and urban developments in the inner-city is a campus trend adopted by universities to enhance quality of place, strengthen their image in the city and support users' activities while involving external stakeholders to allocate resources efficiently (Section 2.4.2)
- Combining facilities for living and studying is a campus trend adopted by universities to support users' activities, improve the quality of place and make the campus more attractive (Section 2.4.2)
- Supporting image and improving the quality of place is an explicit campus goal or strategy in nearly the half of UTs participating in this research (Section 5.2)
- 50% of the participant UTs has campuses located in both the inner city and its periphery. The share of UTs with campuses solely in peripheral locations is 14% (Section 5.3.1)

2) The European campus is a (potential) problem for Europe's knowledge economy: a 'disabler' for Europe 2020.

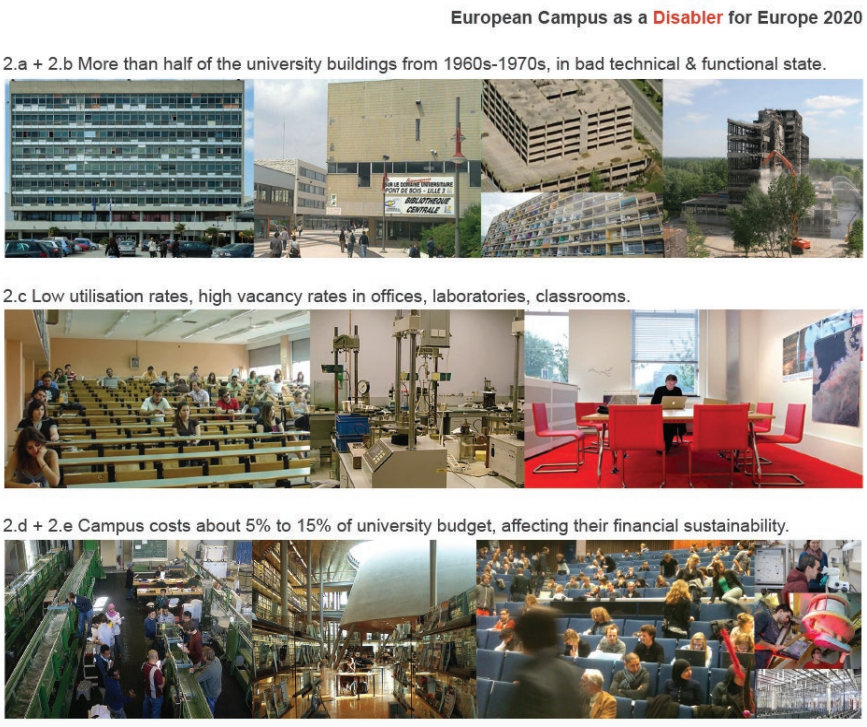

Figure ii. Proposition of the European campus as a disabler of Europe 2020 (Den Heijer and Tzovlas, 2014)

By estimating that a large share of university buildings is heritage, researchers also guessed that more than half of the floor area at European campuses is 50 years older. This assumption led to identify the scale of a potential problem: about 30% to 50% of the floor area (m^2) at European campuses will require reinvestments (i.e. about 40 to 70 million per m^2). Moreover, by looking at the financial data collected and project references, researchers stressed that most universities cannot afford to upgrade their aging buildings to current standards for functionality and resource-efficiency. Moreover, the researchers advise to avoid campus strategies that separate European campuses from cities such as:

- Reconsider selling (heritage) buildings, having a negative effect in loosing 'sense of place'
- Reconsider building new, resulting in a larger footprint for the campus and more expensive to manage
- Reconsider moving to cheaper locations that requires more resources for extra functions (residential, retail & leisure, business and infrastructure)

They described both a virtuous and vicious circle in campus management and advise universities to be aware of them when formulating campus strategies.

This book presents more evidence to support the following:

2.c. Low utilisation rates, high vacancy rates in offices, laboratories, classrooms

- Reducing footprint -by means of decreasing CO2 emissions and/or using their space more efficiently- is an explicit campus goal or strategy addressed only by 28% of the UTs participating in this research. Similarly, increasing flexibility is marginally (21%) addressed (Section 5.2)
- UTs are using shared facilities in education and research but there are variances in the ways they define and measure these spaces (Section 5.3.1)

2.d + 2.d Campus costs about 5% to 15% of university budget, affecting their financial sustainability.

- The operating revenues of the UTs participating in this research range between €75 million up to €1,5 billion but their annual operating expenses per m2 UFA range from €1K to €3,3K (Section 5.3.2)
- UTs estimate that their investments in research facilities range between 2% and 9% of their annual operating expenses. This is between €175 and €1,4K investments in research facilities per student (Section 5.3.2)

Apart from these two comprehensive propositions from the 2014 book, this 2019 book added 11 propositions that are divided in four clusters:

The dynamic context of campus decision-making

3) The UTs' mission of advancing technologies for society has remained intact for more than two centuries and today's campus strategies are explicitly supporting this mission (Section 2.1 and 5.2)

4) (Inter)national relations, competition, funding, politics and societal issues determine the increasingly dynamic context in which universities operate (Section 2.3)

5) To address the manifold challenges faced by universities now and in the future, managers (must) acknowledge the interrelation of the multiple perspectives in campus management (Section 2.3)

6) Identity, sustainability, location, collaboration, flexibility, digitalisation and health are shaping the physical campus in a combination of traditional, network and virtual arrangements (Section 2.5)

7) Campus managers can use the overview of campus projects as a catalogue of references (Section 2.5)

Data overviews as references in campus decision-making

8) Multi-perspective data overviews offer comprehensive pictures to various campus decision makers (Section 4.2)

9) Campus decision-making remains a multi-stakeholder process regardless the governance structure of the university (Section 5.1)

10) Stimulating innovation and supporting users activities are the ultimate UTs' campus strategies and Europe should invest in CMI to track successful implementation (Section 5.2)

Towards a sustainable campus management knowledge base

11) Campus managers of UTs are collecting CMI but their willingness to share it is limited (Section 6.3)

12) In an open data-driven society, sharing campus management information (CMI) encourages learning and professionalises campus management. (Section 6.3)

Future research

13) Managers' participation in research is essential to advance the current understanding of campus management and its improvement (Section 6.4)

Largely, the researchers of this book invite university policy makers, campus management professionals and researchers to reflect upon- and debate these propositions in order to position the European campus as a crucial enabler for the future of Europe.

Figure iii. European campuses of universities of technology (UTs) studied in this research trough four campus management perspectives.


ÉCOLE NATIONALE SUPÉRIEURE DES MINES
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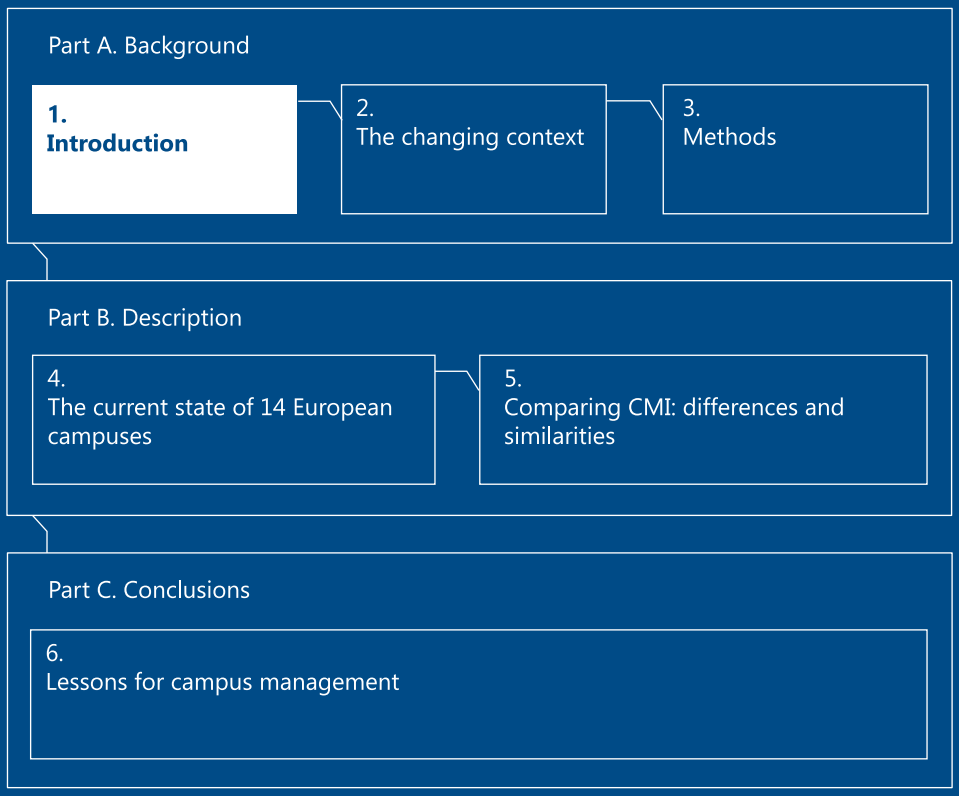
A. Background

The European campus is an asset for Europe’s knowledge economy.

Introduction



1. Introduction

What 'The European Campus' is? What is the basis for this research project? What lessons can be derived from previous research? And what is the way forward for current and future research? The following paragraphs address these questions by introducing first the role of universities and their campuses in the contemporary European agenda as the foundation of 'The European Campus' as a research project conducted at Delft University of Technology (See Figure 1.1). Then, it summarises the focus and findings of the first phase of this research project (i.e. The European Campus: Heritage and Challenges), which provides a rationale for the second and current phase of this research project. The European Campus: management and Information is then introduced as well as the outline of this report.

Figure 1.1 Publications of the Campus Research Team at TU Delft outlining the two milestones of the European Campus project

1.1. The European Campus

Strengthening knowledge creation and its application has become crucial in the contemporary European agenda. In 2010 a ten-year roadmap for Europe was envisioned in 'A strategy for smart, sustainable and inclusive growth' regarded as 'Europe 2020' (European Commission, 2010). It aims at making Europe's economy more knowledge-based. In regional policy, the knowledge-based economy (KBE) is regarded as a system used by governments to frame their perspectives for developing science, technology and innovation policies (Cooke & Leydesdorff, 2006). The idea of knowledge as an economic factor is attributed to Schumpeter (1934). It developed in the 1950s with changes in the labour force composition, and technological and institutional trajectories (Cooke & Leydesdorff, 2006). In the 1990s, this idea gained relevance when the word 'knowledge' was explicitly adopted in global and regional policies (Curvelo Magdaniel, 2016; Jessop, 2017). European policies have addressed knowledge' as economic driver (European Commission, 2000) and as enabler leading the transition to a smarter and greener European economy (European Commission, 2009).

The university

The universities' role in the European future has been explicitly outlined since 2000 with the Lisbon Strategy (Keeling, 2006). Herein, the European Commission highlighted the crucial role of higher education in achieving 'growth and jobs' as main goals. Investing in research became an action plan to support the goal of making the EU the most dynamic KBE in the world by 2010 (European Council, 2000). This announcement recognised higher education institutions (HEIs) as key stakeholders in European research. Specifically universities, since they employ most researchers and produce most of the fundamental research in the region (European Commission, 2005). Investing in research and development (R&D) has remained a central goal of Europe 2020 and so, is the

critical universities' role attaining these goals (European Commission, 2010). The general consensus that universities hold the key to the European economy and society is an example of KBE developments occurring at supranational scales (Jessop, 2017).

The universities' new roles are recognised in contemporary research reflecting the rise of the KBE discourse (Jessop, 2017). Etzkowitz (2004) used the term 'entrepreneurial university' establishing universities as economic actors. These are universities leading education, advancing research, controlling their resources, organising their own capacity to transfer technologies and fostering entrepreneurship as culture among their faculty and students (Etzkowitz, 2008). Similar functions are outlined by Drucker and Goldstein (2007) and illustrated by Simha (2005). Discussions about entrepreneurialism in universities has been discussed in earlier research (Deem, 2001; Marginson & Considine, 2000). By analysing and extending Schumpeter's ideas on innovation (Schumpeter, 1934) to the social world, Jessop (2017) affirms that entrepreneurial universities have a longer history than the contemporary phenomenon so-called 'academic capitalism'. Kauppinen (2012) defines academic capitalism as a wide variety of market (and market related) activities used by faculty and institutions to secure external funding due to reduced public funding (e.g. Patenting, spin-off companies, grants, university-industry partnerships and tuition fees).

Moreover, the intellectual, social and cultural dynamics resulted from the concentration of highly educated people at a university's location have been addressed in European urban studies in the KBE (Fernández-Maldonado & Romein, 2008; McCann, 2012; Van Den Berg et al., 2005; Van Den Berg & Russo, 2004; Van Winden & Carvalho, 2008). Despite universities are increasingly recognised as key agents for regional and urban competitiveness, their simple presence does not guarantee success in the KBE. Undeniably, universities concentrate human capital, whose interplay with local actors favour regional economic development. Baltzopoulos and Broström (2013) showed how universities affect regional entrepreneurship through the localisation decisions of entrepreneurial alumni in Sweden. Recently, Florida (2014) found associations between venture investment and the geography of talent showing that 'where talented people are matters'. However, in linking HEIs and growth in European regions, Lilles and Rõigas (2017) found that the share of tertiary students is not correlated with the share of knowledge intensive employment. Rather, this is related to increasing levels of GDP per capital and R&D expenditures. Laursen et al. (2010) suggested that managing the interaction between universities, industry and governments is the basis to remain competitive. Investing in R&D may strengthen the innovation chain, which relies on the synergetic interaction between these actors. The scope of these investments is broad, including funding for cooperation initiatives, project-based research, research support and improving the infrastructure that supports the creation and application of knowledge.

The campus

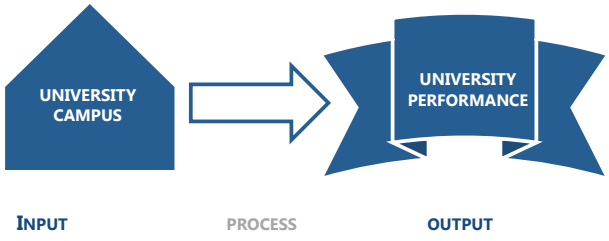
Investing in physical infrastructure has already been addressed as a way to strengthen the relationships between universities, industry and governments (Van Winden, 2008). This infrastructure is regarded in early global policies as part of national science systems (OECD, 1996). Facilities, transportation networks and telecommunication systems have been outlined as enablers of economic activities at national level (Florida, 2010; Porter, 1990). In organisations, Joroff (1993) emphasised the view of managing real estate as the fifth resource besides human resources, technology, capital, and information technologies. Existing studies in university campus management outline the enabling and disabling function of real estate in attaining the goals of key agents in the KBE (Curvelo Magdaniel, 2016; Den Heijer, 2011; Den Heijer & Tzovlas, 2014). The European

BUILDINGS
LAND
INFRASTRUCTURE
PUBLIC SPACE

campus discusses this perspective through a dual proposition by which the university campus can be perceived as both a problem and an asset for Europe.

Campuses support universities and other parties engaged in the successful accommodation of activities leading to knowledge creation. Herein, the campus is assumed as a resource supporting organisations' goals as discussed in theories of corporate and public real estate management (CREM/PREM). CREM/PREM is defined as the management of a real estate portfolio by aligning this and services to the objectives of an organisation and the needs of its end-users and other stakeholders (De Jonge et al., 2009). Thus, real estate can be steered to influence the performance of individuals, organisations and society as a whole (See Figure 1.2). Studies in this field refer to this steering process as 'adding value' (Jensen et al., 2012).

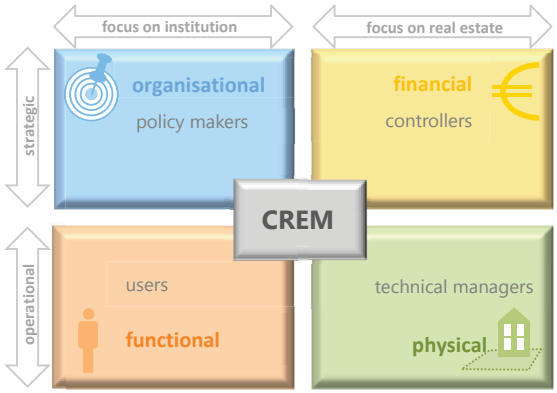
Figure 1.2 Schematic assumption of the university campus as strategic resource as seen in CREM/PREM theories.



Maintaining a balance between conflicting interests inside (and sometimes beyond) the organisation is necessary in adding value. That is because 'organisational performance' is understood as the fulfilment of organisational goals according to the judgement of various stakeholders and their perspectives on their available resources (De Vries et al., 2008). Den Heijer (2006) emphasises four main stakeholders and their perspectives in campus decisions – i.e. policy makers (strategic), controllers (financial), users (functional), and technical managers (physical) (See Figure 1.3). Each perspective distinguishes main variables to be considered in campus decision-making processes:

- Goals to support and attain with the existing campus (strategic)
- Budget in euros including the campus costs, benefits and value (financial)
- Number and types of users on campus (functional)
- Quantity and quality of campus space including location, space types and building condition (physical)

Figure 1.3 Stakeholders model linked to four CREM/PREM perspectives (Den Heijer, 2011)



Generating multi-stakeholder information contributes to decisions awareness and understanding. An important type of information relates to key performance indicators (KPIs). They allow universities to position themselves in the contemporary contexts in which they operate (De Vries, 2007). Despite their criticised role shaping the distributions of resources in HEIs, indicator-based evaluations are considered a core feature to measure research performance and teaching quality (Schulze-Cleven et al., 2017). There are multiple perspectives affecting HEIs competitiveness that can be adequate to assess universities' performance. Den Heijer (2011) used the stakeholders' perspectives to link real estate decisions to four different performance criteria by which one can assess universities' overall performance in the KBE: competitive advantage, profitability, productivity and sustainable development. In her descriptive model, adding value should consider the balancing of stakeholders' interests and information from these perspectives to weigh different alternatives on various variables.

These performance criteria can be applied to both universities' and Europe since their futures are tied and their goals seem to align matching each of the four perspectives (Table 1.1). The priorities of Europe and universities are mutually reinforcing each other through goals related to these four perspectives, which in turn relate to global developments in higher education. The European campus research suggests the university campus becomes a resource influencing Europe's:

Competitive advantage by attracting and retaining talent: In science and education, competition is understood in non-monetary terms, since it revolves around 'goods' such as prestige, recognition or distinction (Schulze-Cleven et al., 2017). How students and staff value these aspects is crucial because they embody unique expertise or intellectual achievements, which in turn, is the way these goods are valued by the broader public. According to Briggs (2006) besides 'academic reputation', 'distance from home' and 'location' are the main important factors influencing undergraduate students' choice in Scotland. These factors link to two global developments universities are facing when balancing quality and location to attract talent. The first is the development of multi-campus universities, which is characterised by universities spreading their activities through multiple geographic locations due to increased competition, overcapacity and fragmentation (Pinheiro & Nordstrand Berg, 2017). According to Zeeman and Benneworth (2017), multi-campus universities via merges is used to ensure universities' long-term financial sustainability and increase their attractiveness to students. Both researches conclude that managing multi-campus universities is challenging because of associated tensions in local places threatening universities' quality. The second is the emergence of international branch campuses, described by Wilkins and Huisman (2012), as a transnational education strategy to achieve competitive advantage. They show that universities have different attitudes to risk in establishing branch campuses overseas. In avoiding loss of their elite status and maintaining legitimacy, some universities opt to focus in the quality and reputation of their home operations.

Economic growth by focusing on the efficient utilisation of financial resources: Financial competitive in higher education results from increased numbers of students and faculty worldwide and the shifting role of the state in the academic capitalism where public and private expenditures are interwoven (Schulze-Cleven & Olson, 2017). Herein, marketization is one aspect shaping today's higher education. In the US and the UK this process has been characterised by support of business-university cooperation, cuts in public funding and increased pressure on universities to raise revenues through tuition fees, donations and returns on endowments. Besides, transnational collaboration between universities (Kauppinen, 2012) and international branch campuses (Wilkins

& Huisman, 2012) are transnational strategies increasing universities' possibilities to diversify their external funding sources adding to the revenue model in attracting students. In a context where obtaining and sustaining financial resources is increasingly difficult, HEIs must use them efficiently.

Productivity by providing functional environments for students and staff: The campus must support the core activities of their students and staff. Johnsrud (2002) argues that campus leaders wanting to improve the performance and retention of their staff must identify and address the particular issues that matter to those employed on their campuses. This applies to students, who are increasingly conceptualised as consumers in the marketization of higher education (Jæger & Gram, 2017). Moreover, the university campus fulfils new users' functions with the increase of distance learning and MOOCs. Despite the deserved relevance virtual environments have in learning, Bayne et al. (2014) shows that the physical campus continues to be symbolically and materially significant even for students who may never physically attend the campus. Temple (2009) outlines the functional relevance of the campus through its transformation into 'place'. Accordingly, physical capital is transformed into locational capital and then into social capital, which can affect academic productive outcomes. Largely, understanding users' demands on campus may have implications in education and research quality.

Sustainable development by focusing on the efficient utilisation of physical resources: The universities' role on environmental impact is increasing since they are reducing ecological footprint or greening the campus and slowing integrating sustainability in teaching and learning (Ralph & Stubbs, 2014). Equally, Alghamdi et al. (2017) confirm that universities are increasingly focusing on sustainability through five main aspects: environment (e.g. infrastructure, land use and transportation), management (e.g. vision, strategy and policy), academia (e.g. curriculum and research), engagement (e.g. social responsibility and community support) and innovation (e.g. solutions to challenges, and leadership). Their analysis shows that the number of indicators used in the categories 'environment', 'management' and 'academia' are higher compared to other two categories. Generally, Wright (2002) argues that the way HEIs frame and perceive their own commitment to sustainability is influenced by major international declarations and institutional policies.

CREM model	Input	Throughput		Output
Stakeholders' perspectives	**Decision variables**	**University goals (Den Heijer, 2011)**	**Europe 2020 goals (EC, 2010)**	**Performance criteria**
Organisational	Goals	Attract & retain talent	Enhance the performance and international attractiveness of Europe's higher education	Competitive advantage
Financial	Budget	Efficient capital resources allocation	Improve access to finance for research and boost investments levels	Profitability / Economic growth
Functional	Users	Support user's activity	Facilitate the development of skills to increase labour participation and match labour supply and demand	Productivity
Physical	Space	Efficient natural resources utilisation and reduce footprint.	Decoupling economic growth from the use of resources by decarbonising the economy, increasing the use of renewable sources and promoting energy efficiency	Sustainable development

Table 1.1 Linking university's and Europe's goals to four campus management perspectives and their related variables and performance criteria

This holistic view of the university campus as a European asset requires strategic approach to campus management, already emphasized in theory and in the practice of renowned European universities (Den Heijer, 2011; Haugen, 2015; Rymarzak, 2014; Rytkönen & Nenonen, 2014). Strategic management entails facilitating the expected contribution of the campus to university performance considering their dynamic context. The recent emphasis on the institutional autonomy of European universities at a time of significant budget cuts makes university management and campus management a though task. According to Mathies and Välimaa (2013), these dynamics challenge European HEIs to change and to imitate the managerial practices of US research universities already referred to as the model of a 'world class university'. When describing the costs and benefits of these universities, Altbach (2004) argues that 'the cost of maintaining a research university continues to grow because of the increasing complexity and expense of scientific research' (i.e. adequate facilities, access to appropriate libraries, laboratories, offices, internet and other electronic resources). Largely, adequate, consistent and long-term funding must be available in supporting the university's research, teaching and other functions.

1.2. The European Campus: heritage and challenges

The first phase of the European Campus research sought to highlight the campus relevance as a strategic resource of the European KBE (Den Heijer & Tzovlas, 2014). Furthermore, it aimed to support campus decisions of European universities, when investing in the physical infrastructure that facilitates advancing education and research. Its results and discussion were organised around the following questions: (A) What is the current state of the European campus? and (B) How might this state influence the Europe 2020 strategy?

This first study described the European campus by focusing on the properties used and owned by HEIs that provide PhD education in 28 EU member states. These HEIs are recognised as universities based on the qualification framework of the European Higher education Area. Moreover, it focuses on public universities because they account for more than 60% of the total European student population in higher education. They are considered a public asset since they are primarily financed by national and European funds (Den Heijer & Tzovlas, 2014). This resulted in a sample of 866 European universities.

1.2.1. Approach

The European Campus 1.0 employed the four perspectives in campus management to provide an integral picture of the current state of the European campus. It used variables in each campus management perspective to collect data and derive KPIs linked and useful to multiple universities' stakeholders. Despite several variables can be used for this purpose, the study focused on selected variables addressed in research (Den Heijer, 2011) because of its likelihood to obtain and compare them (Table 1.2).

Data collection sources and analysis

Data on all variables –except university rank- was collected using open data accessed through each university's official site. Primary sources of data collection included four main types of documents: 1) policies and strategic reports – e.g. universities' vision booklets and development plans, 2) listed performance indicators – e.g. 'facts & figures' sheets, 3) management reports, and 4) annual financial statements. These multiple sources allowed collecting detailed information on the broad spectrum of variables researched.

Perspectives	Variables / KPIs	Indicates
Organisational	Age (year of establishment)	Institutional stability/prestige
	University rank	Institutional international reputation
Financial	Budget	Institutional financial capacity to invest in real estate
	Annual expenditure per student	Annual institutional expenses in relation to their student populations
Functional	Number of students	Annual student enrolment at the institution
	Number of academic staff	Annual academic staff employed by the institution
	Teaching capacity	Annual academic staff employed for every student enrolled at the institution
Physical	Size of the campus	Square meters of built facilities treated as GFA (Gross Floor Area)
	Amount of GFA per student	Number of square meters of built facilities in relation to the university's population

Table 1.2 Variables (KPIs) collected in relation to the four campus management perspectives

To cope with language barrier a web browser with automatic translation was used when necessary. This data was retrieved in 2013. However, the data collection periods varied per university ranging from 2007 to 2012.

Data on the variable 'university rank' was collected using the Times Higher Education World University Rankings (THE) 2011-2012. This one was selected from the available rankings because it uses a methodology based on several indicators outlining the contemporary universities' roles in the KBE[1]. Furthermore, this ranking includes only institutions offering PhD programmes aligning with this study's scope. The rankings were used as grouping variable for comparison at European level. Empirical data on European universities listed in the Top 200 university rankings was converted into geographical information, which allowed mapping some variables.

[1]. The university score in THEWUR is calculated based on 30% Teaching (learning environment); 30% Research (volume, income, reputation); 30% Citations (research influence); 7,5% International outlook (people, research); and 2,5% Industry-Income innovation.

The data collected per each university was categorised in four sets corresponding to each of the campus perspectives, and stored in a computer database for descriptive statistical analysis. The heterogeneity in the accessibility and metrics of each variable among the different sources supposed a limitation for comparison. Only the variable 'university rank' was retrieved from the same source and required no homogeneity (Table 1.3).

Most universities provide institutional information matching those variables in the strategic and functional perspectives. Data about their age and the number of students were easily found (91% and *4% of the sample respectively). Few universities provide information on variables in the financial and physical perspectives. Data about their budgets, expenditure per student and the campus size was less accessible (47%, 46% and 37% of the sample respectively). Similarly, universities use different metrics for some variables such as staff, budget and size limiting its comparison.

The available data variations resulted in 203 out of 866 valid cases in sixteen countries (i.e. cases having available information for each KPI studied). For the statistical analysis, this study uses the samples with valid cases per each KPI describing the average current

state of the university campus in 28 member states. The mean is used as a reliable measure indicating also the ranges in the values analysed. The average values of the European campus per KPIs were obtained using a bottom-up approach crossing three levels. From obtaining the average values on the university level to build up two types of information: national profiles at country level and the campus description per KPI on European level. This approach allowed to have a general picture of the European campus and to compare information among countries.

EU member state	**# cases**	**# valid cases** (all KPIs)
Austria	21	4
Belgium	13	0
Bulgaria	37	0
Croatia	7	0
Cyprus	3	0
Czech Republic	26	0
Denmark	8	5
Estonia	6	0
Finland	14	6
France	74	24
Germany	83	9
Greece	21	2
Hungary	19	0
Ireland	7	4
Italy	58	1
Latvia	6	0
Lithuania	15	0
Luxembourg	1	1
Malta	1	0
Netherlands	13	13
Poland	90	0
Portugal	16	3
Romania	49	1
Slovakia	20	0
Slovenia	5	1
Spain	59	4
Sweden	36	10
UK	158	115
TOTAL	**866**	**203**
	% valid cases	**23%**

Table 1.3 Data collected organised by countries and their availability per KPIs

1.2.2. Results

What is the current state of the European campus?

The average current state of the European campus was described based on available data per KPIs researched on the strategic, functional, financial and physical perspectives of campus management. Besides using samples with valid cases per KPIs, the results distinguish the sample with valid cases in all KPIs (n=203) as the second sample to outline differences in average values between them.

Organisational perspective

The European campus accommodates many historic and prestigious universities. 91% of the sample (n=791) suggests the average age of the European university is 147 years (Range= one to 925). For the second sample (n=203), this average is 160 years, suggesting universities providing all KPIs are on average older. Figure 1.4 illustrates that more than 50% of the European universities are mature (i.e. >50 years old) and historic universities (i.e. >100 years old). Country comparison shows the oldest universities are in Italy and the UK (>900 years old) while the youngest are in Finland, Sweden, France and the UK (<5 years old).

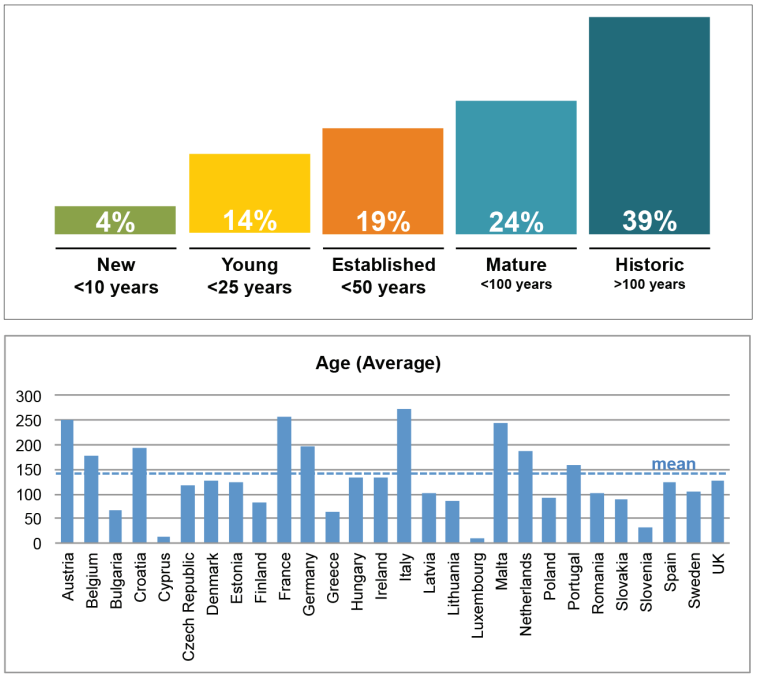


Figure 1.4 The European universities' age (Above: 791 universities distributed per age. Below: Average universities' age per country)

The university rank indicates many universities in Europe are perceived as prestigious universities regarding education and research: 77 European universities are in the top 200 and 29 in the top 100 according to THE WUR. Figure 1.5 illustrates most European top universities are concentrated in Western- and Central Europe. Those in the top 100 are in the UK, Germany, the Netherlands, Sweden, France, Belgium and Finland. Correspondingly, most European top universities are also mature and historic universities.

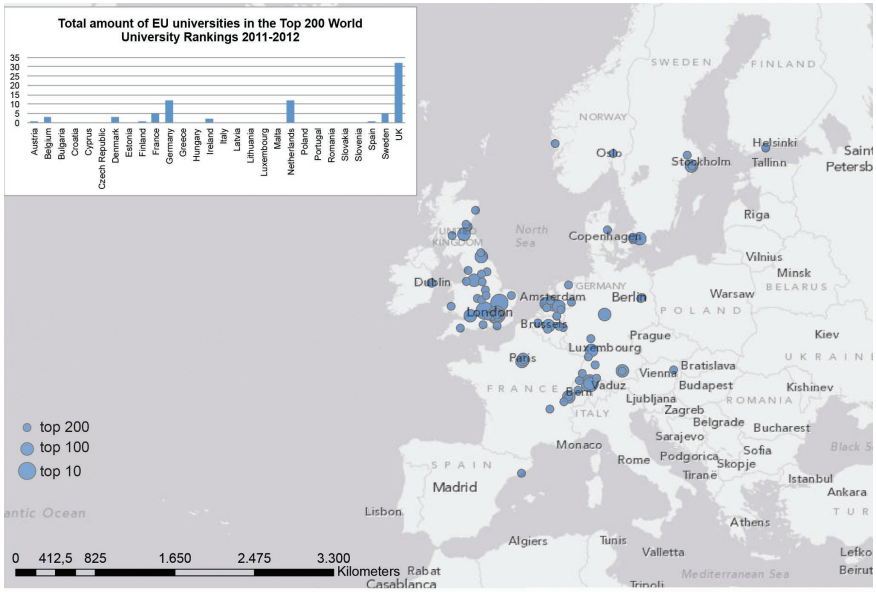


Figure 1.5 European top universities (THEWUR 2011-12) (Above: share of top 200 universities in Europe. Below: age of European top universities)

Functional perspective

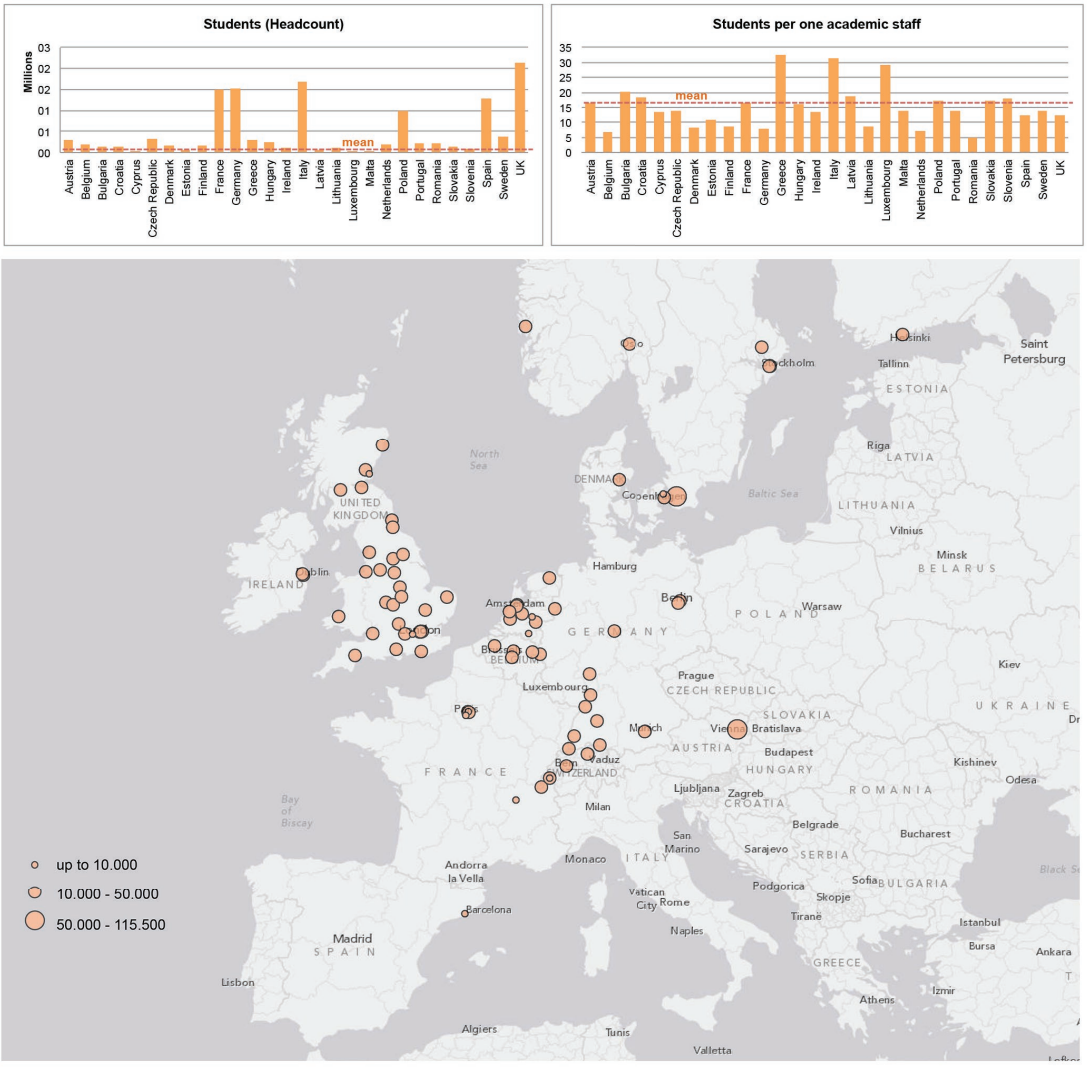
The European campus accommodates a substantial workforce of highly educated people. 84% of the sample (n=725) suggests the average student population of the European university is 17.550 students (Range= 218 to 206.000). Similarly, in the second sample (n=203) this average is 17.600 students. Together, 725 European universities accommodate 12,7 million students in their campuses. At least one million of this potential workforce is made of non-European students.

62% of the sample (n=539) indicates the European university employs on average 1.370 academic staff (Range= 31 to 37.370). Thus, the average teaching capacity of the European university is 16,8 students per one academic staff (Range= 0,7 to 81). For the second sample (n=203) the average academic staff employed in European universities

is 1.490 and the average teaching capacity is 11,8 students per academic staff. These differences suggest cases having available information for all KPIs have a smaller student-to-teacher ratio in comparison.

Although there is not an established standard, this indicator enlightens how capable universities are to teach in small class sizes and to provide individual supervision. Comparing data from both KPIs illustrates marked country differences (Figure 1.6). Universities in the UK, Italy, Germany and France have the largest student populations on average (≥1,5 mln students) compared to Cyprus, Malta and Luxembourg (≤12.000 students). However, when comparing each country's average teaching capacity, universities in Greece, Italy and Luxembourg (≥29 students per one staff) differ widely compared with universities in Netherlands, Belgium, Spain, Denmark, Finland, Germany, Romania and Lithuania (≤8 students per one staff). These results suggest that despite the European campus accommodates a significant workforce; universities' have different teaching capacities to prepare the future knowledge workers.

Figure 1.6 Functional KPIs (Above left: average students' number per country. Above right: average students' number per academic staff in countries. Below: Total students' number and academic staff in European top universities (THEWUR 2011-12)

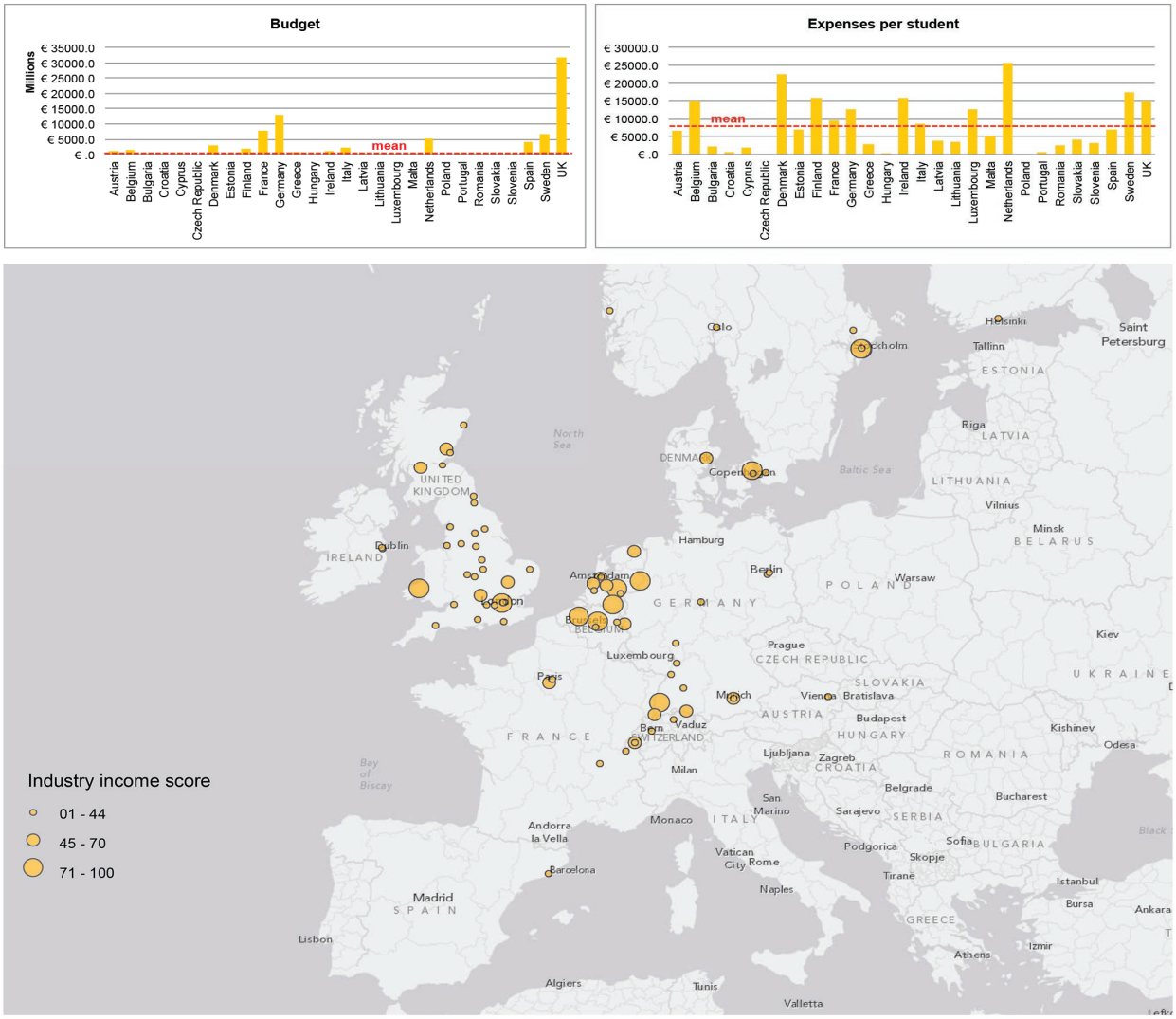


Financial perspective

The European campus spends a generous amount of resources to operate and improve education and research. 47% of the sample (n=404) suggests the average annual budget of the European university is about €203 million (Range= €14.500 to €1,5bn). Together, 404 European universities spend over €82 billion annually. For the second sample (n=203) the average budget is €260 million, showing a difference of 21% in financial resources between universities in both samples.

46% of the sample (n=395) indicates European universities spend €7.200 per student on average (Range= €4,5 to €206.400). For the second sample (n=203) this average is €16.800 per student. This difference suggests universities having available data on all KPIs have more financial capacity to improve education and research in relation to their student populations (Range= €663 to €111.300 per student).

Figure 1.7 Financial KPIs (Above left: countries' average university budget in euros. Above right: countries' average expenses per student. Below: European top universities by THEWUR 'industry research income' score)



Universities' financial capacity to improve education and research differs widely among countries. Results show marked country differences on universities' funding level per student (Figure 1.7). Denmark and the Netherlands spend on average much more per student (>€21.000) compared to Croatia, Hungary and Portugal (<€1.000). This disparity suggest countries' capacity to invest in education and research are different and some maybe spending their financial resources in more or less efficient ways. This finding stresses the increased role of external funding in higher education. According to various strategic documents, contract research accounts for about 30% of some universities' income. Figure 1.7 illustrates several European top universities score high in the research income received from industry per one academic staff.

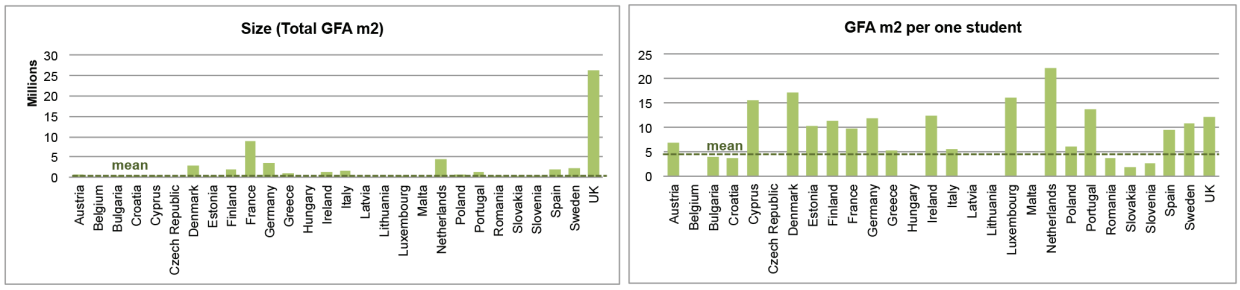
Physical perspective

The European campus operates occupying a large built area in cities and regions. 37% of the sample (n=319) indicates the European university campus uses 187.250 m2 of gross floor area (GFA) on average (Range= 4.000 to 830.000). These vast differences indicate universities may require more or less spacious facilities or additional functions other than the academic ones. Together, 319 European universities are accommodated in 59,7 million m2 GFA on campuses, which suggests that European universities provide 5m2 per student on average (Range=0,5 to 84,5).

Data from the second sample (n=203) indicates the European campus uses 228.420 m2 GFA on average. Thus, universities in this group provide 13m2 per student on average, indicating that they use 18% more floor area to operate in comparison.

Space utilisation differs per universities and countries (Figure 1.8). Universities in UK have the largest built area (>20 mln m2) while Estonia and Slovakia have the smallest (≤20.000 m2). Universities in the Netherlands and Denmark provide on average more space per students (>17 m2) compared to Croatia, Slovakia and Slovenia (<4 m2).

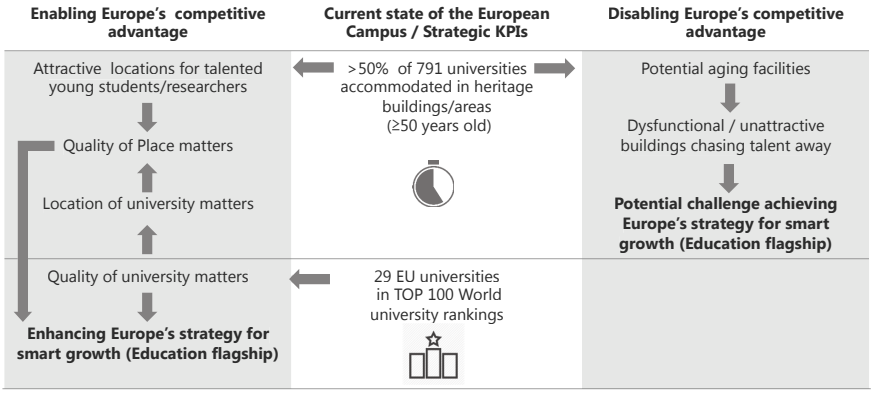
Figure 1.8 Physical KPIs (Left: countries' average GFA in m2. Right: countries' average m2 GFA per student)



How might the current state of the European campus influence Europe 2020 strategy?

Different perspectives on the European campus pose challenges and opportunities faced by multiple campus decision makers (i.e. policy makers, controllers, facility managers and planners/designers). This section discusses in four propositions how the campus is perceived as both an enabler and disabler of Europe's KBE vision.

1) The European campus enabling and disabling Europe's competitive advantage



The strategic perspective's results suggest the European campus is both an asset and a problem in the global competition for talent. The universities' age showed more than 50% of the European universities are over 50 years old and potentially accommodated in heritage buildings in the inner city. These locations are often very attractive for students and young knowledge workers because of the convenient access to cultural amenities, international transport hubs and diversity of functions matching students' and knowledge workers' preferences on where to live and work.

Equally, this KPI suggests campus managers in more than half of the European universities may be dealing with an aging campus. To support students' and staff's activities, the aging buildings need to become safe and functionally efficient as well as attractive and inspiring. Buildings without a significant image, social and cultural value to their users may undermine the universities' attractiveness.

Moreover, the strategic perspective's results indicate many universities in Europe are considered prestigious regarding teaching and research quality. Where these universities are located matters and so, it does the quality of those places. These results represent an opportunity for campus managers to use the quality of the university, the campus and the city to brand a 'distinctive European experience' for global competition.

2) The European campus enabling and disabling Europe's productivity

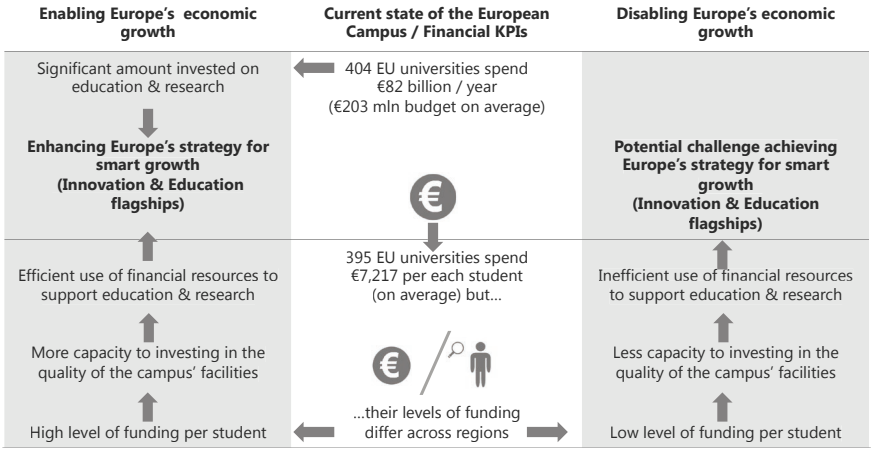
Enabling Europe's productivity	Current state of the European Campus / Functional KPIs	Disabling Europe's productivity
Potential workforce of highly educated people ↓ University campuses concentrates Europe's knowledge capital	← 12,7 mln students in 725 universities	
High teaching capacity prepared high skilled workforce ↓ **Enhancing Europe's strategy for smart growth**	← Diverse Teaching Capacity across regions → 16,8 students per academic staff (on average in 539 universities)	Low teaching capacity dissimilar preparation of high skilled workforce ↓ **Challenge achieving Europe's strategy for smart growth**

The functional perspective's results indicate the European campus accommodates the activities of a substantial amount of highly educated people (students and staff). The ways students are prepared determine the chances for Europe to enhance the higher education system's performance and Europe's productivity in the KBE.

Differences in the number of students per academic staff indicate disparities in the teaching quality preparing Europe's human capital. These results show the unequal capacity of universities as engines for productivity and growth across Europe, which suppose a challenge for Europe's 2020 ambition to attain smart growth.

The absence of indicators illustrating the type of functions and users on campus calls for better insights on the universities' profiles and discipline focus to estimate how specialised and/or diversified the human capital is the European campus add to Europe's productive sectors.

3) The European campus enabling and disabling Europe's economic growth



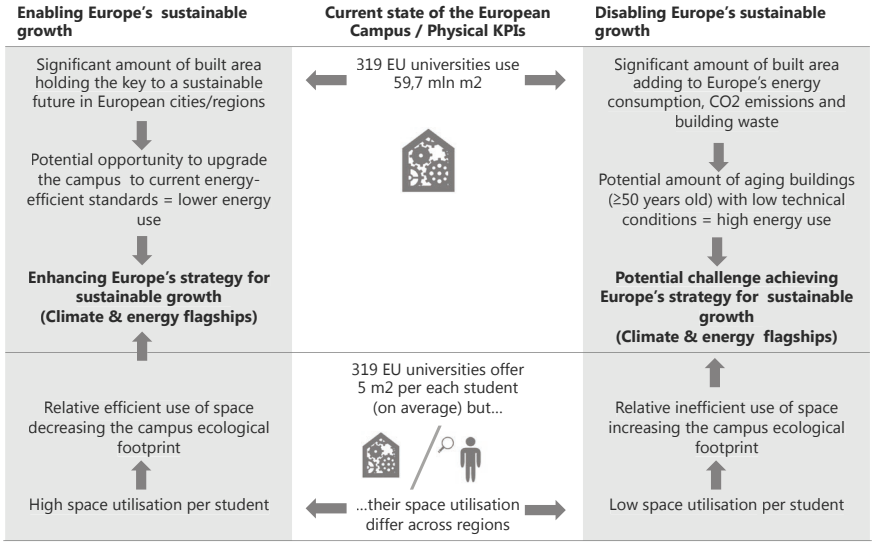
The financial perspective's results indicate the European campus is both an asset and a problem for Europe's strategy Smart growth. Investing in the physical campus is simultaneously at the benefit and cost of investing in education and research. Den Heijer (2011) estimates that about 10 to 15% of the resources spent on research and innovation are required to improve the universities' physical infrastructure. The universities' financial capacity to invest on campus might affect Europe's smart growth and ultimately, Europe's productivity and competitive advantage. Investing in both, teaching and the quality of the campus' facilities is key in attracting and retaining students and staff for research universities (Altbach, 2004). Working in functional and attractive facilities might influence the preferences of future knowledge workers on where to live and work as well as how to spend their incomes in cities (McCann, 2012). Conversely, working in dysfunctional and unattractive facilities may chase away a potential workforce of highly educated people.

This latter can happen in many European universities considering more than half of them may be accommodated aging facilities (≥50 years old). These universities may need reinvestments to improve their campus' technical and functional condition. Den Heijer (2011) estimates that the investments required to upgrade the university campus

to just functionally efficient facilities are at least €1.000 per m2 GFA. Roughly, investing in upgrading the likely aging campus (about 60 million m2 GFA) would cost European universities about 60 billion euros. These results illustrate the scale of a potential problem the aging campus represents affecting universities' expenditure for maintenance, supporting people's functions and ultimately, attracting talent.

Although these results showed European universities spend every year a substantial amount of resources to improve education and research, their budgets and expenditure per student differs widely per country. These funding level disparities suppose a challenge for the financial sustainability of some European universities and for the attainment of Europe's smart growth strategy. Thus, the required resources to sustain European universities' change must be used efficiently and estimated considering these country differences.

4) The European campus enabling and disabling Europe's sustainable growth.



The physical perspective's results indicate the European campus is perceived as both an opportunity and a challenge to attain Europe's strategy for sustainable growth, since the built environment is a main contributor to climate change but also hold the key to a sustainable future in cities and regions (Van Bueren et al., 2011).

Few of the European universities studied occupy a huge built area to accommodate their activities. This built area is adding to Europe's energy consumption, CO2 emissions and building waste. A significant part of the European campus may require upgrading to current energy-efficient standards assuming that more than half of the European universities are accommodated in aging buildings. Den Heijer and Tzovlas (2014) estimated that reinvestments in energy-efficient buildings could lead to lower energy use and lower maintenance costs in the long term.

Differences in m2 per user suggest European universities may be using their space in more or less efficient ways by reducing or increasing the campus ecological footprint. However, differences in space requirements related to particular activities, users' preferences and weather conditions in each university are required to assess such efficiency. A reference to measure the optimal capacity of campus facilities is needed to collect more information considering the significant size of the European campus affecting Europe's strategy for sustainable growth.

Relationships between campus perspectives

The previous discussion suggests the KPIs used to describe the current state of the European campus have implications for more than one performance criteria (e.g. competitive advantage, productivity, economic growth and sustainable development). Although this article discussed the implications of each KPI per campus perspective, it acknowledges particular relationships between KPIs and performance criteria. These relationships strengthen the potential campus' roles enabling and disabling Europe's ambition based on the four campus management perspectives reinforcing each other. Largely, such relationships evidence two potential feedback loops for campus decision makers based on how efficiently the campus is managed (Figure 1.9).

The first loop displays a virtuous circle of campus management. Accordingly, decisions in each of the four perspectives reinforce favourable results benefiting the attainment of Europe's KBE vision. The large built area the European campus occupies and the likely aging status of about 50% of this area suppose an opportunity for managers to support Europe's ambition. Campus decisions to improve the campus' technical and functional conditions will have positive consequences for the financial and technical sustainability as well as functionality and attractiveness of the campus. Correspondingly, the decisions to improve the campus condition suppose substantial capital investments that can be at the benefit of improving education and research for smart economic growth.

The second loop depicts a vicious circle of campus management. Equally, decisions in each of the four perspectives reinforce detrimental results at the costs of attaining Europe's KBE vision. The lack of strategic management of the physical campus may have a negative effect on the functional, economical and symbolic value of the campus. The depreciation of buildings over time without a strategic attitude results in technical and functional obsolete buildings (some in unattractive locations). Similarly, the decisions to marginally improve the campus condition can be at the cost of improving education and research for smart economic growth.

These loops raise the necessity of strategic management to steer the campus as a strategic resource to attain goals instead of investing resources in response to incremental accommodation. Differences in budgets and funding levels per student determine the

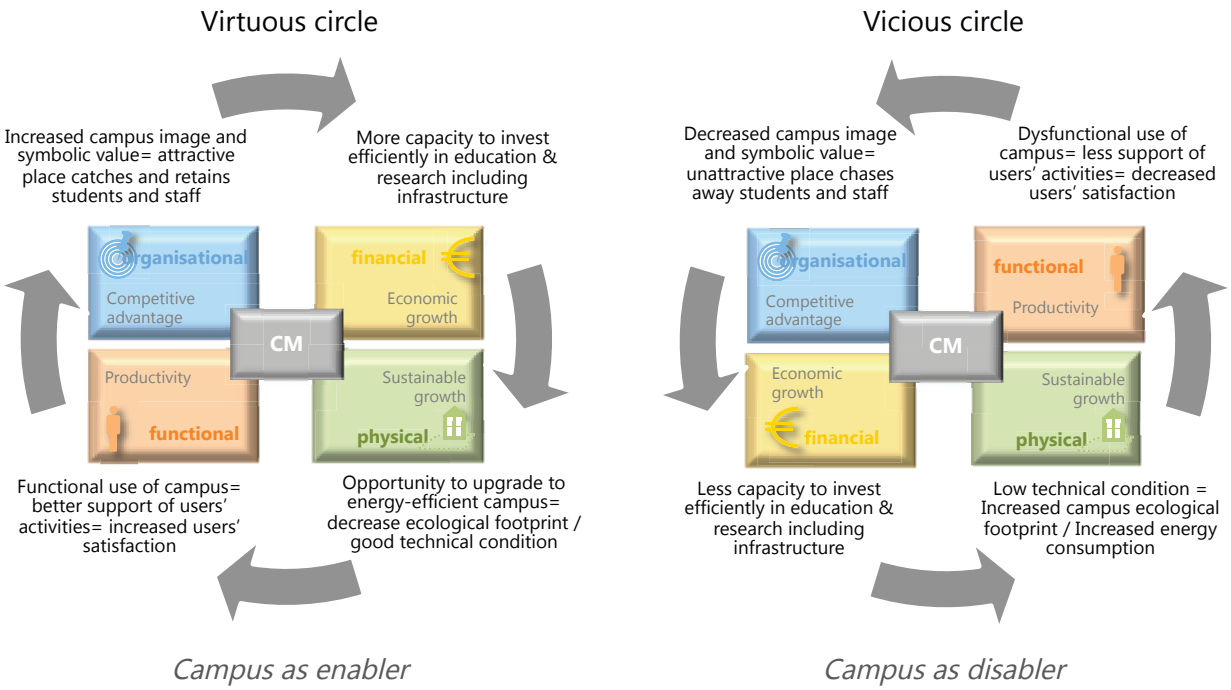


Figure 1.9 The virtuous and vicious cycles of campus management, enabling and disabling Europe's vision respectively

universities' capacity to improve education and research – e.g. acquiring technologies, hiring talented and enough staff and building and/or improving existing facilities. Such differences determine the contrasting universities' capacities to enhance or undermine Europe's strategy. The challenge for campus managers is to steer strategic investments to sustain the attractiveness of their universities and Europe as place to study and work while remaining competitive in the KBE.

1.2.3. Learning points

The first phase of the European Campus research provided a comprehensive overview of the current state of the European university campus, which differs widely among the 28 EU member states. This state is estimated through various strategic, financial, functional and physical indicators that can be used for future benchmarks in campus management. The differences in all indicators stress that universities have different resources and unequal financial capacities to invest on campus, which according to Schulze-Cleven et al. (2017) outlines 'the distributional conflicts and power dynamics in the EU higher education sector'. Herein, elite universities (in rich regions) benefit of having excellent facilities and conditions that can attract globally renowned professors and faculty. These findings strengthen the persistence of existing hierarchies between institutions in Europe and US outlined by Schulze-Cleven et al. (2017).

Similarly, the study discussed how the current state of the European campus poses challenges and opportunities for Europe's ambition in the KBE. The European campus is both an enabler and disabler for Europe's competitive advantage, economic growth, productivity and sustainable growth. These propositions have three practical implications. First, it outlines the importance of the campus and other physical infrastructure as a strategic resource for Europe's innovation policy agenda. Second,

it encourages the efficient use of university resources to effectively support strategies beyond the university. Third, it raises the necessity of setting a common agenda for campus managers in Europe to jointly acquire resources and develop management information to be shared among existing networks.

Similarly, the study acknowledged limitations in the data collection process. The research's broad empirical scope and the multiple data sources available led to data diversity. This resulted in information's shortage for some KPIs. The study took a step towards unifying this European diversity by providing a comparative picture at country level. Thus, it recommended exploring further the differences in campus management information between universities and countries.

The process of gathering publicly available information also revealed the dissimilar ways in which European universities present their facts to the world. This observation strengthens the need for 'institutional research' in the European higher education system, already outline in existing research (Mathies & Välimaa, 2013). Accordingly, reorganising existing data systems and establishing a unit-like institutional research could help HEIs to improve their managerial practices for better planning and decision-making. Besides, more uniform and transparent information can be obtained with alternative methods such as surveys and interviews with university managers. The analysis per type of university and type of property could lead to a more appropriate comparison of campus management information and more accurate picture of the European campus.

1.3. The European Campus: management and information

The second phase of the European Campus research project aims to advance the existing understanding of campus management and the usefulness of collecting and sharing campus management information (CMI). Considering the learning points from the previous phase, this research uses a particular segment of universities operating in a similar context within Europe. These are universities of technology (UTs) located in Europe's most innovative regions. Thus, the European Campus 2.0 follows a similar approach by asking, what is the current state of the campus in European UTs?

1.3.1. Approach

Campus management and the performance of UTs

This research reaffirms the notion that views real estate as strategic resources of organisations next to personnel, knowledge, ICT and capital. In this view, the campus -as any other university resource- requires strategic management in order to track its impact on universities performance.

As discussed in the previous sections, the performance of contemporary universities is shaped by the knowledge-based economy adopted in many societies including the European society. This is particularly visible in UTs because their focus on advancing and applying technologies to develop new products and services, positions them as innovators in the knowledge-driven societies and economies. Correspondingly, stimulating innovation has become one explicit ambition of universities in general but also high-tech firms and governments at national, regional and municipal levels (Curvelo Magdaniel, 2016). To do so, these parties are jointly developing and managing campuses with a focus on research infrastructure (Van Drooge & Deuten, 2017), shared facilities, urban connectivity and mix of functions (F. T. D. J. Curvelo Magdaniel et al., 2018) to foster the so- called open innovation ecosystems (Chesbrough, 2003). Developing not just science parks but also 'innovation districts' is a common joint venture between

municipalities, universities, private- and third parties to attract the most talented knowledge workers and students (Curvelo Magdaniel, 2019). Notwithstanding, it remains a challenge how to actually measure the contribution of campuses to the performance of UTs and other organisations driven by innovation in their primary business.

Den Heijer's (2011) conceptualisations of 'campus management' can be used to address this challenge. Accordingly, campus management is a process that involves four steps (See Figure 1.10):

1. Assessing the current campus,
2. Exploring the changing demand,
3. Generating future models for the campus, and
4. Defining projects to transform the campus.

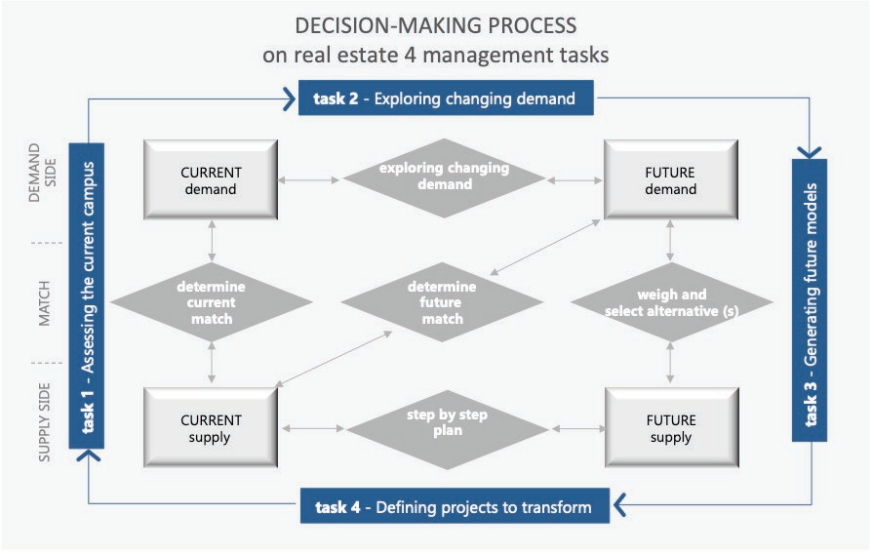


Figure 1.10 Den Heijer's (2011) decision-making process of campus management in four steps based on De Jonge et al. (2009)

At strategic level, this process can span over decades, which makes decisions on campus relevant to enable universities' long-term visions. Moreover, this approach stresses the need for supporting information that enables decision-makers and campus managers to perform these four different tasks. Such information must consider all stakeholders involved in campus decision-making and their performance-related campus goals[2]. This information (i.e. CMI) forms the bridge between campuses' current situations and decisions about the campus of the future since campus managers need it to both design and implement their strategies.

Campus Management Information (CMI)

In this study, CMI is defined as the required data campus managers may use to create campuses that add value to universities. This information can be metrics, descriptions, images, maps and/or testimonies. However, metrics are the most common type of information used to evaluate performance in management practice and research. Benchmarking, balanced scorecard, post-occupancy evaluation, critical success factors, and key performance indicators (KPIs) are common performance measurement approaches in the literature of facility management or FM (Lavy et al., 2010).

2. Den Heijer (2011) connects twelve main real estate goals with four performance perspectives in universities: 1) improving quality of place, 2) supporting image, 3) supporting culture, 4) stimulating innovation and 5) stimulating collaboration as universities' primary goals contributing to competitive advantage; 6) decreasing costs, 7) increasing real estate value and 8) controlling risks as financial goals contributing to profitability; 9) reducing footprint, as physical goals contributing to sustainable development; and 10) supporting users' activities, 11) increasing users' satisfaction and 12) increasing flexibility as functional goals contributing to productivity

According to the FM and CREM literature, KPIs facilitate: a) guidance to management, b) accountability, c) external legitimacy, d) efficiency in the operation and design of facilities, e) comparison in positioning, f) the ability to react in changing contexts, and g) the alignment between organisational strategy and real estate strategy. However, their use is limited as they can be difficult to quantify and/or provide redundant or inappropriate measurements (Lavy et al., 2010; Neely et al., 1997; Shohet, 2006). In CREM studies the lack of proper KPIs has limited the comparison of CREM strategies both in quantitative terms (Lindholm et al., 2006) as well as in qualitative terms (De Vries et al., 2008).

The proper categorisation of KPIs is addressed as a major issue that can determine their wider applicability, use and reliability (Douglas, 1996; Lavy et al., 2010). CREM and FM researchers have classified KPIs in different ways deriving lists of over hundred KPIs, which can also limit their applicability (Hinks & Mcnay, 1999; Ho et al., 2000; Lavy et al., 2010; Slater et al., 1997). This study distinguish four categories to group the many distinct but related categories in these studies based on the holistic categorisations by Lavy et al. (2010) and Den Heijer (2011) for facility management and campus management respectively: organisational, financial, functional and physical. This can be particularly important for this study comprehensive approach to campus management considering four stakeholders' perspectives. In this way, campus managers can make not only holistic performance evaluations but also assess specific aspects of the campus according to each perspective. Indeed, categorising CMI into the four perspectives of campus management provide campus decision-makers to select the KPIs that interest them most.

Additionally, his categorisation can help campus managers to link particular CMI to the multiple aspects of performance assessment that characterizes contemporary universities. Organisationally, UTs strive to sustain their competitive advantage. Financially, they attempt to sustain the efficient allocation of their capital resources. Functionally, they want to support the activities that make them productive. And physically, they are inclined to foster environmental sustainability. Campus managers can help them to create environments that support these multiple aspects. For that, CMI can be also categorised to facilitate the job of campus decision-makers in filtering extensive lists of KPIs.

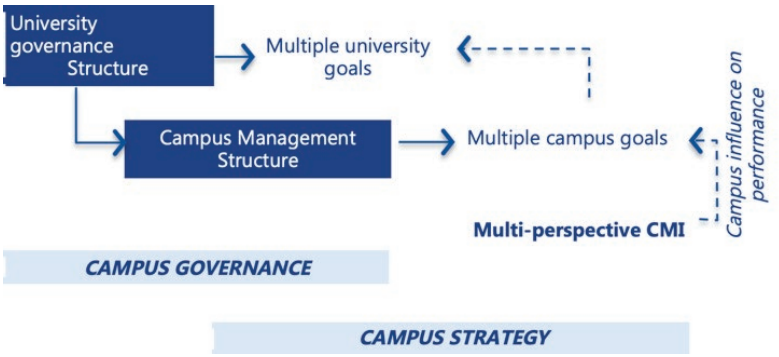
1.3.2. Analytical framework

This study uses the previous categorisation to collect CMI that will help to describe the current state of campuses of universities of technology as the first campus management task. Similarly, this can serve to illustrate the campus managers' attitude towards the use, collections and wider applicability of CMI. These insights may help to understand potential differences on how CMI is used in relation to university governance models[3] and the management structures binding campus decisions (Rymarzak et al., 2019). Accordingly, this study distinguishes two interrelated domains (Figure 1.11):

1. Campus governance that entails how campus management is organised within certain university governance structure, and
2. Campus strategy that entails how the multiple campus goals align with multiple university goals

[3] In Europe, two main models of university governance are identified: Unitary and Dual structures (EUA, 2017). Accordingly, the former distinguishes one decision-making body while the latter recognises two or more entities with defined responsibilities.

Figure 1.11 Analytical framework

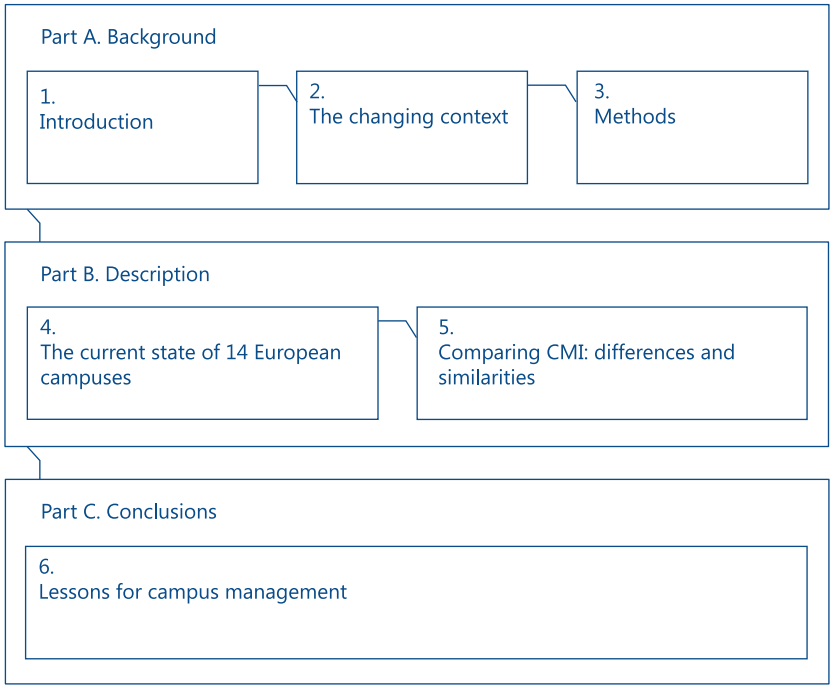


Accordingly, these two domains are interrelated because campus strategy is shaped by the stakeholders involved in campus governance, which in turn those deciding about university- and campus goals. Herein, multi-perspective CMI is positioned as the connector to track the design and implementation of campus strategies adding value to multiple universities goals (See Figure 1.11).

1.4. Report outline and reader's guide

This study is presented in three parts (See Figure 1.12). **Part A** provides a background for the European Campus 2.0 and consists of three chapters. This chapter has introduced the reasoning behind this research as well as its conceptual and analytical frameworks. Chapter 2 explores the past, present and future of UTs to provide a context for this research and the dynamics influencing campus management in this particular type of universities. Chapter 3 describes how the research is performed using particular methods of data collection and analysis.

Figure 1.12 Structure of this report



Part B describes the information collected in this research in a comprehensive way appealing to campus managers and researchers. This part consists of two chapters. Chapter 4 provides a comprehensive assessment of the current campus in fourteen European UTs. Rich descriptions accompany this chapter with a readers' guide to the CMI presented. Chapter 5 compares the available CMI among the fourteen participant UTs and draw some concluding remarks from the comparison.

Part C concludes this study with Chapter 6. Herein, the main lessons of the research are offered to both researchers and practitioners that aim to improve campus management. These lessons can be read as summary of the main findings combined with recommendations for future research and campus management practices.

1.5. Definitions

This research uses key terms that need explanations for the reader of this dissertation because they entail particular meanings. The following definitions deserve special attention in this research. Other definitions are addressed in particular chapters when required.

1.5.1. Concepts

Campus refers to the land and buildings, used for university or university-related functions, either rented or owned by the university, not necessarily on one location (Den Heijer, 2011).

Campus management entails the alignment of the university campus with the changing context and various stakeholders' demands, adding value to the university's performance (Den Heijer, 2011). More details about this research's approach to this term can be found in Sections 1.3.1.

Campus management information (CMI) entails information about campus-related key performance indicators (KPIs) and answers to relevant questions for certain campus management tasks or supports decisions (adapted from Den Heijer, 2011). More details about this research's approach to this term can be found in Section 1.3.1.

Innovation has multiple views. This research uses a definition from previous CREM research that regards innovation as the processes of knowledge creation, diffusion and its further application in the development of new and improved technologies (Curvelo Magdaniel, 2016). Accordingly, 'the human dimension is inherent to these processes because they involve tacit knowledge (i.e. knowledge embedded in people). The process of knowledge diffusion is key in this context because it enriches knowledge creation and its application (e.g. knowing what other researchers do and connecting this knowledge to their own work might drive knowledge further and also enhance possibilities for collaboration to create more knowledge or to apply this knowledge)'. Thus, innovation becomes a learning process addressing the human dimension at the core of these three processes, which in turn, have become essential for the competitive advantage of multiple organisations in industrialised economies. Stimulating innovation is, therefore, a common goal of many organisations including universities of technology.

Knowledge-based economy refers to an existing view distinguishing an economy that had emerged in the 1950s focusing on the composition of the labour force and has developed by adding structural aspects such as technological trajectories and institutional frameworks (Cooke & Leydesdorff, 2006). Accordingly, the knowledge economy is seen

as a system perspective used by governments to frame their perspectives for developing science, technology and innovation policies.

Stakeholders are individuals, organisations, or institutions, whose interests are involved or affected by a course of action. For instance, any decision on the built environment counts as a course of action. Thus, there are several stakeholders involved in the development of technology campuses whose interests can affect and be affected by such developments.

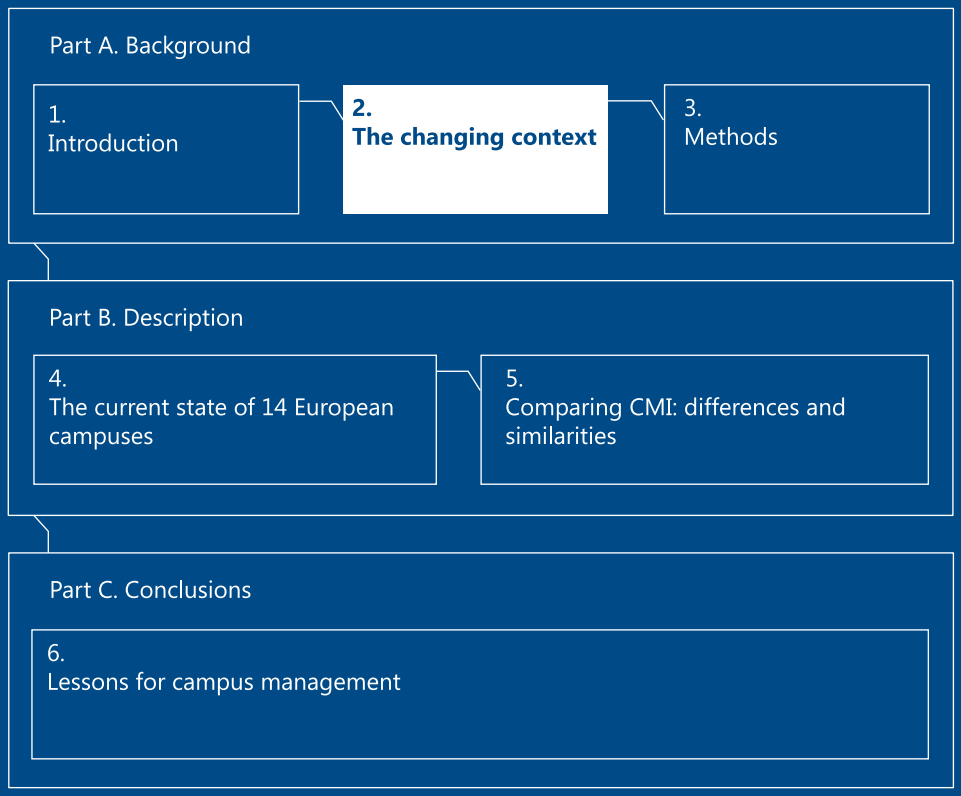
Universities of technology (UTs) entail a variety of universities that specialize in engineering, technology, and (applied or natural) sciences. Institutes of technology, polytechnic universities and technical universities are the most common terms used when referring to this definition of UTs. However, the strict or loose definition and use of these terms varies from country to country – i.e. Some of these labels have formal or informal meanings depending on the country. Regardless these contextual differences, in most countries, UTs are higher education institutions that offer all three level of higher education: BSc, MSc and PhD. More details about the use of this term can be found in Section 2.1.

1.5.2. Abbreviations

CM	Campus Management
CMI	Campus Management Information
HE	Higher Education
HEIs	Higher Education Institutions
ICT	Information and Communication Technologies
KPIs	Key Performance Indicators
UTs	Universities of Technologies

To address the manifold challenges faced by universities now and in the future, managers (must) acknowledge the interrelation of the multiple perspectives in campus management.

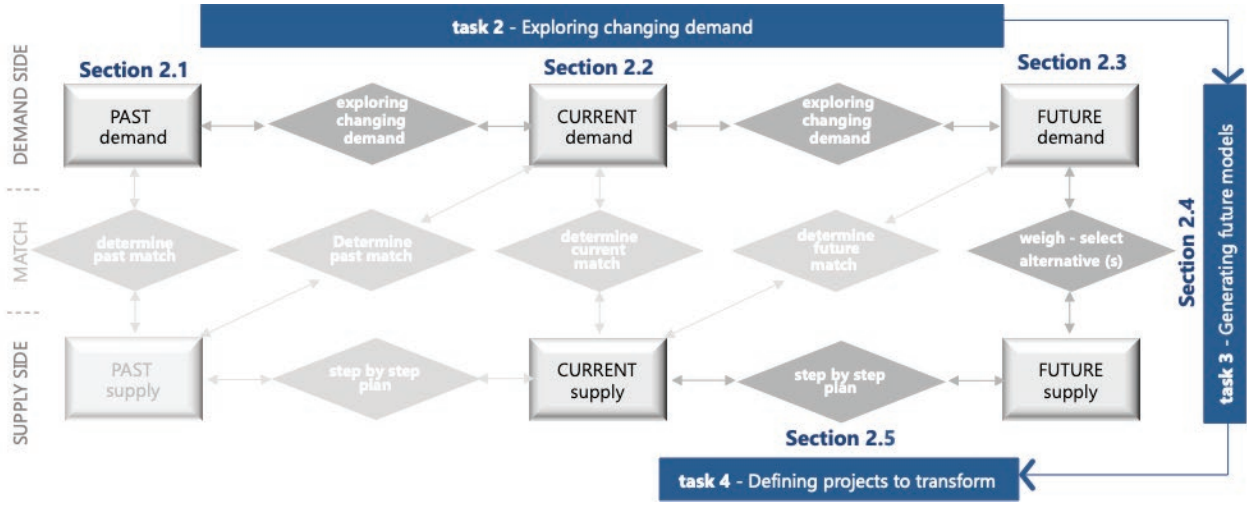
The changing context



2. The changing context of European UTs: past, present and future

This chapter provides a context to understand campus management and information in UTs. It looks into the past, current and future demand influencing UTs as well as the future options and current projects that are transforming the campuses of many European universities. The reader of this chapter can use the campus management tasks as a guide to dive into this context (See Figure 2.1). As shown, this chapter focus on three of the fourth campus management tasks. Herein, the second task in campus decision-making is being extended to explore the changing demand as from the emergence of UTs. The understanding provided in this chapter will set the context to explore the first task by using data from fourteen UTs in chapters 3, 4 and 5.

Figure 2.1 Outline of this chapter within the framework of campus decision-making in four tasks (based on Den Heijer, 2011)



2.1. Emergence and development of UTs

In this research, **Universities of technology (UTs)** entails a variety of universities that specialize in engineering, technology, and (applied or natural) sciences. Institutes of technology, polytechnic universities and technical universities are the most common terms used when referring to this definition of UTs. However, the strict or loose definition and use of these terms varies from country to country – i.e. some of these labels have formal or informal meanings depending on the country. Regardless these contextual differences, in most countries UTs are higher education institutions that offer all three level of higher education: BSc, MSc and PhD.

2.1.1. French origins

The origins of UTs date back to 1794 with the establishment of the French École Polytechnique (or engineering school). This school is today one of the most prestigious and selective grandes écoles of France and well-known for its polytechnicien engineering degree program. This school was founded under the name École Centrale des Travaux Publics (Central School of Public Works) as a response to the scarcity of engineers and high-level officials in France. Its foundation coincides with a period of political, economic and social change during the French Revolution and the Napoleonic period.

The mission of the school was twofold. First, it aimed to provide its students with a comprehensive scientific education with a strong emphasis in mathematics, physics, and chemistry. Second, it aimed to prepare them upon graduation to enter the national institutes of public works, such as École d'Application de l'Artillerie et du Génie (School of Artillery and Engineering Applications), École des Mines, and École nationale des ponts et chausses (National School of Bridges and Roadways). Soon after its foundation, Napoleon Bonaparte granted École Polytechnique its military status and gave the school its motto: "Pour la Patrie, les Sciences et la Gloire" (For the Nation, for Sciences, and for Glory, See Figure 2.2). Undoubtedly, this school was envisioned as a national strategy to advance science and technology for the public and for strengthening France's competitive advantage.

Figure 2.2 Motto of École Polytechnique engraved in the pediment of the Joffre Jardin pavilion, École polytechnique Paris

According to Graves (1965), the term grandes écoles is not an official one and has evolved with usage to indicate a category of higher education establishments that is separate from the French Universities. When Graves (1965) conducted his/her study, there was no official list of grandes écoles, they were dependent upon different French Ministries and the common element linking them was that they were concerned with professional training. These schools emerged as the need for them arose and each of them was set up for a specific purpose (e.g. to support industry and commerce). Similarly, their control and financing were a matter for the Government department that created them. Graves (1965) identify about 60 schools in French cities using a broad classification divided into nine categories defined by their dependence upon different ministries or other public bodies such as of the Paris Chamber of Commerce and the municipality of Paris. Similarly, Graves classify them functionally as: (i) teacher training establishments; (ii) schools for administrators; (iii) technical institutions; (Srivastava et al.) agricultural schools; and (v) military establishments.

Broadly speaking, grandes écoles are well known for preparing the administrative, scientific and business executives - or cadres - for their place as leaders in government or in private enterprise. In 2003, over 60 per cent of the chief executives in France's 100 largest firms were graduates of the grandes écoles (Power, 2003). Historically,

they have been regarded as exclusive places for the elite (Graves, 1965), considering the high standards and selective recruitment process since their establishments. With demographic changes over the 20th century in general, and the importance given to access to education in the knowledge-based economy in particularly, these schools have been subject to major criticisms. One of the main reasons is that they are not obliged –as French universities are- to accept in the first year of undergraduate studies all candidates of the region who hold a corresponding *baccalauréat*[4] and therefore, they were graduating too few engineers to satisfy the demands of the industry and society.

[4] *Baccalauréat* is an academic qualification that French students take after high school. It was introduced in 1808 as the main diploma required to pursuing university studies

Since 1947, there have been recommendations to reduce the differences between the grandes écoles, the specialist schools and the universities to open higher education to a broader spectrum of the French society (Elliot, 2007). This vision was reinforced in the 1980s with the so-called 'Savary Law' (French Law 84-52 of 1984), which aimed to make French higher education more competitive by improving its accessibility and quality hampered by institutional insularity and disparity, defence of privilege, lack of autonomy and access to resources (Elliot, 2000). After a challenging process, including the opposition of several unions and the alumni association of the grandes écoles, the minister Savary was able to pass the bill but without considering the grandes écoles, which would retain their autonomy. In 1997, the Attali Commission recommended that the grandes écoles open themselves to a broader range of students and demonstrate their dedication to practical research (Attali, 1998). These efforts allowed French universities to become self-governing institutions and both, universities and grandes écoles productive engines of research (Elliot, 2000).

To date, there is not an official or accepted list of grandes écoles in France but there about 200 schools that can be distinguished between (a) Écoles normales supérieures; (b) Engineering schools (grandes écoles d'ingénieurs); and (c) Business schools (grandes écoles de commerce). Next to the grandes écoles, there are three French Universities of Technology (Universités de Technologie), which are public institutions created by decree in 1999 (i.e. Belfort – Montbéliard, Compiègne and Troyes). These universities focus on education, research and technology transfer and award engineer, masters and doctoral degrees accredited by the French Ministry of Higher Education and Research. Although they are called universities, they are classified as non-university institutes (or écoles extérieures aux universités), as defined by Law 84-52 of 1984. This is also the case of more than 100 university institutes of technology (institus universitaires de technologie or IUTs) created in 1964 to provide highly skilled technicians. Nonetheless, they are not considered UTs -as seen in this research- because they only offer undergraduate degrees (Diplôme universitaire de technologie or DUT).

Generally, 'grandes écoles', 'universités de technologie', 'UITs' and 'écoles supérieures' –among others- are expressions used in France to indicate HEIs that are not categorised as universities. Only the National Polytechnic Institutes (Instituts Nationaux Polytechniques or INPs) are classed together with French universities by the Law 84-52 of 1984. INPs are three consortiums of grandes écoles that offer engineering degrees including the National Polytechnic Institute of Toulouse (Institut National Polytechnique de Toulouse or INP Toulouse), The Grenoble Institute of Technology (Institut National Polytechnique de Grenoble or INP Grenoble) and The National Polytechnic Institute of Lorraine. Regardless the classes these HEIs have in common their focus on engineering, science and technology but; close links with the industrial world both on national and international levels; and a strong reputation for their ability to innovate, adapt and provide an education that matches the ever-changing demands of industry. Indeed, this common goal is reducing the historical differences between the grandes écoles, the specialist schools and the universities. In 2014, 19 HEIs – including three universities, seven research centres and nine major engineering and business schools- joined forces to

strengthen their competitive advantage by launching the Université Paris-Saclay. Under this brand, these institutions are currently implementing a campus-wide coordinated research strategy, focusing on fundamental science as well as socioeconomic issues, to compete internationally. The Paris-Saclay site already hosts the research, development and education centres of several large international companies.

2.1.2. Worldwide adoption and profiles

The grandes écoles model has influenced higher education systems in other countries, which adopted the French 'École Polytechnique' ideal and popularized the so-called Polytechnic Institute. The English word 'polytechnic' originated in 1805, meaning 'pertaining to instruction in many (technical) subjects' (Oxford-Dictionaries). Accordingly, the use of this term came from the French École Polytechnique, which derived from the Greek polytekhnos or 'skilled in many arts,' (i.e. polys or 'many' plus tekhne or 'art'). As a noun, the word polytechnic is used as a short for polytechnic institution from 1836. The Polytechnic of Central London (today the University of Westminster) was the first English polytechnic founded as the 'Polytechnic Institution' in 1838[5] (See Figure 2.3). Although, a philanthropist originally established it, the polytechnic became publicly funded in 1891 and renamed the Regent Street Polytechnic.

[5] Our Heritage', University of Westminster's website accessed in December 2018.

Figure 2.3 Entrance of the current University of Westminster where Sir George Cayley opened the Polytechnic Institution at 309 Regent Street in London.

In Europe and beyond, the polytechnic model was established in some former French colonies such as Switzerland (e.g. ETH Zürich founded under the name 'Polytechnikum' in 1855 – See Figure 2.4), Italy (e.g. Politecnico di Milano founded as 'Instituto Tecnico Superiore' in 1863) and Canada (e.g. Polytechnique Montréal founded as 'École des sciences appliquées aux arts et à l'industrie' in 1873).

Figure 2.4 ETH Zürich in 1880 founded as Polytechnikum

In the United States, there are no well-defined categories to designated universities of technology. The words polytechnics as well as institutes of technology are used but have no formal meaning. However, they are well-known and prestigious HEIs such at Caltech, the MIT, Georgiatech, among others. Indeed, the label Institute of Technology emerged in the mid- 19th century. This term was employed along with the already known 'Polytechnic Institute' (e.g. Rensselaer Polytechnic Institute was the first of

this kind established in 1824 in New York). The first Institute of Technology was the Rochester Institute of Technology founded in 1829 also in New York followed by the MIT established in 1861 in Boston. These were private institutions founded by ambitious individuals with a vision to improve education in the US (See the box next to the text). As their French predecessor, institutes of technology in the US have become also elite institutions and are research-intensive universities with a focus on Science, Technology, Engineering and Mathematics (STEM).

Today, the term University of Technology is widely used along with Polytechnic Institute and Institute of Technology to refer to HEIs that focus on STEM subjects[6]. Nonetheless, their profiles and developments differ given each country's legal, political and cultural contexts. Generally, universities of technology distinguish themselves from technical colleges (in the US and the UK), universities of applied sciences (in the Netherlands and Germany), and Polytechnics schools (in Finland). Depending on each country's higher education system, the latter type generally focuses on training vocational skills and offering bachelors' and (sometimes) masters' degrees rather than PhDs.

[6] STEM is a wide categorisation in the supply of higher education that refers to any subjects that fall under these four disciplines: science, technology, engineering and mathematics. In some contexts, it may also include the curricula of research universities that specialise in agricultural and medical research.

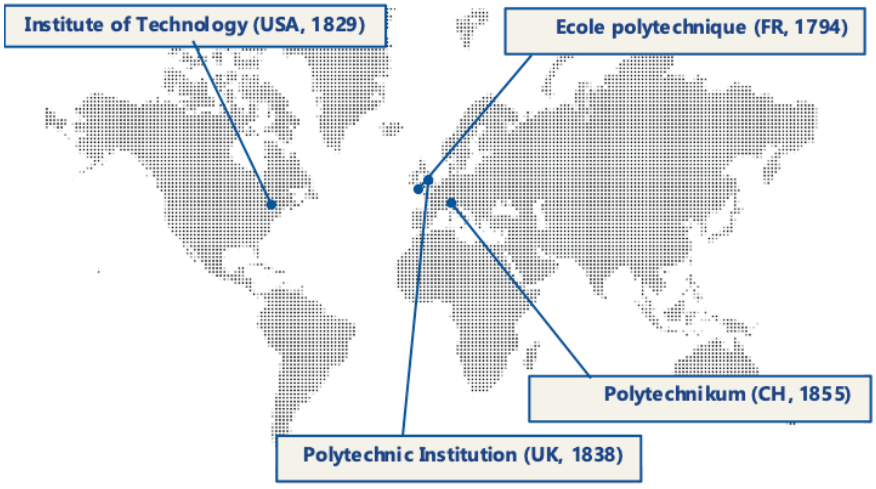


Figure 2.5 Map of different labels used to denominate universities of technology in their emergence.

"The true and only practicable object of a polytechnic school is ... the teaching, not of the manipulations and minute details of the arts, which can be done only in the workshop, but the inculcation of all the scientific principles which form the basis and explanation of them ..."

Letter, William Barton Rogers (Founder of the MIT) to Henry Darwin Rogers, March 13, 1846, William Barton Rogers Papers (MC 1), Institute Archives and Special Collections, MIT Libraries (MIT, 2019).

In the United Kingdom, polytechnics developed as distinct institutions from universities creating tensions in the higher education system such as the universities' monopoly of degree-awarding powers. Before 1992, polytechnics granted undergraduate and graduate degrees through the Council for National Academic Award (CNAA); created in 1964 to advance education, learning, knowledge and the arts.

The CNAA approved courses at educational institutions other than universities and granted degrees to persons who carried out research under the conditions approved by the Council and comparable to those granted by universities (University of Warwick, 2019). The CNAA ceased to exist after Further and Higher Education Act 1992 passed in England and Wales. Among several reforms in the funding and management of the higher education system, this Act gave to more than thirty polytechnics the status of universities allowing them to award their own degrees and participate in publicly funded research.

However, the tensions in the HE systems did not ease as they were politically differentiated as 'new universities' or 'post-1992 universities'. Moreover, the identity of these institutions faded as most of them changed their names by simply replacing the word polytechnic with the word university in their titles. Unlike in Europe and the US, polytechnics in the UK were not viewed as elite universities. Brosan (1972) distinguished seven dimensions differentiating British universities from polytechnics (Table 2.1).

Dimensions	Universities	Polytechnics
Purpose	Preservation of learning	Application of education
People	Nurturing apprentice scholars (elite)	Nurturing apprentice industrialists (comprehensive)
Discipline	Stating and solving problems within disciplines regardless the situations involved	Formulating problems from situations regardless the disciplines involved
Inquiry	Speculation-driven	Problem-driven
Research	Intrinsic value independent of results achieved	Specific with expected implications
Society	Detachment from- and independent criticism of society	Involvement in industry, commerce and society
Entry	Selective admission focused on committed, full-time student	Wider admission focused on part-time students engaged on re-education

Table 2.1 Summary of Brosan's (1972) dimensions of differences between universities and polytechnics in the United Kingdom

These dimensions not only illustrate some traditional assumptions of the university system in the UK such as the gap between 'pure and applied' but also unveiled the future challenges polytechnics offered to the higher education system in the changed knowledge-economy. Particularly, it distinguished their wider role in knowledge-transfer and access to education. The old distinction seems to be timeworn, especially for students who can hardly question some of these universities commitment to world-class engineering and technology (Scott, 2012). Nonetheless, there are still concerns from politicians who argue that some former polytechnics, which are considered 'underperforming institutions', should lose their university status (Adams, 2017).

Overall, a shift away from 'practice' and towards 'science' is identified in engineering education (Harwood, 2006). By reviewing literatures on the USA, Germany, Britain and (to a lesser extent) France, the author argues that the contemporary understanding of the dynamic system of higher engineering education is limited and needs more comparative analysis. For instance, what he called 'the academic drift in engineering' seems to be fostered by a search of academic status. However, this is more or less evident depending on the context. For instance, this is less evident in contexts where there is no 'status deficit' and there is less abundant public funding for research. All in all, the fact that engineering education shift away from practice gains importance as it can become increasingly irrelevant to actual needs. Perhaps the current call from policy makers to address societal problems in UTs can be seen as a way to reverse this drift and/or to find a balance between academia and practice in engineering education.

2.2. Competition and collaboration between UTs

2.2.1. Top research requires top infrastructure

Technology-based research is an essential activity performed in UTs. It refers to both, (1) fundamental or basic research and (2) research and development activities, which have a focus on the advancement of technologies in various fields. The infrastructure that supports these activities has been acknowledged as national science systems in early global policies on knowledge economy (OECD, 1996). These systems include public research laboratories used and/or managed by higher education institutions, government science ministries, research councils, certain enterprises and other private bodies.

Research laboratories are important targets for investment and management in the European agenda when it comes to use physical infrastructure as resources to stimulate innovation. Since the establishment of the European Strategy Forum on Research Infrastructures (ESFRI) in 2002, both physical and digital infrastructures available on campuses are a priority of the EC, which is closely cooperating with member states to define, evaluate and implement strategies and tools for world class European research infrastructures. Certainly, most of the attention has focused on dedicated research laboratories supporting sciences and engineering research, which exist and are iconic in many UTs (Figure 2.6).

Besides this unique infrastructure, UTs own and use other types of physical infrastructure in which creative process are undertaken such as libraries and learning centres, incubators, accelerators, ateliers and congress centres. This physical infrastructure supports the social and functional infrastructures that make campuses an essential aspect of UTs' competitive advantage. In turn, the high costs and specific knowledge required to manage the campus can challenge some UTs to sustain their competitiveness. Undoubtedly, sharing their competences and resources has become a key strategy for many UTs to strengthen their profiles in Europe and beyond.

Figure 2.6 Unique European research infrastructure. Left: Research reactor I and II at the campus of the Technical University Munich (TUM) in Garching. Right: the European Synchrotron Radiation Facility, a joint facility supported by 22 countries and situated in the GIANT campus (Grenoble, France) where the École Nationale Supérieure de l'Énergie, l'Eau et l'Environnement and several institutes are located (Photos: Google Earth).

2.2.2. European UTs: united in competences

European UTs are collaborating to strengthen their education, research and valorisation and thus, to remain competitive in the global context in which they operate. Since the early 1970s, six major institutional umbrellas for transnational collaboration between UTs have been established.

SEFI (est. 1973) or European Society for Engineering Education is a non-profit international organisation considered as the largest network of engineering education players in Europe. Their members are institutions of higher engineering education, rectors, deans, professors, students, but also companies and other international associations and societies involved in the field. The mission of SEFI is to contribute to the development and the improvement of engineering education in Europe, to emphasise the need for and to strengthen the image of both engineering education and engineering education professionals in society.

CRP (est. 1980) or Conference of Rectors and Presidents of European Universities of Technology is an informal group of representatives from leading engineering universities in Europe. As an informal group The Conference has no formal international or European organisational structure. However, this group meet every year to offer an open forum for:

- Discussing topics of major common concern, that are not discussed in other fora,
- Identifying differences and commonalities of existing solutions to problems of common interest,
- Developing new ideas and - if appropriate - preparing recommendations on specific topics, and, thus,
- Forming a "think tank" for the future development of the universities of technology in Europe.

CESAER (est. 1990) is the European association of leading specialised and comprehensive universities of science and technology. They profile themselves as 'the strong and united voice of universities of science and technology in Europe'. CESAER supports 53 universities in 25 European countries (See Figure 2.2) through five key objectives:

- To learn from each other by sharing information and best practice in the areas of higher education, research, innovation and university governance;
- To aid policy-makers and funders to shape European strategies, policies and funding programmes;
- To boost their participation in (European) funding programmes;
- To promote our strengths globally: support our Members in displaying their excellence and distinctiveness at European level and beyond;
- To advance debate on key issues by promoting reflection and understanding of the role of science and technology in open knowledge societies.

Although many of CESAER's members are considered UTs as defined in this research, other comprehensive universities offering doctorate degrees are also members of this association due to their broad definition of science and technology and their focused membership by invitation only. In fact, the scope of the memberships seems to be extended beyond the European context as the Technion - Israel Institute of Technology has joined this association.

CLUSTER (est. 1990) or Consortium Linking Universities of Science and Technology for Education and Research is a consortium of 12 elite European Universities in Science and Engineering (and architecture) with associate members from around the world. CLUSTER is an active platform in the promotion and creation of frameworks aiming to tackle societal issues. It has evolved from being focused only on Engineering Education to be, nowadays, acting on the so-called knowledge triangle comprising Education, Research and Innovation. CLUSTER is a proactive advocate of engineering futures for policy decisions, implementation of research programs and frameworks at the regional, national and European level.

IDEA League (est. 1999) is a strategic alliance between five leading European universities of technology. These research-oriented universities are internationally renowned and the largest producer of science and engineering graduates in their own country (i.e. Chalmers University of Technology in Sweden, Delft University of Technology in the Netherlands, ETH Zürich in Switzerland, RWTH Aachen University in Germany and University Politecnico di Milano in Italy). IDEA League profiles itself as 'a focused network of leading European universities of science and technology'. This network shares the ambition to contribute in making Europe a world leader in science and technology by sharing academic resources and knowledge. Therefore, they organise joint activities in education, research and quality assurance and jointly participate in EU programmes and initiatives. By pooling resources for collaborative and complementary programmes they add value to their students, researchers and staff.

EuroTech Universities (est. 2011) is a strategic partnership of leading European universities of science & technology. This partnership profiles itself as committed to 'excellence in research, science and technology'. Its six members are DTU in Denmark, TUM in Germany, L'X and EFPL in France, TU/e in The Netherlands and the Technion in Israel[7]. They work together to strengthen their capacities to address challenges and achieve multi-scale initiatives of high impact to society. The EuroTech Universities Alliance has a research strategy with activities anchored in five fast developing research and innovation areas:

- Entrepreneurship & innovation
- Health & Bio Engineering
- Smart & urban mobility
- Data Science & Engineering
- High Performance Computing

Such activities include the establishment of internationally renowned educational programmes, research centres and infrastructures.

Next to these European umbrellas, there are also (trans)national institutional umbrellas established to strengthen national and regional science and technology. Some of these institutions have been established long before the institutions at European level. The following paragraphs describe some of these umbrellas for (trans) national cooperation in European countries.

Conference of Grandes Écoles (est. 1973) is a French national institution dedicated to cooperation between its 285 members. These include 227 Grandes écoles recognized by the State, 21 member companies or partners and 37 member organizations. Among other things, it promotes international partnerships, advises the government on programmes at the preparatory course for enrolment in one of the grandes écoles and recognises post-graduate courses.

[7] Similarly to CESAER, the geographical boundary of this partnership is not as relevant as to other socio-economic relations between these countries. For instance, the relation between Israel and Europe is framed in the European Neighbourhood Policy (ENP) and its EU Association Agreement signed in June 2000.

TU9 (est. 2003) is an alliance of nine German universities of technology: RWTH Aachen University, TU Berlin, TU Braunschweig, TU Darmstadt, TU Dresden, Leibniz University Hannover, Karlsruhe Institute of Technology, Technical University of Munich, and University of Stuttgart. These nine universities are excellent in research attracting a fourth of all third-party funding in Germany. Similarly, 57 per cent of all German doctorates in engineering are awarded at TU9 universities. Their scientific potential, range of courses and increasing student numbers is the common ground that forms the basis of their cooperation.

Nordic FiveTech (est. 2006) is a strategic transnational alliance of the five leading technical universities in Denmark, Finland, Norway and Sweden (Aalto University, Chalmers University of Technology, DTU – Technical University of Denmark, KTH Royal Institute of Technology, NTNU – Norwegian University of Science and Technology). The alliance was established to use these universities' shared and complementary strengths and create synergies within education, research and innovation. These five institutions collaborate in a range of activities including developing joint master's programmes, PhD courses, participating in joint research projects. The Nordic Five Tech universities are particularly strong within the areas of energy, environment, ICT, maritime technology, cold climate engineering, materials, and sustainable development.

4TU Federation (est. 2007) is an alliance between the four Dutch universities of technology: TU Delft, Eindhoven University of Technology, University of Twente and University of Wageningen. They are strengthening and pooling their technical knowledge with the aim of producing sufficient numbers of highly qualified engineers and technical designers, of conducting outstanding and socially relevant research of an international standard, and of promoting cooperation between research institutes and businesses.

TU Austria (est. 2010) is an alliance of three Austrian universities of technology: Vienna University of Technology, Graz University of Technology and Montanuniversität Leoben. They have joined forces with the ambition to coordinate research focal areas and study offers; to enhance cooperation in research, education and services; to enable permeability within the curricula of the technical/engineering study programs to enhance mobility within TU Austria; to coordinate policy; to identify and exploit synergies including joint access to research infrastructure data bases for efficient use of resources; to unity their appearance in public and lobbying; and to develop common positions in science policy and representation of these common interests towards third parties and stakeholders.

Where is the campus in the common agenda of UTs?

As described above, most of these umbrellas for national and transnational collaboration between European universities of technology focus on strengthening their core processes: research and education. The activities they organise involve the management of resources other than the built environment. Collaborations to strengthen the development of personnel, information, technology and capital resources are explicit in most of their missions. However, how to strengthen their campuses as strategic resources is yet a marginal ambition in these institutional arrangements. Undoubtedly, these umbrellas can play a role in pushing forward the important role of the campus as a strategic resource supporting the primary processes of UTs. It might be the case that they already acknowledge this fact. The question remains who can take the lead and what capabilities can they share for better campus management.

2.3. The changing landscape of UTs

What is the future of UTs? Exploring the changing demand as the second task in campus management can shed light to answer this question (Figure 2.7). Knowing what UTs want/need now and in the future can allow stakeholders involved in campus decisions to foresee developments affecting the future of universities and the campus. Thus, they can make better and more resilient decisions.

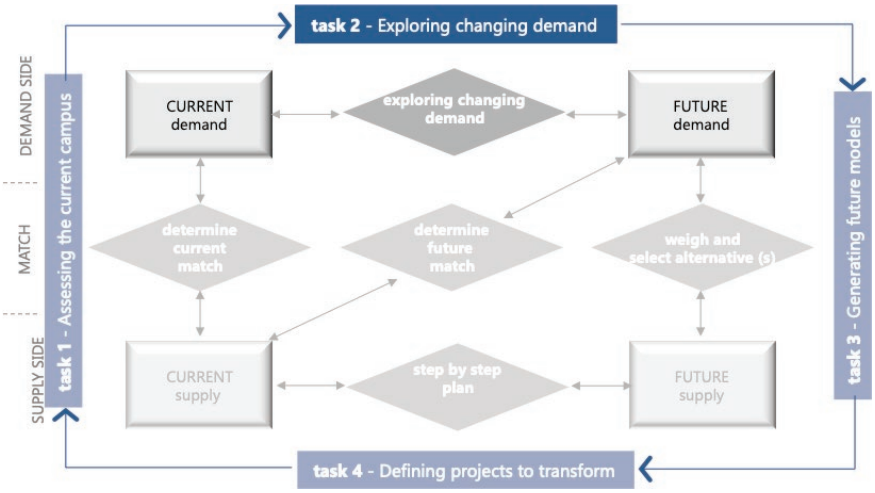


Figure 2.7. The second task in campus decision-making: exploring the changing demand (Den Heijer, 2011).

Universities, in general, operate in a dynamic context driven by the creation, diffusion and application of knowledge, which idea as an economic factor Schumpeter (1934) spread during the 1990s as adopted in global and regional policies (Curvelo Magdaniel 2016; Jessop 2017). UTs, in particular, have a large role to play in the latter process to develop new- and/or improve existing technologies, services and products. These interrelated processes are at the core of innovation, which is stimulated not only by universities but also firms and the government -at municipal, regional and national levels- to sustain their competitiveness.

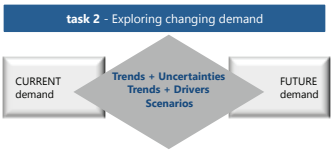
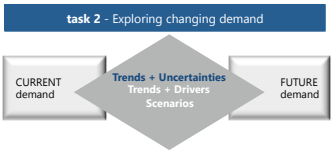


Figure 2.8 Approach to describe the changing landscape of UTs using trends, uncertainties, demand drivers and scenarios.

Certainly, competitiveness is an important driver but just one of the many influencing the demand for higher education worldwide. This section will provide an overview of how the landscape in which UTs and other universities operates is rapidly changing. This overview is given in three parts based on existing research and a scan of the press and the literature (See Figure 2.8).

First, the section will introduce trends and uncertainties identified in previous research in the Dutch context as a milestone to understand the interaction between the changing demand in higher education and campus management research. Second, a quick scan of existing and emerging demand drivers at European level is presented and linked to the four perspectives on campus management. Third, a review of contemporary literature on future scenarios for higher education worldwide is summarised. Finally, the main conclusions of this section are drawn.

2.3.1. The changing context in campus management: lessons from Dutch universities



This section builds upon recent research (TU Delft, 2016) about developments taking place around Dutch universities and influencing their campuses and its management. Herein, eight main trend-clusters were identified: (1) globalisation and internationalisation, (2) diversity and demography, (3) the more rapidly changing context, (4) the cooperation outside the university, (5) the changing working environment, (6) digitalisation, (7) shift in funding and (8) educational and research innovation. Accordingly, their impacts were translated into particular effects for each of the four perspectives on campus management (See Table 2.2).

Perspective	Trends effects on...
Organisational	University goals and ambitions
Financial	University costs, income and value
Functional	University users and user's satisfaction
Physical	University's spatial condition (quantity/quality and location)

Table 2.2 Operationalisation of trends according to their effects on campus perspectives (Adapted from TU Delft, 2016)

Their detailed analysis concludes with ten learning points regarding the main uncertainties and interrelated aspects to consider in the future of Dutch universities.

First, the number of students is difficult to predict and universities should take into account both rising and decreasing student numbers to better anticipate the latter, which is often not expected.

Second, the demand for teaching space per student is changing and universities can steer it in an efficient way. For instance, students are spending more time on campus and require more study places than ten years before. With the variable numbers of students, universities are forced to make strategic choices such as increasing occupancy and/or extending opening hours occupied and used.

Third, students are spending more hours- and want to be on campus regardless digitalisation enables them to study anywhere else. In turn, this sets high standards on the quality, availability and accessibility of facilities.

Fourth, research cannot be planned on the long term due to the changed systems for research funding operating under rapidly changing themes, shorter deadlines and highly flexible networks. This makes the demand for research space less predictable and more unique.

Fifth, the requirements for research facilities and their costs per square metre are increasing due to stricter health, safety and quality prerequisites to attract and retain the best researchers in a highly competitive environment.

Sixth, the increasing dynamic workforce requires accommodation that is more flexible. The increase of research projects with shorter duration has also increased the number of temporary staff, part-time and mobile employees at universities. This workforce demands a working and living environment that is easy to access, change and adapt.

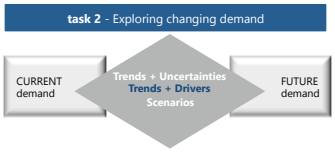
Seventh, the academic office environment is less well occupied due to the changing workforce described above. Facilitating traditional territorial workplaces is more complex and sensitive with the increased number of guest researchers and professors that need temporary workplaces.

Eighth, the willingness towards sustainable use has increased. Students and academics are more aware of the scarcity of resources and are willing to share those to attain environmental, social and economic sustainability.

Ninth, flexibility as answer for uncertainty seems to be key to deal with a future that involves different visions.

Last, planning for change rather than for a final picture will help universities to incorporate flexibility in their projects, which need to be adaptable to the changing circumstances. With this in mind, the following paragraph will present some trends and drivers affecting higher education institutions and thus the management of their campuses.

2.3.2. The European university: a quick scan of trends in demand drivers



The following overview of trends at European level complements the trends identified in previous research (TU Delft, 2016), which were introduced in the previous section. These trends are presented and linked to the four perspectives on campus management through particular drivers. Accordingly, scanning the news and institutional websites enabled to identify a number of trends linked to organisational, financial, physical and functional drivers (Figure 2.9). Although the campus perspectives serve to categorise the trends linked to particular drivers, they also help to illustrate the interrelation between campus perspectives.

Organisational drivers:
- Competitiveness
- Governance
- Identity

Financial drivers:
- Growth
- Value
- Efficiency

Physical drivers:
- Quality of place
- Distinctiveness
- Circularity

Functional drivers:
- Users' well being
- Productivity
- New ways of learning - NWoL
- Demography/Migration/Mobilisation

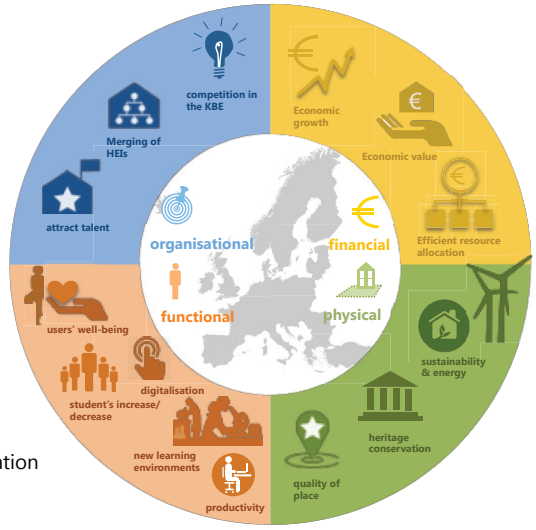


Figure 2.9 Drivers influencing the changing demand in universities categorised by campus management perspectives.

Organisational drivers

Competitiveness, policy and identity are the main drivers affecting organisational demands in universities. Competitiveness refers to how universities sustain their comparative advantage in terms of quality of education, research and valorisation as core businesses. Governance refers to how universities are envisioned, organised, funded and operated in societies and considering their policies. Identity refers to how universities profile and project themselves in society.

Accordingly, universities want to be the best, efficient and distinctive institutions in a world of many universities producing knowledge as the most valuable asset for the European economies and societies. To do so, many universities and other HEIs are using mergers as a strategy to become stronger in each of these aspects (Figure 2.10).

EUA
University mergers in Europe
Click on the map for an overview of mergers in a given country.

Taylor & Francis Online
Built to be excellent? The Aalto University merger in Finland
Janne Tienari, Hanna-Mari Aula & Timo Aarrevaara, 27 Oct 2015

University World News
Merger makes Tampere the second-largest university
By Jan Petter Myklebust 11 January 2019

"The University of Tampere and the Tampere University of Technology merged on 1 January to create Tampere University, the second-largest university in Finland, a move that will further break down the borders between Finnish universities and university colleges".

BBC News
Big is beautiful for merging universities
By Nic Mitchell, 25 November 2015

"Universities across Europe are talking about merging or forming alliances like never before.
Almost 100 mergers have taken place since the beginning of the century.
The European University Association (EUA), representing universities in 47 countries, is mapping this changing landscape with an interactive merger map."

"The EUA says mergers gathered pace from 2005 onwards, with Denmark and Estonia being the early trendsetters. Estonia cut its number of higher education institutions from 41 to 29 between 2000-2012. The University of Tallin in the country's capital absorbed eight smaller institutes and colleges. In Denmark, the number of universities was reduced from 12 to eight and government research centres integrated into the university sector."

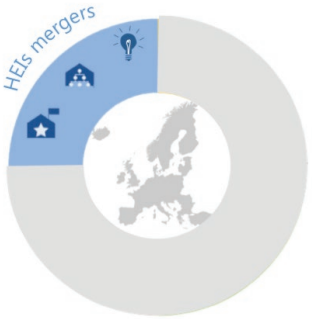


Figure 2.10 HEIs mergers as a trend in competitiveness and governance affecting organisational demands in universities

The EUA has mapped almost 100 mergers that have taken place in 47 countries since 2000[8]. Although this seem to be strategy that may strengthen their size and quality, for some universities this may lead to the loss of their identity as the weaker names may be absorbed by the prestigious ones. In terms of governance, this can lead to complex structures.

[8] For more info, visit: http://www.university-mergers.eu/

Recently, the identity of 'elite and prestigious university' can be seen as negative in a world that increasingly strives for diversity, equity and inclusiveness. In the UK, there is a growing criticism towards the entry and recruitment policies in prestigious universities such as Oxford and Cambridge (See Figure 2.11). The argument centres on the narrowed opportunities for low-income student to access elite universities and so,

excellent education. In turn, political pressure to adjust their entry requirement for low-income students can have a negative effect on their quality and also can create social frictions as these decisions can also affect middle-class students.

The politics of fear and division as well as populist leaders are undermining democratic institutions all over the world. This has also consequences for higher education sector and its happening in Europe (See Figure 2.12). The case of the Central European University in Hungary calls for political consideration as the university has been forced out of the country after the government banned the teaching of gender studies. The decision to relocate elsewhere has also been constrained by differences in accreditation systems.

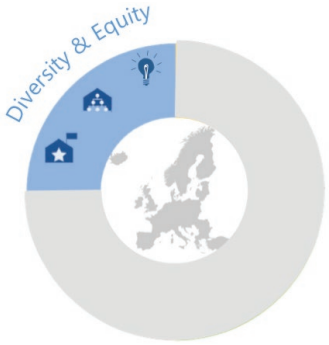


Figure 2.11 Diversity, equity and inclusion as a trend in identity and governance affecting organisational demands in universities.

The Economist
New rules will push universities to cut entry requirements for poor pupils
It is hard to see how else targets can be met
December 15, 2018

tes
Universities are damned if they do and damned if they don't
The HE sector is castigated as elitist and castigated as lowering the bar when it makes unconditional offers
By Bernard Trafford, December 15, 2018

The Guardian
Oxford 'spends £108,000' to recruit each extra low-income student
By Richard Adams, September 19, 2018

The Guardian
Cambridge University plans scheme to open door to poorer students
By Sally Weale, October 1, 2018

Figure 2.12 Politics and democracy as a trend in governance affecting organisational demands in universities.

Inside Higher Ed
Central European University Forced Out of Hungary
By Elizabeth Redden, December 4, 2018

The New York Times
George Soros-Founded University Is Forced Out of Hungary
By Marc Santora, December 3, 2018
"The closing of the university, founded by the American billionaire George Soros, came after a nearly two-year struggle with the Orban government, which has quashed dissent and consolidated control over all aspects of Hungarian life. The university will move its United States-accredited degree programs to Vienna in September.
Mr. Orban also banned gender studies this year."

The Washington Post
There's more to the story of Central European University
December 12, 2018
"How can Central European University award diplomas from the United States when CEU does not deliver accredited degrees in the United States?"

The quality of education is increasingly taking back its central place in the higher education sector. Indeed, the exclusive attention given to research in societies that have adopted the knowledge-based economy has placed universities and academic staff under pressure. Although the global rankings and national statistics consider both education and research as the most important aspects to rank universities, the performance of their academic staff is increasingly measured by research outcomes. A turn is starting to be seen in European countries that give attention to measure the excellence in teaching through policy frameworks (Figure 2.13). In the end, strict measures (such as the categorisation of teaching excellence in the UK into gold, silver and bronze) can lead to frictions between universities as this can influence the (international) student choices for academic programs.

The Guardian
Degree courses to be ranked in price comparison-type system
March 12, 2018

Inside Higher Ed
A New Model for Professors in the Netherlands
By David Matthews, December 7, 2018

The Guardian
Is the teaching excellence framework shaping international student choice?
UK students have been unfazed by the new ranking, but international students are taking the results seriously, which could damage bronze universities.
By Aaron Porter, October 16, 2017

Figure 2.13 Excellence in teaching as a trend in competitiveness affecting organisational demands in universities

Universities profile themselves not only as problem-solvers of societal challenges but also as influencers of social change. Throughout history, their stand on societal issues has been influenced the public and political opinions. They are increasingly seen as game changers to address global environmental issues (Figure 2.14). Therefore, many of them are adopting their socially responsible role from generating clean technologies in research to bringing awareness in education (Alghamdi et al., 2017).

The Guardian
'It's like tobacco funding health research': should universities take money from fossil fuel?
By Rachel Hall,
November 22, 2018
"Imperial ranks in the bottom tier of People & Planet's annual sustainability ranking for universities. In response to the poor performance, it produced a report aimed at understanding what had gone wrong. Of the staff and students surveyed for their views, 98% felt the university should be doing more on sustainability and climate change."

The Guardian
Business education helps create a culture where the profit justifies the means
By B. van der Kolk,
November 22, 2018

The Guardian
Universities leading climate research must stop funding fossil fuels
By K. Rogaly and S. Thorpe,
November 23, 2018

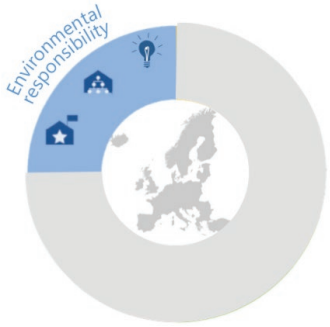


Figure 2.14 Environmental-responsibility as a trend in identity affecting organisational demands in universities

Financial drivers

Growth, value and efficiency are the main drivers affecting financial demands in universities. Growth (or decline) refers to the economic context that affects the funding and operations of universities. Value refers to the economic significance of the activities performed by universities and that allow them to obtain funding. Efficiency refers to how universities use the funding they obtain to perform their activities. Financial and organisations drivers can be seen as deeply interrelated and affecting each other.

Accordingly, universities want to operate in a healthy economic environment, provide valuable activities to their socio-economic context and be financially sustainable using their resources efficiently. Some universities may have a hard time to match their financial demands given the turbulent political relations in today's European Union. Brexit is posing pressures for universities in the UK to obtain research funding and sustain their collaboration with European universities (Figure 2.15). The UK's decision to leave the EU has repercussions also in the mobilisation of staff and students, the enrolments of international students and thus, the income of UK universities. Besides, it can also generate tensions among countries in the British Isles affecting also the economic growth of the region as context of the higher education sector.

Figure 2.15 Cuts in research funding as a trend in value affecting financial demands in universities

Financial Times
UK universities told to speed up EU funding requests before Brexit
By Andrew Jack, December 16, 2018

-50,000 EU nationals working in UK universities;

-135,000 undergraduate and postgraduate EU students;

-EU students generate £2.7bn a year net revenue;

-1/3 of the latest round of European Research Council funding for humanities and social sciences went to the UK, on top of €626m between 2007-15.

Foreign Policy
The Brexit-Fueled Death of the British University
For centuries, British schools were the envy of the world. Now they're scrambling to stay alive.
By Stephen Paduano, December 7, 2018

University World News
Erasmus+ uncertainty as risk of no-deal Brexit rises
By Brendan O'Malley, January 30, 2019
"Thousands of students could be denied government funding to study abroad in future if the United Kingdom leaves the European Union without a deal, Universities UK has warned."

Clyde 1
Business education helps create a culture where the profit justifies the means
By Berend van der Kolk December 12, 2018
"Figures from Universities Scotland estimate universities are worth #11 billion gross to the economy, while benefiting from 558 million euros from the Horizon 2020 programme and 64 million euros from the Erasmus programme."

According to the EUA (2018), the divide between higher education systems that increase public funding, and those that reduce investment, is getting wider since 2008. Measures to increase both, the efficiency of the (scarce) financial resources (Figure 2.16) and the effectiveness of investment are a concern in many universities (Figure 2.17). Indeed, where to allocate the money can be a dilemma for HEIs taking into account the many uncertainties and ambitions such as strengthening internationalisation. The setup of the 'efficiency hub' by the USTREAM project[9], allows universities to share their own experiences and learning from each other on how to achieve efficiency, effectiveness and value for money.

[9] More info: http://efficiency.eua.eu/

Figure 2.16 Scarce resources as a trend in growth and efficiency affecting financial demands in universities

Inews
Ratings agency warns of 'negative outlook' on seven institutions
Only Oxford and Cambridge did not have a negative outlook in the coming years.
By Richard Vaughan,
November 23, 2018
"Serious financial pressures facing the higher education sector has prompted the influential credit ratings agency Moody's to issue a warning that several major universities are likely to fall into deficit."

The Irish Times
'If society values third level education, we need to find a way to pay for it'
By Peter Hamilton,
February 1, 2019
"He pauses to flag this as a lesson for the State's investment in education. - If we don't invest now in 10 years or 15 years' time, when we look back, we'll regret that we had the opportunity to do so and didn't."

University World News
Funding for Europe's universities rising, but not enough
By Rebecca Warden , October 20, 2018
"Governments have increased funding for European higher education over the past decade but this recovery is not happening fast enough to produce a catch-up effect, according to the European University Association (EUA)."

Inside Higher Ed
End of Branch Campus Boom?
By Chris Havergal , May 31, 2015
"Opening branch campuses is now the lowest internationalization priority for European universities, according to a major study, prompting suggestions that a market dominated by British institutions is now past its peak. In a survey conducted by the European Association for International Education, just 1 percent of respondents who worked for universities said that they had witnessed a substantial increase in branch campus activity at their institution in the past three years."

EUA | European University Association
Welcome to the University Efficiency Hub
This online portal allows university practitioners and policy makers across Europe to share knowledge and hands-on experience of efficiency, effectiveness and value for money in the field of higher education.

Inside Higher Ed
The Cost of Agents
By Chris Havergal , February 20, 2015
"Data obtained by Times Higher Education from 158 higher education institutions under Britain's Freedom of Information Act reveal that all but 19 elite or specialist institutions now use agents to enroll non-European Union students."

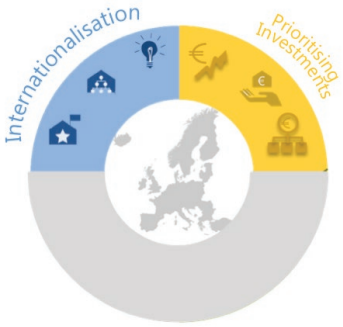


Figure 2.17 Prioritising investments as a trend in value and efficiency affecting financial demands in universities

Physical drivers

Quality of place, distinctiveness and circularity are the main drivers affecting physical demands in universities. Quality of place refers to how universities are creating and maintaining a physical environment that not only supports but also adds value to their core activities (i.e. provides a shelter for- and inspire education, research and valorisation). Distinctiveness refers to the ability of universities to convey a message to society about their own identity through their own space. Circularity refers to the progressive view of many universities on environmental sustainability and how they apply what they preach on their own premises.

Accordingly, universities want to have inspiring places to support their many functions, landmarks that reflect their identity and infrastructures that showcase their commitment to save the planet. To do so, many universities are collaborating with cities and other partners to bring their common societal and spatial agendas forward. For instance, universities and cities are developing joined programmes or strategies to promote campuses and cities or 'UniverCities' as attractive magnets for young students, researchers and entrepreneurs (Figure 2.18). Herein, quality of place (on campus and in the city) is essential next to the quality of the education and research provided by the universities. The former covers multiple aspects such as the student mix, safety, cleanliness, green areas, freedom and openness, job opportunities, housing provision, affordability and cultural amenities.

The environmental commitment of universities extends to their own campuses and the cities in which they locate. The cities and districts hosting universities are centres for innovation and platforms to address societal challenges that are becoming more prominent in the European agenda (European Commission, 2017a). Environmental sustainability is one of those challenges (Figure 2.19). Indeed, universities in the North America, Europe and Asia are partnering with cities and their external stakeholders for co-designing and co-producing sustainable urban environments. Certainly, campuses are becoming ideal living labs to test and advance technologies for cities.

Figure 2.18 Attractive UniverCities as a trend in quality of place affecting physical demands in universities

The Class of 2020
UNIVERSITY & CITY FROM IVORY TOWER TO THE NON-CAMPUS CAMPUS
University interventions in the urban landscape
By Clare Melhuish,
February, 2019

EUniverCities Network
"EUniverCities is a European network, launched in 2012, in which medium sized cities as well as universities work together in order to give knowledge cities more visibility within Europe. The network aims to exchange and spread the knowledge, expertise and experience about city-university cooperation across urban Europe. Network members learn from each other how to shape co-operations in a fruitful way, apply the lessons, take next steps on the local level, and spread the lessons and ideas. The network has been inspired by the EU2020 Strategy on Smart, Sustainable and Inclusive Growth attributes great importance to knowledge, innovation and technology."

Figure 2.19 Sustainable and Smart Campus-City as a trend in circularity affecting physical demands in universities

The Guardian
Are university campuses turning into mini smart cities?
Universities are experimenting with AI and big data to improve how students live and learn on campus
By Zofia Niemtus,
February 22, 2019

Journal of Cleaner Production
Co-creating sustainability: cross-sector university collaborations for driving sustainable urban transformations
By Gregory P. Trencher,Masaru Yarime, Ali Kharrazi
Volume 50, 1 July 2013, Pages 40-55

Global Environmental Change
University partnerships for co-designing and co-producing urban sustainability
By Gregory Trencher,Xuemei Bai,James Evans, Kes McCormick, Masaru Yarime,
Volume 28, September 2014, Pages 153-165

Current Opinion in Environmental Sustainability
Living labs and co-production: university campuses as platforms for sustainability science
By James Evans *et al.*
Volume 16, October 2015, Pages 1-6

Contemporary cities are facing the problem of urban decline in historic urban areas including former industrial districts with cultural heritage components. Finding ways to bring these areas back to life and integrate them better with the rest of the city has been a major challenge for many local stakeholders. While some areas have been targets of urban regeneration and renewal projects, some others have remained vacant and abandoned. Previous projects aimed to develop urban models are reinforcing European cities as hubs of innovation, entrepreneurship and social inclusion (European Commission, 2013). This focus presents an opportunity for abandoned and/or declining landscapes to shine again in redefined ways to accommodate research and entrepreneurial activities. Herein, universities -with the activities of their students and staff- seem to be essential as they are already identified as major agents of innovation processes and owners and/or users of portfolios located in historical urban landscapes and their vicinities (Figure 2.20). Universities can help to transform areas in line with urban regeneration goals. Simultaneously they can improve their heritage buildings with adaptive re-use interventions to accommodate incubators and offices for start-ups, reinforcing the symbolic, cultural, social and economic value of their portfolio and their distinctiveness in cities.

Figure 2.20 Universities heritage in urban regeneration as a trend in quality of place and distinctiveness affecting physical demands in universities

Functional drivers

Demography, productivity, user's well being and new ways of learning are the main drivers affecting functional demands in universities. Demography refers to the changing social context influencing the size of the students and staff population, who will perform the primary processes of universities. It interrelates with the migration and mobilisation of human capital across the globe. Productivity refers to the capacity of universities' users to successfully perform their core activities. Herein, success depends on the ambitious goals set by universities in the highly competitive environment in which they operate. User's well being refers to the ability of universities to provide safe and healthy conditions that allow their students and staff to perform their activities in a way that keep them satisfied and interested. New ways of learning (NWoL) refers to changing educational methods, tools and technologies used by universities to teach and train the future knowledge workers and problem solvers.

Accordingly, universities want 1) to have a critical mass of human capital to carry on and succeed in their activities, 2) to keep them happy and motivated to perform such activities at the high levels expected and 3) to optimise learning as a central process of their core business. To do so, many universities have to deal with many uncertainties. An important one - already outline at the beginning of this section - is the number of students (Figure 2.21). In many countries, universities are preparing for growth but underestimating the risk of shrinking students' population. This can have enormous effects on the universities income and capacity to take care of their payrolls and their potential vacant space.

Moreover, the shrink in students enrolments can be triggered by other dynamics related to national policies, access to research funding and competition between in universities, where the less prestigious HEIs can be at risk (Figure 2.22). The interrelation of these trends can have serious effects on universities undermining their productivity if not their existence.

Figure 2.21 The risk of shrinking students' enrolments as a trend in demography affecting functional demands in universities

University World News
Universities face shrinking student enrolment
January 25, 2019
"The number of students enrolled at Romanian universities has been dropping over the past 10 years, prompting the education minister to warn that in three years' time some local universities might be left without students, reports the Romania Insider."

Inside Higher Ed
Shrinking Enrollments in Poland
Dwindling student numbers and limited progress in international recruiting pose challenges for country's universities.
By Jack Grove, March 6, 2014

Financial Times
Eastern Europe has the largest population loss in modern history
By Valentina Romei,
May 27, 2016

Figure 2.22 The risk of shrinking students' enrolments as a trend in productivity affecting functional demands in universities

BBC News
Ulster University: 'Crisis point for Northern Irland student places'
By Eve Rosato,
December 14, 2018

"- In 2016/17 there were 1,800 fewer places for local and EU students at Ulster University (UU) and Queen's University Belfast (QUB) than 2014/15.

- 7% drop is due to funding cuts from the Department for the Economy (DfE).

- More than 80% of students that attend local universities are from Northern Ireland.

-"universities need to be sustainably funded with a system that allows higher education to be accessible to students from all backgrounds, as well as being affordable to the taxpayer".

- Professor Ian Greer, vice chancellor at QUB, said that new funding models are needed.

- "We can make this funding happen through an increase in public funding or an increase in tuition fees, but it's a matter that should be debated at the executive level."

The Guardian
Fears of university closures after removal of safety net
Some universities in England could be at risk as figures show drop in student numbers – but the Office for Students has no remit to help
By Anna Fazackerley,
January 30, 2018

"The number of 18-year-olds enrolling at London Metropolitan University, the University of Cumbria, Kingston University and the University of Wolverhampton have shrunk every year, with major losses over the past five years.
However, with more universities in a potentially dangerous position than ever before, fear is growing that there is no government body with a clear responsibility to predict or prevent a university failure."

Digitalisation has changed the way societies perform many activities. Teaching and learning is one of those. Universities cannot deny the effect of this and many are implementing technologies to make their campuses stat-of-the-art places to learn (Figure 2.23). Having high-speed connections to the Internet and easy access to it, enough computer-based classrooms and technology-wired rooms and halls are just a few examples on how this trend is embraced at universities. However, the widespread adoption of mobile devices in the classroom is generating other annoyances that can harm learning processes. Universities must find ways to deal with them through smart teaching methods and perhaps policies.

The Star

Universities must enter the digital age or risk facing irrelevance

By Don Tapscott, May 10, 2016

"Campuses that embrace the new models become more effective learning environments and more desirable places. Computer-based learning for instance, can free up intellectual capital — on the part of both professors and students — to spend their on-campus time thinking and inquiring and challenging each other, rather than just absorbing information."

The New York Times

Laptops Are Great. But Not During a Lecture or a Meeting

By Susan Dynarski, November 22, 2017

"Step into any college lecture hall and you are likely to find a sea of students typing away at open, glowing laptops as the professor speaks. But you won't see that when I'm teaching. Though I make a few exceptions, I generally ban electronics, including laptops, in my classes and research seminars. That may seem extreme [...] But a growing body of evidence shows that over all, college students learn less when they use computers or tablets during lectures. They also tend to earn worse grades. The research is unequivocal: Laptops distract from learning, both for users and for those around them."

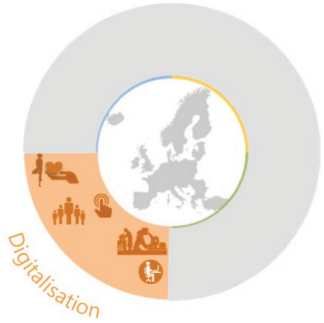
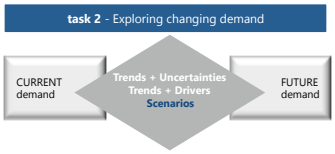


Figure 2.23 Digitalisation of the classroom as a trend in NWoL and users' well being affecting functional demands in universities

This brief repertoire of trends and their links to demand drivers in university campuses serves as an opening for the following section, in which more scholar discussions about alternative futures related to these and other trends in universities are presented.



2.3.3. Scenarios for universities

Universities cannot predict their future. Simultaneously, exploring universities' future is extremely important because most of their actions are aimed at what lies ahead, which changes frequently. In this context, universities must not only to think ahead but also repeatedly. That is the basis of this section.

The following pages describe the outcome of a literature review on future scenarios for higher education and universities. After a brief but systematic scan of the literature in Scopus and Google Scholar, 13 publications discussing the future of higher education were selected for analysis. Their selection criteria include 1) the focus of the scenarios (universities and higher education institutions); 2) the year of publication (after 2000) and 3) the time horizon of the scenarios described (beyond 2020). Table 2.3 list the studies considered for analysis in this review.

Year	Source	Scope-Horizon
2004	Vincent-Lacrin, S. (OECD) Policy Futures in Education Journal	Universities and HE (30 OECD countries)
2005	Enders et al. – CHEPS	EU HEIs 2020
2007	Van der Wende, M. - CHEPS (Journal of Studies in International Education)	HE in OECD countries - 2017
2008	University of Bristol, School of Education (Workshop Eight (JISC) Mobility and Learning and Teaching in HE)	Universities - 5 years (2013)
2010	Blass, Jasman andShelley (Futures journal)	English higher education - 2035
2012	Southern Africa Regional Universities Association - SARUA (SARUA Leadership Dialogue series)	Southern African universities - 2025
2012	Jeroen Huisman Harry de Boer Paulo Charles Pimentel Bótas (Higher education Quarterly)	English higher education -2025
2014	VSNU - Rathenau Instituut	Dutch universities 2025
2014	Magalhães (Book Chapter SensePublishers)	European HE - 2020
2015	Beynaghi et al. (Journal of cleaner Production)	Universities (global) - 2024
2018	Hantian and Qiang (Journal of Studies in International Education)	Universities
2018	Hammershøj (Futures Journal)	Universities and HEI in general
2019	Van Sprang, Driessen, and Groen (Journal of Corporate Real Estate)	Dutch universities of applied sciences - 2030

Table 3.3 Overview of studies about scenarios for universities and higher education found in the literature

The majority of these studies were published after 2010 and the time horizon of the scenarios described in these publications range from 2013 to 2035. As illustrated in Figure 2.24 most of the scenarios described are alternative futures beyond 2020. Eight of the 13 publications selected are peer-reviewed articles published in scientific journals and the remaining five studies are published as reports, book chapters or online articles.

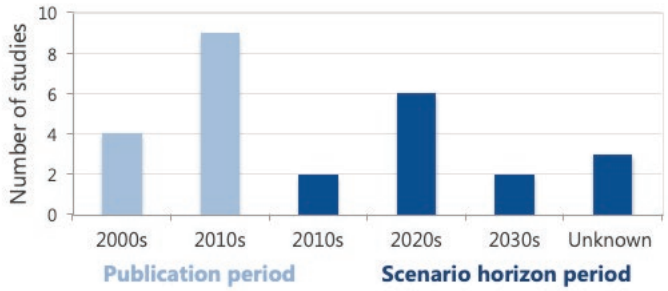


Figure 2.24 Publication periods of the studies analysed and time horizon of the scenarios described in them.

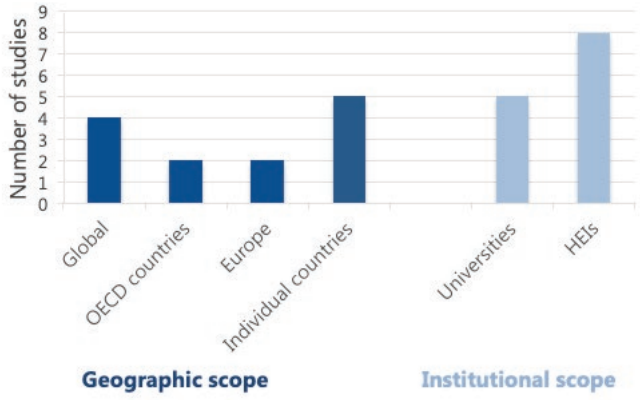


Figure 2.25 Scope of the scenarios described in the selected studies by geography and institutional focus.

The scope of these studies is diverse (Figure 2.25). Some of the scenarios in these studies are directly intended for universities while most of them are describing alternative futures for the higher education sector in general and thus, affecting all higher education institutions (HEIs) in particular. Regardless their institutional scope, these studies focuses on various geographical contexts. While a few focuses on OECD countries and Europe, most of the studies have either a global scope or a national scope[10].

[10] Five of the studies with national scopes describe scenarios for Dutch universities (n=1). Dutch universities of applied sciences (n=1), English higher education (n=2) and South African universities (n=1).

Two studies were excluded due to limited access to the journals in which they were published. The remaining eleven studies accessed describe between one and six scenarios each. As illustrated in Figure 2.26, the authors used different developments to construct these scenarios (i.e. scenario making) as well as different topics to describe them (i.e. scenario description). The number of developments and topics used by the different authors differ per study. Nonetheless, some qualitative patterns are identified and described as follows.

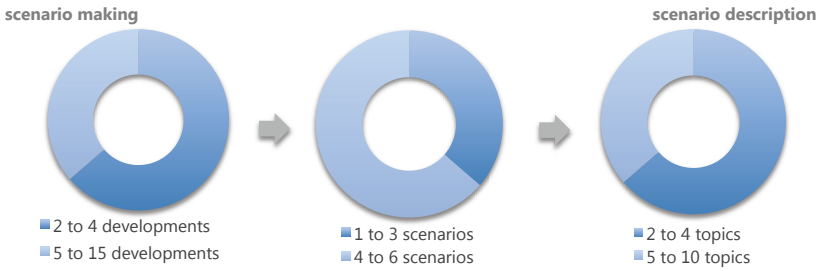


Figure 2.26 Overview of the number of scenarios described in the selected studies, the number of developments used to make them and the number of topics used to describe them.

The analysis of this section interrelates the four stakeholders' perspectives of campus management with the main focal issues and developments identified in the scenarios studied (Figure 2.27).

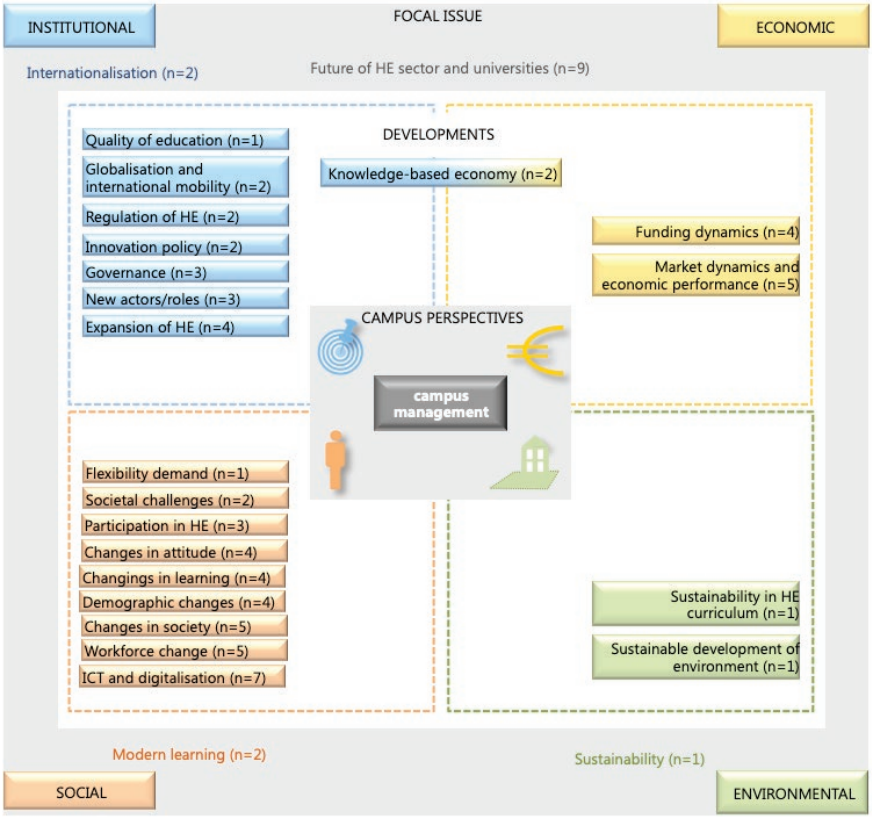


Figure 2.27 Focal issues and developments of the scenarios analyses in relation to the four perspectives on campus management organised by number of studies addressing them. Note: HE= Higher Education. The development highlighted in bold are the most predominant in each perspective.

The reviewed studies have four main focal issues: the future of HE and universities in general (n=9); internationalisation (n=2); modern learning (n=2) and sustainability (n=1). They have different aims and addressed particular questions. The first and most prominent in the studies can be considered a broad focal issue concerned with all institutional, economic, social and environmental transformations affecting the higher education landscape. Internationalisation deals with institutional changes affecting competition, access and quality in HEIs. Modern learning focuses on the social dynamics affecting the demand for and supply of higher education. Last, sustainability relates to environmental challenges and concerns that have to be tackled by the HE sector.

Moreover, this research identified 21 developments in total. Most of them area institutional, technological and social developments related to the organisational and functional perspectives on campus management. Although the aspects related to financial developments are not numerous the number of studies addressing them are representative. Accordingly, five main interrelations between particular developments were identified as predominant in the studies and clustered. These five clusters are ordered according to the number of studies that address the interrelated developments (See also Figure 2.28):

a) The ICT revolution and digitalisation (n=7) influencing changes in learning (n=4)
b) Changes in population (n=4) and the participation in higher education (n=3) affecting the workforce and the human capabilities (n=5);
c) Changes in the market and financial performance in countries (n=5) influencing the dynamic of funding schemes (n=4); and
d) The expansion of higher education sector in general (n=4) adding new actors and roles to HEIs (n=3).
e) Social changes (n=5) and societal challenges (n=2) changing the attitude towards the role of universities (n=4)

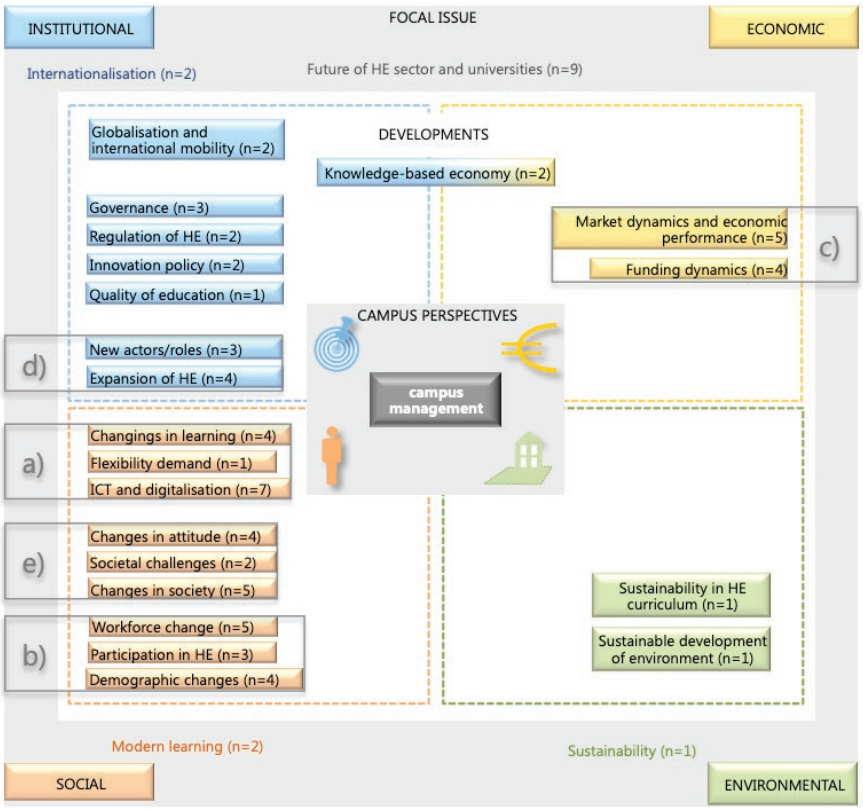


Figure 2.28 Clusters exhibiting the most predominant relationships between developments according to the number of studies

The following pages summarise the scenarios that were analysed in this research. The presentation of the studies is organised by the year of publication starting from oldest to newest. The heading contains generic information and each study is presented as the authors did. Tables are used to summarise and operationalize the analysis. Each column represents one scenario and the rows displays each of the topics used by the authors. Herein, the relationships between these topics and the campus management perspectives are outlined using colours (See table 2.4). That is:

- Blue topics covering institutional developments associated to the organisational perspective
- Yellow topics covering economic developments associated to the financial perspective
- Orange topics covering social developments associated to the functional perspective
- Green topics covering environmental developments associated to the physical perspective

	Scenario 1	Scenario 2	Scenario 3	Scenario ...
Topic 1				
Topic 2				
Topic 3				
Topic 4				
Topic ...				

Table 2.4 Schematic guide for the readers of the scenarios

Additionally, descriptive text summarises the number of scenarios, topics and the existing relationships with those institutional, economic, social and/or environmental developments. The following pages present ten different studies in total, which were reviewed from 11 publications listed below (Table 2.5):

Presentation order of the studies	Source
1	(Vincent-Lancrin, 2004)
2	(Enders et al., 2005) (Magalhães, 2014)
3	(University of Bristol, 2008)
4	(Blass et al., 2010)
5	(SARUA, 2012)
6	(Rathenau Institute, 2014)
7	(Beynaghi et al., 2016)
8	(Wu & Zha, 2018)
9	(Hammershøj, 2018)
10	(Van Sprang et al., 2019)

Table 2.5 Studies of scenarios described in the following pages

Six scenarios for universities and HE in OECD countries

Year: 2004

Source: Vincent-Lacrin, (OECD) Policy Futures in Education Journal

Focal issue: University futures

Aim: "To consider the possible future of the university in order to create a common understanding of the socioeconomic changes affecting it and to help post-secondary education stakeholders propose adequate responses to these changes."

Scope: Universities and HE in 30 OECD countries (unknown time horizon)

Although this study explores alternative futures without a time horizon, it describes six scenarios using different topics. These topics cover institutional, economic and social developments in line with three of the four demand perspectives on campus management. Nonetheless, its detailed segmentation in six scenarios provides short rather than comprehensive descriptions of the future with an emphasis on general consequences.

	Tradition	Entrepreneurial	Free market	Open & Lifelong	Network	Diversity Disappearance
Students	Selective Initial education Mostly young students	Selective Initial education Mostly young students	Selective Initial education Mostly young students	Open Lifelong learning All ages	Open Lifelong learning All ages	Open Lifelong learning All ages
Funding	Mainly public	Mixed - variety of funding sources	Mainly private (tuition fee as main share of income)	Mixed (mostly financed by companies)	Mainly private (+partnerships with industry)	Formal tertiary sector disappears
Mission	Teaching & research	Teaching, (strong) research and community service are well balanced.	Specialisation by missions (function, field, audience)	Mostly teaching - less research (learner and demand oriented)	Mostly teaching - (most research outside universities)	Specialisation by missions (professional education, mostly free and non-commercial)
Interna-tionalisa-tion	Mostly national	Importance of international - strong link to local economy	Importance of international - greater competition	Mostly national focus	Importance of international (programmes and courses matter more than institutions)	Importance of international (global networking among individuals goes beyond institutions)
Faculty's status	Homogenous	Polarisation	Polarisation (Hierarchy between institutions - global super-elite)	Homogenous (few elite universities, more corporate universities)	Polarisation (academic superstars and developers of learning tools)	Knowledge is less determinant for a career or in the stratification of society
E-learning and ICT role	Low Developed outside universities	High Commercial approaches to international markets and e-learning are important	High Technology highly used in teaching and research becomes more demand driven	High More distant and e-learning with business-oriented investments	High Training content standardised and embedded in technology and media	High Technology as enabler for knowledge diffusion

Three scenarios for European HEIs in 2020

Year: 2005

Source: Enders et. al. – CHEPS (summarised also by Magalhães, 2014)

Focal issue: Futures of EU HE and research landscape

Question: "Will a uniform study structure be implemented across European higher education systems? Will a European research Council be the most important organization funding basic research? Will academics still play an important role in university management?"

Scope: European HEIs in 2020

This study explores three alternative futures in a comprehensive way by describing ten topics affecting the HE sector. These topics cover four main developments in institutional, economic and social contexts. Despite its relevance for the European context and its all-inclusive approach, the time horizon for these scenarios is now. This calls for reflection about the aspects on those alternative futures that align or deviate from current tendencies in Europe and affected by political action such as Brexit.

	Centralia: City of the sun	**Octavia: Spider-web city**	**Vitis Vinifera: city of traders and micro-climates**
Dominant mechanism of coordination	State	Networks (global/multinational, local and interregional)	Market
European integration and harmonization	Strong and existence of large national teaching and research institutions, with enormous campuses that cooperate with international consortia.	EU as a network involving partners beyond geography with small universities as the most successful.	EU remains the same with tensions between national sovereignties and supranational levels of regulation but has not become the most competitive region of the world. Diversity is extreme, more in national contexts and more mitigated in the European space.
Education	Homogenous reflecting the firmness of Brussels with emphasis on long-life learning	Variety: the size and types of HEIs is not standardized. Some of them are the result of mergers of R&D units of diverse types; others were reorganized around disciplinary or professional groupings	One third of the HEIs are private. Institutional autonomy and the adaptability enhanced by it are crucial. The identity of educational and research institutions are profoundly reconfigured. Education is seen as a kind of merchandise or product susceptible of being bought and sold.
Research	Clear divide between public and private. Public universities had regressed to basic research= public good. R&D is developed separately in private laboratories belonging to businesses, or resulting from public-private partnerships.	Relocated from organic units to inter-university networks funded by the European research Council, by national agencies and by international business consortia.	The European research Council, by means of a highly selective and concentrated funding structure and process, became central.
Innovation	Driven by the strong action of the EU research Council	Knowledge production becomes dominant and it is organized into public, private or public-private networks.	Innovation and applied research are crucial, but the former as a political driver has been balanced and even overcome by the centrality given to other concerns (quality of life, critical consumption. Leisure, etc.)

	Centralia: City of the sun	Octavia: Spider-web city	Vitis Vinifera: city of traders and micro-climates
Funding	Primarily public, based on student numbers, under supranational supervision of the European union	Both public and private sources. Public funding is primarily directed to teaching with flexible utilization of vouchers at different stages of students' careers.	Private investment on research and innovation.
Quality HE	Sophisticated system to evaluate quality, as a uniform structure of grades, 3+2+3, was implemented based on a more elaborate ECTS applied to modular standardized courses.	The problem is increased by the great diversity of HE: lack of consistency derived from the flexibility and decentralisation of its regulation	The consumer rules making difficult to promote and compare uniform standards (ECTS) imposed by the authority of coordination levels. The very idea of national systems of assessment and quality control no longer makes sense, these matters having been put in the hands of the European union's higher education and training Authority.
HE sector	Evident stratification with most prestigious HEIs in North and west EU	Stratification is identifiable with a cleavage between HEIs of the north and West of Europe, dedicated to research, and those of the South and east more dedicated to teaching.	Not mentioned
Labour market	The European Graduate Competence tests and a system of EU Civil Service Concourses are developed.	The certification of the worth of diplomas by social actors is linked to the world of works.	Concern grows among citizens about the quality of higher education institutions. Social institutions are fighting for a critical and responsible citizenship, eventually as a counterweight and resistance to the excesses of regulation through the market.
Institutional governance and management	Little institutional diversity. The HE systems and institutions are very much dependent on the upper European levels administration that guarantee the coordination of the sector by rules and regulations and financing of research and HE.	Complex system at multiple levels in which power and authority are shared among supranational, national, and local actors, with obvious difficulties and coordination. Emphasis changes from resource management to network fluidity management as they are in constant reconfiguration.	Governance is even more dominated by institutional leadership. Since the market is the main source of political coordination and social regulation, HE and research actors are essentially private and maintain an entrepreneurial type of relationship. Undergraduate education is still under state funding and coordination. Funding occurs regardless of the public or private nature of the institution, and fees vary much from institution to institution.

Three possibilities for learning in HE in 2013

Year: 2008

Source: University of Bristol, School of Education (Workshop Eight (JISC) Mobility and Learning and Teaching in HE)

Focal issue: Use of mobile devices for teaching and learning in HE

Aim: To identify what is driving change with respect to the use of mobile devices for teaching and learning in HE

Scope: Global universities in 2013

Although this study does not make explicit scenarios, it explores in a simple way three future possibilities in the use of mobile devices affecting learning in the classroom and the interaction between students and teachers. Nonetheless, its description is limited to functional aspects driven by four main developments. Since its time horizon is already due (2013), it provides an opportunity to assess its current validity and the potential wide adoption of these possibilities.

	My own mobile	My feedback	My peer support
Driver pair	'Choice and personalisation' vs 'Funding models'	'Formative assessment and feedback' vs more 'Choice and personalisation'	'Student practice in formal and informal learning' vs 'Formative assessment and feedback'
Mobile device use	Students appropriate their own devices for learning, leading to good integration with university systems, encouraging collaboration and leading to more potential for innovation	Mobile devices would be used not only as audience response systems, using SMS management systems, but for feedback from student to tutor/lecturer throughout a unit or module; University systems will develop to support a wide variety of mobile devices; students and staff will be able to determine how they give and receive feedback	Increasing likelihood of students' use of mobile devices breaking barriers between formal education and informal learning. Depending on the level of formative assessment, students will use mobile device for different activities. Low use is linked with introduction of e-portfolios and records as well as new ways of assessing focused on process not on end product. High use means students will tap into their own networks for peer support and feedback through social network and chat sites) with the support of the staff.

Five scenarios for English HE in 2035

Year: 2010

Source: Blass, Jasman and Shelley (Futures Journal)

Focal issue: Visioning 2035: The future of the HE sector in the UK

Aim: To identify the environmental factors that are going to impact on the sector, setting out a range of scenarios within which institutions will need to shape their individual future

Scope: English higher education in 2035

This study explores alternative futures within a 25-year time horizon. It uses four descriptive topics to cover institutional, economic and social developments in line with three of the four demand perspectives on campus management. The authors provide extensive and detailed descriptions of the future tailored to the English context. However, these scenarios are subject to change given the turbulent political relations between Europe and Britain, which have relevant consequences for the HE sector.

	Leading knowledge creation	Responsive knowledge creation	Regional conglomerates	No government funding	Total government funding
Key driver	Societal paradigm shift to debt aversion impacting the full-time undergraduate market. Fewer people opting to take out student loans to pay fees.	Division of disciplines. The corporate sector leading to a funding stream for professional qualifications and research.	Combination of funding cuts needing cost savings. 55% of all staff employed by HEIs is not academic.	The economy is in recession. The government is funding the banking sector. More people are living longer.	The economy is in recession. General unease in the population that the education system is continuing to decline.
Education	People will opt for part-time education while working full-time. Smaller HE sector with the transference of undergraduate provision to the further education (FE) sector. Few 'castle' institutions survived to offer full-time education to the upper middle class and those who can afford it. Undergraduate (UG) education is small with transferable modules combined with work-based learning to accumulate to degree awards. FE colleges have degree awarding powers at undergraduate level.	Dual sector split between 'pure' and 'applied' provisions, providing all levels of degree. Pure specialises in the arts and liberal subjects, leading to the doctoral qualification of PhD. Applied specialises in vocational and professional qualifications, leading to professional doctorates in Business Administration or in Education. The pure element of the sector is characterised generally by the 'castle' institutions, offering liberal arts, politics, philosophy and economics (PPE) and history.	The purpose of the regional conglomerate is educationally driven for sustainable society and the contribution to the region, democracy, individual communities and the environment is greater than is currently the case.	HE is differentially priced according to the market. Individuals develop their own learning agenda and select delivery options to their needs and budget. They swap and choose between institutions collecting credits, gaining accreditation for an award via a global process. Most students and workers are part-time. Most classes take place in the evenings or weekends. Experienced professionals teach, bringing 'real life' experience to the classroom.	High participation with courses in a variety of forms: part-time, full-time, flexi and distance learning. Lots of full-time students. No fees in undergraduate studies. Many younger students live at home. The sector is more unified and uniform in provision but no homogenous. Students move between institutions accumulating credits, as they desire. The curriculum becomes modularised in many subject areas. Quality will be measured by customer satisfaction and the government will impose new quality measures.

	Leading knowledge creation	Responsive knowledge creation	Regional conglomerates	No government funding	Total government funding
HE sector and workforce	The sector is concerned with leading innovation and contributing to policy, offering high level, conceptual development in an specialised manner. The FE sector builds the critical mass of knowledge workers and the undergraduate provision is concerned with developing its own future workforce. Entry into the HE workforce is through the traditional research career entry route. The academic workforce has no working experience outside of the university. Requirements for knowledge transfer pushed the emergence of a new professional who focuses on public relations (PR), communications with business, brokering and selling the knowledge created in the university. It is a highly paid job and more regarded than the one of professors.	HEIs in 'pure' represent the minority of the sector (i.e. 20% of the workforce and 10% of the students). Academic careers are developed along traditional routes with undergraduate students remaining within the academe to study full-time for a PhD, obtaining no experience of life outside of the university sector. The 'applied' represents 80% of the sector in terms of workforce and 90% of the student population. It has a workforce of individuals with a combination of academic qualifications and professional experience. HEIs in 'applied' have strong links with industry and professional bodies and offer a wide range of undergraduate, professional and work-based learning qualifications. Few students undertake doctoral research through professional doctorates. Market forces determine pay levels.	Consists of regional universities, dispersed across a range of campuses, providing education at all levels to anyone who is beyond school age. Degree awarding powers are centrally held within the region and HEIs lose their individual identity in favour of a regional identity. Competition within the sector is between rather than within regions, allowing regional conglomerates of HEIs to play to their strengths. HEIs become mutually dependent as they specialise in certain areas of provision, working in partnership with others. Being an academic is lower status than it currently is in society and less specialist. The culture is one of knowledge sharing and networking; knowledge is managed generally as a team-based expertise rather than having individual	Small and privatised sector. It has to generate its own funding base, largely from individual students and corporations. Some HEIs manage to maintain an international element of funding through overseas campuses and collaborations but the majority are reliant on home markets. Being an academic is like any other highly skilled job: high stress and highly competitive. Everyone has to generate enough income to secure a salary and pay is individually negotiated within a bonus culture. Networking and lobbying have become core skills for the academic workforce and a 'celebrity culture' develops around key individuals and their contribution to 'society'. This contribution is more to the economy than to society and results in hybrid for-profit spin-off companies that further reinforce the celebrity culture.	The sector offers secure, stable employment with a variety of job roles. There is national bargaining on pay and conditions to maintain equity within the sector. Internal competitiveness has shifted towards a collaborative model as funding becomes equitable. HEIs have no cap on the numbers of students they take. A free market operates providng balance across HEIs in terms of focus, speciality, research, teaching and third activites. The security in funding allows the players in the sector to develop their strengths, take risks in new areas of development and work collaboratively to develop specialism. There are long term career structures in teaching, research, professional or management roles. There is increased partnership with schools, colleges, community groups and industry, for new career path opportunities.
Funding	Largely government funded.	In 'pure', research councils fund the research. In 'applied', research can be described as 'just in time', being funded to solve problems and innovate for corporations, as well as contribute to societal development through EU funded programmes and the public sector.	Funding is distributed through a regional core fund and additional funding according to the regional needs. Efficiencies are achieved through regionalising services and quality functions and partnership working.	The government gradually withdraws funding from the HE sector on the basis that it has to fund itself through individual student fees and corporate funding for third stream activity. The funding base is insecure for the majority of HEIs (a couple have property revenue that gives them an underpinning security).	The government announces a new 2% income tax specifically for education, which is paid in addition to national insurance. This brings funding of the education system squarely within the welfare state and every citizen gains a minimum entitlement to education at level 4 (an undergraduate degree). While this tax is not popular – as no new tax ever is – it is appreciated.

Three scenarios for South African universities in 2025

Year: 2012

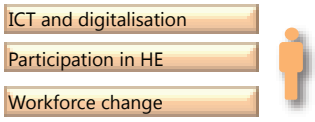
Source: Southern Africa Regional Universities Association - SARUA (SARUA Leadership Dialogue Series)

Focal issue: Higher Education

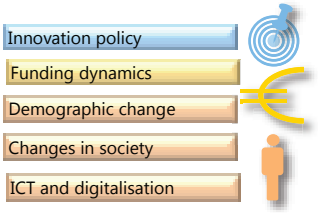
Aim: "To identify the change drivers in the regional higher education sector, explore the implications of these drivers and prioritise strategic interventions for building the capacity of the sector to meet the ever-increasing demand for higher education in the region."

Scope: Southern African universities in 2025

Although this study focuses on a context different than Europe, it shows that similar social and technological developments affecting HE are used to imagine alternative futures. This study describes three scenarios through four aspects with implications in the South African context. It starts from functional and financial aspects and ends with a general assessment of improvements in the HE sector for each scenario. This gives them a positive or negative connotation rather than a simple exploration into the future.



	Higher education: a missed flight	The knowledge village	The demise of SADC higher
Accessibility to technology	High: Advanced tech infrastructure is underutilised and misused	High: universal access to education; wide-spread technological connectivity	Low: very weak tech base
Available human capabilities	Scarce: inadequate human capital; building up a strong human base would take time	Abundant - competent system that values human capital and social innovation.	Scarce: there is high demand for higher education but the teaching has low quality and the academic pursued is minimised to obtaining a degree. Understaffing and poorly supported teaching programs leads to mediocrity culture.
Funding	Focus on tech investment with a short strategic horizon leads to inefficient use of funds, existing investments likely to become redundant.	Public and private sectors finance high demand for higher education	Public and private sectors will train their own resources directly as universities become unproductive and irrelevant.
Improvements in HE sector	Insufficient: Poor system planning wastes opportunities.	High: ICT connectivity, quality assurance systems, academic mobility, high level research outputs	Poor: low impact research. Little innovation or added value to society.



Four scenarios for Dutch universities in 2025

Year: 2014

Source: VSNU and The Rathenau Instituut

Focal issue: Future of universities

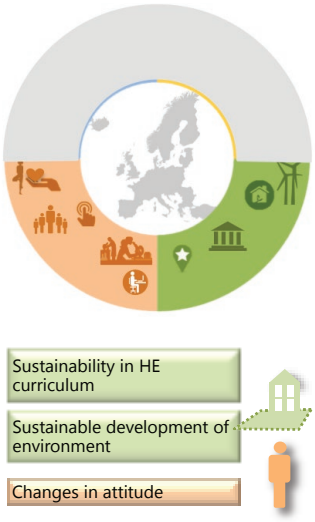
Aim: "To arrive at a long term vision regarding the university itself, in terms of its scientific knowledge function and its relationship with stakeholders. How universities can optimally fulfil their scientific knowledge function in the future optimally?"

Scope: Dutch universities in 2025

This study explores alternative futures within a 20-year time horizon. It uses two main uncertainties as drivers (i.e. degree of competition and value network) and three descriptive topics (Europe ad world relations, education and research) to cover institutional, economic and social developments in line with the organisational, financial and functional demand perspectives on campus management. The authors provide extensive and detailed descriptions of the future of HE tailored to the Dutch context. The emphasis on the relation with Europe and the world provide a comprehensive overview that can be compared with contemporary dynamics.

	National solidarity	Regional power	International selection	European variation
Degree of competition	A stable environment with little competition	A stable environment with little competition	A hyper-competitive environment in which competitive advantages are highly volatile	A hyper-competitive environment in which competitive advantages are highly volatile
Value network	Society emphasises the public value of education and research	Knowledge is seen as a private commodity	Knowledge is seen as a private commodity	Society emphasises the public value of education and research
Europe and world relations	Globalisation has failed. The world is divided into five different power blocs. Trade agreements between Europe, the US, Turkey, South America and Asia have ensured a stable and prosperous 'Fort Europe'. Solidarity and happiness are more important goals in life than possessing money and goods. With better energy storage techniques, a change in consumer culture, eco-taxes and a reasonably functional resource recycling system, sustainability has become a less urgent political issue. Security, healthcare and privacy issues are high on the agenda. Economic growth is limited.	Europe has fragmented into sub-regions that work together with varying degrees of success and cooperation. In NL, extensive deregulation has drastically decreased the national government's power. Citizens, local businesses and local authorities have joined forces. Citizens see themselves more as social entrepreneurs. Some parts of Europe have become depopulated, while others have blossomed and become centres of activity. NL has been split up and divided into independent regions that differ significantly from each other with regards to economic development and attractiveness.	The global student population has grown to more than 50 million in less than ten years and competition has become fiercer. America is economically and politically dominant. Europe has been unsuccessful in resolving internal political differences. Economic inequality and mistrust among member states grew up. After a financial crisis EU was torn apart. North West Europe developed into a strong region, while southern countries have left the Eurozone. Employment rates are high and so, the income differences. Automation has led to the disappearance of jobs affecting the middle class. Society splits between 'haves' and 'have-nots'.	European integration has progressed economically, stagnated politically and greatly succeeded socially and culturally. The latter was a reaction to American government's practices that led to re-examination of European norms and values. Right to privacy, respect, courteousness, tolerance, and integrity were worth protecting by the EU government. International relations with the former close ally have cooled considerably.

	National solidarity	Regional power	International selection	European variation
Research	European science policy is strongly focused on science and innovation. Money has been set-aside in one large European research budget. Science and innovation are integrated into public life through co-creation, responsible research and innovation and constructive technology assessment. Research universities have strongly rooting in society. Business funding is relatively low and only from domestic industries. Because the European institutional structure has remained strong, there are still many 'traditional' business laboratories.	Knowledge and science are very important for the economic development opportunities of the region. The business community invests in this area. The university's research program is strongly linked with the region's economic chances and possibilities. Universities behave as public entrepreneurs working with the business community in knowledge production and dissemination. Substantial parts of universities' resources come from the revenues from its life long learning facilities. The research council funding has increased.	Universities with the highest global ranks and outstanding reputations are the most popular. Investments in equipment and scientific staff are expensive and uncertain. The best of the talent pool are becoming harder to retain. They choose for the best conditions. Most research is contracted and planned out by businesses, focusing on the environment attracting R&D. It is unclear who is responsible for solving social problems.The budget of the new 'Frontier 2025' programme is reduced with an exclusive focus on innovative and fundamental research. Grants are difficult to obtain by universities in such competitive environment.	A large European research fund was established. Governments and business became aware of the dependence of scarce resources as a shared problem that requires shared research effort. This led to large-scale investments in research and innovation. There are varied and countless of (semi) private funds for scientific research focused on societal issues. Scientific research is highly respected, making levels of application high and competition fierce. North West Europe benefits from it with high academic mobility within this area but Southern EU member states suffer brain drains and their universities languish. Direct government funding in NL is expanded and distributed based on performance
Education	HE has remained a national issue and is more focused on 'Bildung' than on vocational training, which is a separate market. Education takes priority over research at universities. Higher education is free up including the MSc degree. The BSc/MSc structure is the same, but students choose to focus on a social theme instead of a discipline. They prefer to study in their home region but stay in contact with fellow students in other EU countries via online learning communities. Social sciences have more students. Success is a collective reaching. Students determine their preferred learning environment: knowledge is offered in groups, libraries, at the workplace (hospital, town hall, knowledge institution) and online through MOOC's.	The specific need for knowledge is defined regionally. There is a proliferation of courses with a range of diplomas, certificates and licenses (unclear quality but also affordable because of price variety). Less full time students and more part-time of all kinds. Large market for commercial HE providers in all shapes/sizes. The distinction between universities of 'applied science' and research universities disappears. Students compose their courses themselves in a modular fashion based on their careers' and personal relevance. No fixed curriculums exist. Courses and the labour market are well linked. Students live on campus 'valleys', where many businesses are based. Campuses have all kinds of places where employers, CEO's, students, teachers and customers can meet each other (e.g. catering and shops).	MOOC's and globalisation have had a disruptive effect on the knowledge infrastructure. There is more demand for HE but less supply. Few traditional universities are left, which have rigorous selection procedures to get the best talent. The HE market has a rigid hierarchy with prestigious universities at the top and the bottom is strongly divided. Courses are for sale in every level and field. Education is extensive and varied. Sciences, ICT, marketing, advertising, economics, tech, law and languages are more popular among the young. Humanities' courses are a market for old people. Education is offered 24 /7 or part-time with exact descriptions of opportunities in the labour market, time commitment and expected returns. Part time students at bachelor and masters increase.	The global HE market had a massive growth leading to differences in quality. Too many students have forced universities to offer education at various levels. HE is accessible to all, but not everyone receives the same level or has the same prospects. The OECD has referred to HE as 'quaternary education' (top 10% group in small colleges, who learn and live with teachers in secluded communities in or nearby cities). The other 90% of the student population can follow education at three levels depending on IQ aptitude and motivation tested with rigorous procedures. 'Bildung' and focus on societal responsibility is core at these levels. At the lowest level MOOC's dominate, at the second level live lectures are given and at the third level students encounter various kinds of blended learning.



Three directions for universities in 2024

Year: 2015

Source: Beynaghi et al. (Journal of cleaner production)

Focal issue: Sustainability in HE

Aim: "To analyse the implications of sustainable development trends and future directions universities might take under a potential second decade of Education for Sustainable Development (2015-2024) - UN agenda

Scope: Global universities in 2024

This study explores three alternative directions for universities within a 10-year time horizon. It uses a framework for sustainable development to understand the implications for universities in three main organisational aspects. The authors cover mainly three trends associated with social and environmental developments. Although these are not considered alternative futures, the authors provide an innovative overview of how the current attention on sustainable development goals may affect universities globally. Indeed, it is the only study that considers environmental trends.

	Socially-oriented	Environmentally-oriented	Economically-oriented
universities mission	High: Advanced tech infrastructure is underutilised and misused	High: universal access to education; wide-spread technological connectivity	Low: very weak tech base
Potential impact	Creation of new social configurations; Advancement in the human dimensions of SD; Establishment of monitoring mechanisms for social issues; Improved governance of local challenges through collaborations	Transformations and improvements of environmental conditions; Improved environmental governance; Creation and trial of environmental technologies; Establishment of monitoring and evaluation mechanisms for environmental issues; Generation and diffusion of fundamental datasets and decision-making tools to inform evidence-based policymaking.	Boosting of industrial innovation; Creation and commercialization of new green technologies; Generation of new venture firms, employment and innovation zones; Raising of regional economies and international competitiveness.
Policy measures to achieve it	External University performance appraisal systems promoting societal engagement; Integration of societal impact measures into the allocation of competitive research funds; Government funding system stipulating socially-oriented themes; Internal Societal impact considering when evaluating faculty performance for tenure; Infrastructure to foster faculty-community collaborations via centres, research, internships, learning, etc.	External Allocating performance based research funds according to contributions to the environment; Develop indicators to measure environmental impacts of research; Internal Improve on-campus efforts to attain environmental targets at building and area level; Generate opportunities for faculty and students to exploit urban transformation processes as platforms for experiential and project-based sustainability education	External Privilege university-industry collaborations that tackle sustainability related issues in their allocation of funding support; Shift in expectations regarding U-I exchanges from hard to soft outcomes incl. internships, consultancy, collab teaching, etc. Internal Continue encouraging the commercialisation of research outcomes but privileging those with sustainability impact; Encourage the integration of ESD into business development and economics areas

One scenario for universities and HEIs

Year: 2018

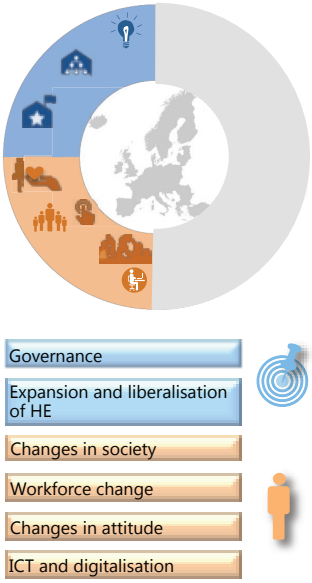
Source: Hammershøj (Futures Journal)

Focal issue: "The perfect storm scenario for the university: Diagnosing converging tendencies in higher education"

Aim: "To examine the future of higher education and higher education institutions and to reflect on the 'Crisis' of universities as organisations or as ideas"

Scope: Global universities and HEIs (unknown time horizon)

This study poses interesting philosophical debate about institutional and social issues affecting universities and HE in general. The author uses six main developments to describe three main tendencies. His comprehensive overview and integration of trends are described as a perfect storm scenario posing future organisational and functional challenges for HEIs. Although the time horizon is not defined, this is a recent study which tendencies are contemporary and relevant.



	The perfect storm
Tendency 1. The crisis of the university as organisation: it is loosing its purpose	Cause 1: the managerial focus on administrative goals among administrative staff. Sign: corporate university has no interest in the purpose of the university but in goals and targets for the quality and performance of research and education) Result: diminishing the university's focus on research and education in general. Cause 2: the academic bias against employability among the academic staff. Sign: deep confusion and ambiguity on the purpose of the university arguing that research and higher education is a public good and it is more than professional training. HE is reduced to the specific purpose of serving a particular ideology. Result: confusion as to the purpose of research-based education in particular.
Tendency 2. Transformation of employability: academic ethos is central	Future employment is not about solving specific tasks or even meeting challenges (that requires skills and competences that can be done by robots and AI) but instead about solving tasks of change, including the innovative task of creating challenges (that requires unique human capacities). Result: Shift from skills to personality and mind-set. Conceptualisation of professional personality/ethos as the future of employability in HE. The unique human capacities are required to solve tasks of change through three ways of relating to work: Professional judgement [relating professionally to new situations]; creativity and innovation [relating in ways that open up for new ideas and ways of doing things]; and the will to work [relating to one's work out of personal interest].
Tendency 3. Digitalisation and liberalisation of HE: reducing the barriers of entry	Liberalisation is visible in HE policy agenda opening up to private providers of HE to enter the market and offer better forms of education, which increases competition between HEIs, widening access to HE and increasing student choice. Digitalisation is visible in the return of the MOOCs as forms of digital education that need to provide the conditions for cultivating academic etho - i.e. by experiencing and imitating the professor's way of relating academically to a question, which requires contact teaching. Digital technologies are making this possible and there could be an emergence of platforms for HE connecting students to teachers instantly (e.g. 'Airbnb model for HE'). This can be disruptive, as it does not exist yet in prevailing practices. Now students choose courses instead of teachers and the latter is known to have higher impact on learning.

Two typologies to analyse emerging scenarios in universities

Year: 2018

Source: Hantian Wu and Qiang Zha (Journal of Studies in International Education)

Focal issue: HE Internationalisation based on the spread of innovations

Aim: "to construct a new typology which can capture the currents and dynamics of HE internationalization as they relate to the spread of innovations to analyse newly emerging scenarios and offer a supplement to existing theories"

Scope: Global universities (unknown time horizon)

This study proposes two typologies to analyse emerging scenarios for universities rather than describing scenarios. The authors looked at four trends in institutional and social developments to create two polar typologies described through two themes. The themes focus on the adoption of foreign models, languages, scholars, students and programs.

	Inward-oriented	**Outward-oriented**
Expansion diffusion	Use of foreign languages as major academic languages; Follow foreign HE models and criteria while developing domestic HE;	Domestic languages become worldwide influential academic language; Domestic HE models and criteria are followed by other countries;
Relocation diffusion	Recruit foreign scholars and researchers; Import foreign HE programs and providers; Send domestic students to learn foreign innovations;	Export HE programs and providers; Implement HE-related cultural diplomacy programs; Recruit international students for soft power enhancement;

Four scenarios for Dutch universities of applied sciences in 2030

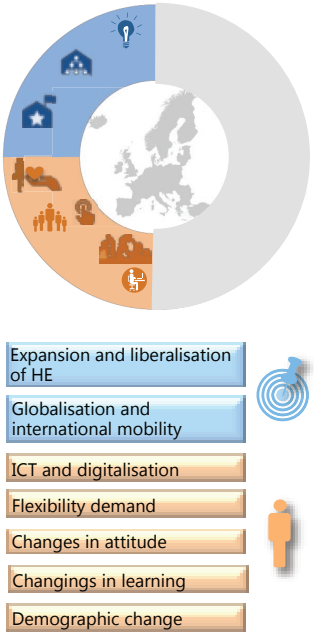
Year: 2019

Source: Driessen, van Sprang, and Groen (Journal of Corporate Real Estate)

Aim: "To explore Modern Learning (ML-)scenarios in Dutch higher education towards 2030 and corresponding consequences for Facility Management (FM) and Corporate Real Estate Strategy (CRES) of Dutch Universities of Applied Sciences (UAS)."

Scope: Dutch universities of applied sciences in 2030

This study identifies several trends that are grouped here into seven main trends corresponding to institutional and social developments. It describes in a very brief manner those organisational and functional aspects that are subject to change in four alternative futures. Although the study is limited to Dutch universities of applied sciences, it considered trends that affect many HEIs in general.



	Institute Learning	Mass customisation	Navigator	Natural learning
Student-focused system (organisation)	Solid - traditional, inflexible, standardised; curriculum-driven, lecturer determines; place bound	Solid - traditional, inflexible, standardised; curriculum-driven, lecturer determines; place bound	Solid - fully tailor-made education; not individual but groups; Hospital model; Customisable institute	Solid - fully tailor-made education; not individual but groups; Hospital model; Customisable institute
Driver	Supply-driven, government control	Demand-driven, student is key, personal training program	Supply-driven, decline of monopoly of HEIs and increase of alternative suppliers of education; students gain control of their own learning pace and content and government funding	Supply-driven, decline of monopoly of HEIs and increase of alternative suppliers of education; students gain control of their own learning pace and content and government funding
Functional and spatial consequences	Function of educational buildings/space remains unchanged; Blended learning applied, fewer classrooms and more informal project space, decline m^2/student	More diverse spaces needed; blended learning dimension; more virtual environments and less floor surface; more distinctiveness because more national competition; focus on hospitality experience (environment, services and education); learning environments highly adaptable	Distinctiveness - buildings and space used for branding; Highly reduced M2/student; Buildings are highly adaptable; fewer classrooms and more informal project spaces	Importance to strategically and well equipped buildings, infrastructure nodes or high-tech digital learning environments that can facilitate community meetings (learning communities)

2.3.4. Concluding remarks about the future of UTs

The catalogue of alternative scenarios for universities outlined in this section gives an overview of what many scholars and experts on higher education policy have explored on the future of universities and HEIs. Although the aspects described varied from study to study, the following are the most common topics or aspects used to describe alternative futures for higher education and universities:

- The composition of the labour market in the higher education sector (n=6);
- The provision of education and research (n=5)
- The liberalisation of higher education for quality and competition (n=5)
- The mission, purpose and impact of universities (n=5)
- The funding for education and research (n=4)
- The strategic drivers (n=4)
- The mechanisms of coordination and governance in the sector (n=3)
- Technology and digitalisation (n=3)
- Research and innovation (n=2)
- Geopolitical relations (n=2)
- Spatial consequences (n=2)

Regardless the use of different analytical methods and techniques as well as the diverse scopes of these studies, European universities in general and UTs in particular can use these insights to imagine what lies ahead them. These imaginary pictures are necessary to frame their visions and anticipate the major uncertainties in their plans. Accordingly, the following can be listed as the main interrelated uncertainties around which most of the scenarios are described:

1. The purpose of the university and its role in society
2. The international and transnational relations affecting the higher education systems
3. The sources of funding in education and research
4. The relationships between universities, the market, third sector parties and civic communities
5. The adoption, integration and adaption of digital technologies supporting the primary processes in universities
6. The types of segmentation of the students and workforce in higher education

Similarly, university- and campus managers can select those uncertainties that are critical to them and determine ranges per uncertainties to develop their own scenarios given their particular institutional, economic, social and environmental developments (See Figure 2.29).

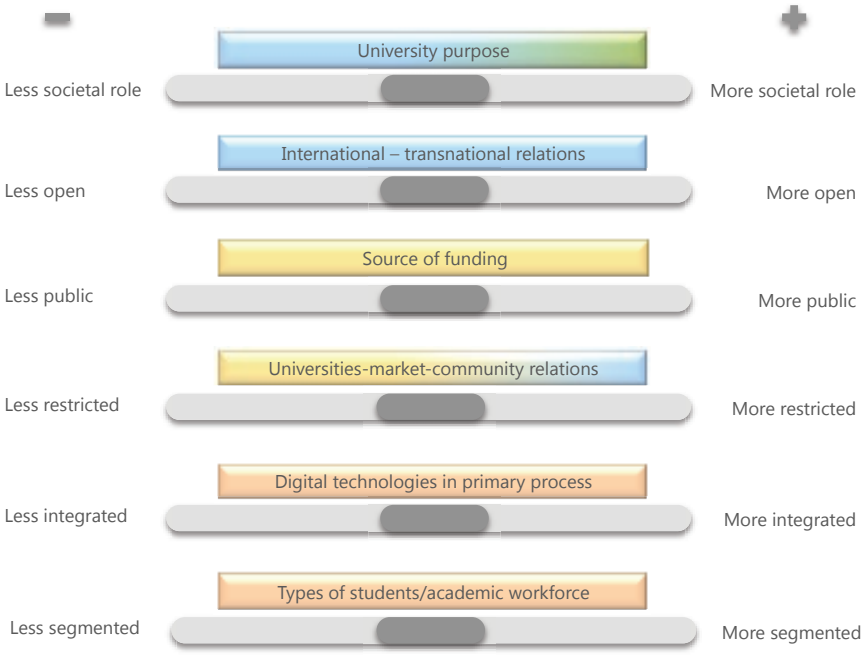


Figure 2.29 Overview of uncertainties to consider in scenario planning.

University- and campus managers should see these uncertainties as interrelated aspects defining the future of higher education. Having more or less emphasis in one of them may affect the others. Similar, the six uncertainties outlined in these conclusions are the most critical based on the review of the literature but certainly not the only ones that can be consider by universities in scenario planning (e.g. growth or shrinkage of students and staff, among others). Ultimately, acknowledging them will guide universities to make strategic choices to accommodate change. The next section dives into these strategic choices or models for the campus.

2.4. Models for the campus of the future

What are the characteristics of the campus of the future? Generating future models as the third task in campus management can help managers to deal with the uncertainties outlined in the previous section (Figure 2.30). Knowing what UTs may have in the future allows stakeholders involved in campus decisions to design, weight and select alternatives (or a combination of them) that best accommodate their future primary processes.

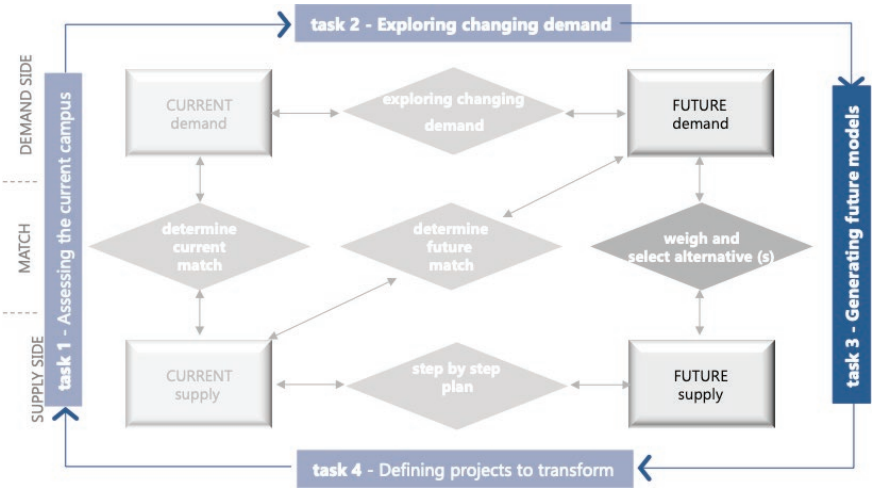


Figure 2.30 The third task in campus decision-making: generating future models (Den Heijer, 2011).

The previous sections identified a number of interrelated uncertainties in higher education and universities. Undoubtedly, this makes the demand for space in universities more dynamic, which calls for flexibility both in the quality and quantity of space supplied on campus. The unclear growth or shrinkage of users and/or the type of communities and processes to be accommodated on campus -next to practical restrictions such as time, money and policies- greatly challenge campus decision-making.

In response to these uncertainties, Den Heijer (2011) proposed three campus models as a framework for thinking, which were elaborated upon in recent research (TU Delft, 2016): Traditional, Network and Virtual. They are considered extreme models but they can also co-exist in today's universities, with their own advantages to be cherished and disadvantages to be avoided.

Traditional model: it is cherished for facilities such as individual workplaces, libraries and restaurants per faculty - the (relative) small scale and the unique academic history, but feared for the compartmentalisation, the relatively large footprint (in m2 and energy consumption) and the high costs (Figure 2.31). The challenge is to find a good balance between the preserving the value of model A and reducing costs and energy costs.

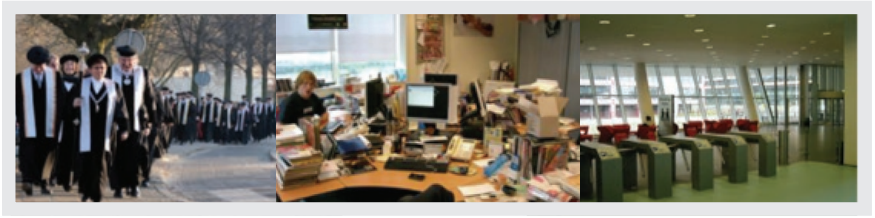


Figure 2.31 Traditional model in pictures (Den Heijer 2011 and TU Delft, 2016)

Network model: it is cherished for the interdisciplinary cooperation and mixing of target groups (Figure 2.32). Facilities are more often shared and used more intensively. The better utilisation and occupation reduces the m2 usage per student and employee and allows for more financial scope for quality of facilities or the primary process. The model can lead to anonymity and lack of feeling at home or group bonding, if much standardization is applied. Consequently, its uniqueness disappears, which can affect the loyalty and performance of individuals and the attractiveness of the university.

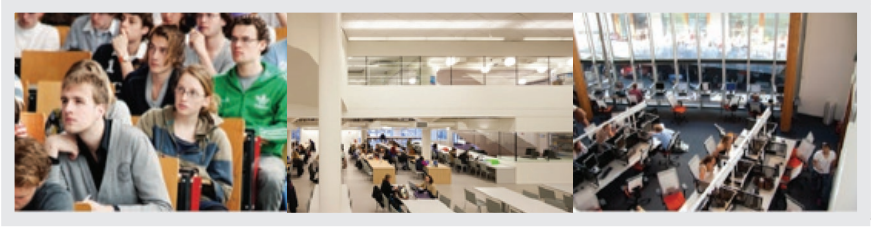


Figure 2.32 Network model in pictures (Den Heijer 2011 and TU Delft, 2016)

Virtual model: this model is cherished in order to reduce the time and place dependence of learning. It makes use of the ICT possibilities and pushes the fading boundaries of the campus (Figure 2.33). Advantages include the flexibility and freedom to learn remotely, to work from home or on the most beautiful, best fitting workplace offered by a city as well as less use of space on the campus (and therefore costs-saving). However, it poses the risk that the university community might no longer be a community, but is made up solely of individuals. The price of this can be higher than the cost savings on campus.

Figure 2.33 Virtual model in pictures (Den Heijer 2011 and TU Delft, 2016)

Furthermore, an analogy of these three campus models with the physical state of substances is suggested (TU Delft, 2016): solid (Traditional), liquid (Network) and gas (Virtual). In this analogy a distinction is made according to a defined shape and a defined volume: a solid state has both shape and volume while a liquid state has only volume and a gas state has neither (Figure 2.34).

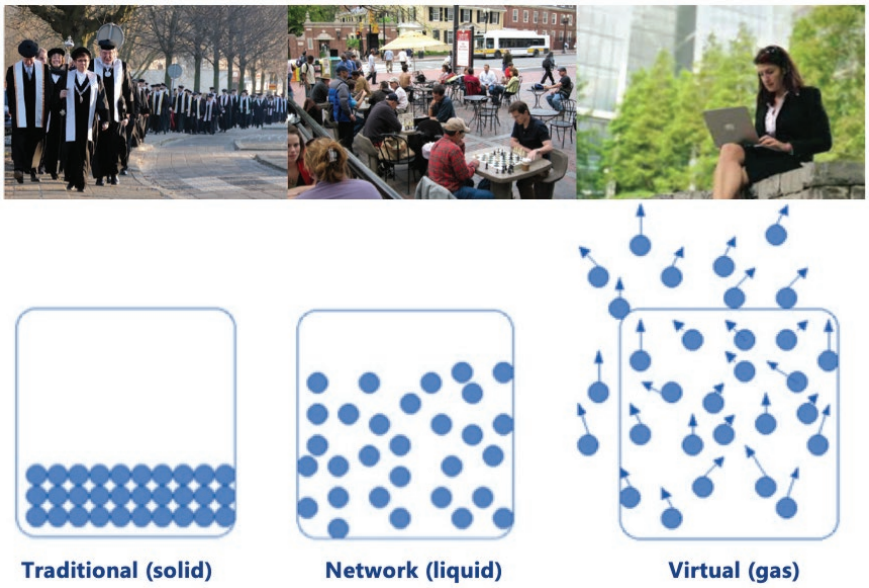


Figure 2.34 Campus models and their physical analogy (Den Heijer 2011 and TU Delft, 2016)

Herein, the molecules could be compared to the users and the future physical state of the campus will be a combination of:

- "solid", representing the fixed structures and (need for) territory on campus
- "liquid", representing the multiple connections on campus and more shared spaces
- "gas", representing the open structure of the campus and the possibility to work and study anywhere

Based on a thorough examination of Dutch universities campuses over the past 15 years, researchers (TU Delft, 2016) confirmed that the transition from traditional via network to more virtual models was a trend from 1995 to 2010 but that has changed in the last decade. Dutch universities are less virtual than predicted and want to have (again) more campus community ('network' model) and an academic home base (traditional model). With the increasing mobility, keeping the academic community together is becoming an ever-greater challenge. Thus, a combination of the three models can be a way forward not only for Dutch universities but European universities since they are confronted with similar uncertainties.

By looking at projects in the Dutch context, researchers (TU Delft, 2016) confirmed that universities are using the three models, trying to achieve the following benefits of the models and to limit the drawbacks of each of them. The following section focuses on the projects that are transforming European the campus.

2.5. The projects transforming the European Campus: a quick scan of strategies and interventions

How to transform the campus of today into the campus of the future? Defining projects to transform the campus as the fourth task in campus management can provide campus managers with a course of action that guide future campus interventions (Figure 2.35). Knowing what to change to attain the desired campus facilitates stakeholders involved in campus decisions to implement their strategic choices.

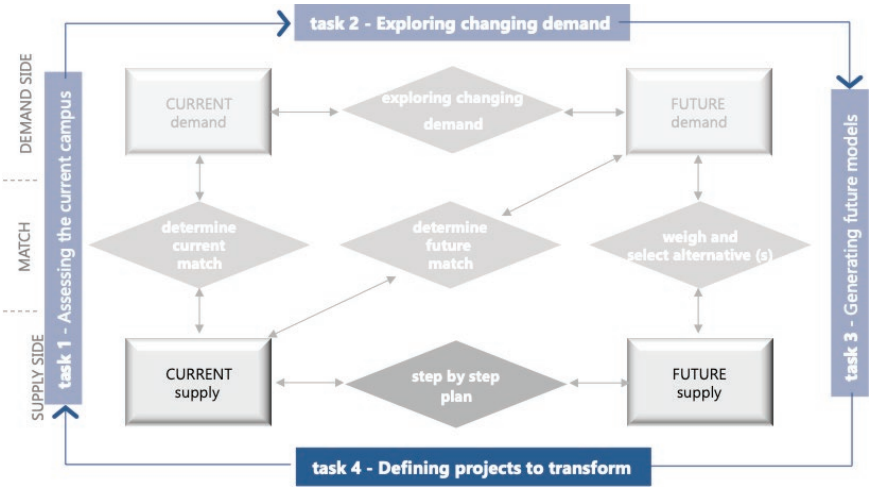


Figure 2.35 The fourth task in campus decision-making: defining the projects to transform (Den Heijer, 2011).

The projects to transform the campus are real estate interventions considered inputs in the process of adding value to universities performance through twelve campus strategies or goals (See Figure 2.36). According to Den Heijer (2011), this model is seen as a tool that can be used either way, 'before taking a real estate decision to make a business case, or after implementing a real estate decision to make a post-occupancy evaluation'.

In this context, every real estate interventions and decisions should be justified by its positive effect on specific performance criteria relevant to universities in each perspective. These campus strategies are the link between campus interventions and universities' strategies. Herein, the interventions and projects that are transforming the campus could support more than one strategy. Therefore, the can also be categorised in themes. The following section dives into them.

2.5.1. Campus strategies in themes

By examining a database of campus projects at Dutch universities, researchers identified a list of ten themes adding value to different campus strategies (TU Delft, 2016). This list has been complemented with two extra themes from existing research and on-going analyses (See Figure 2.37).

Figure 2.36 Adding value descriptive model by Den Heijer (2011)

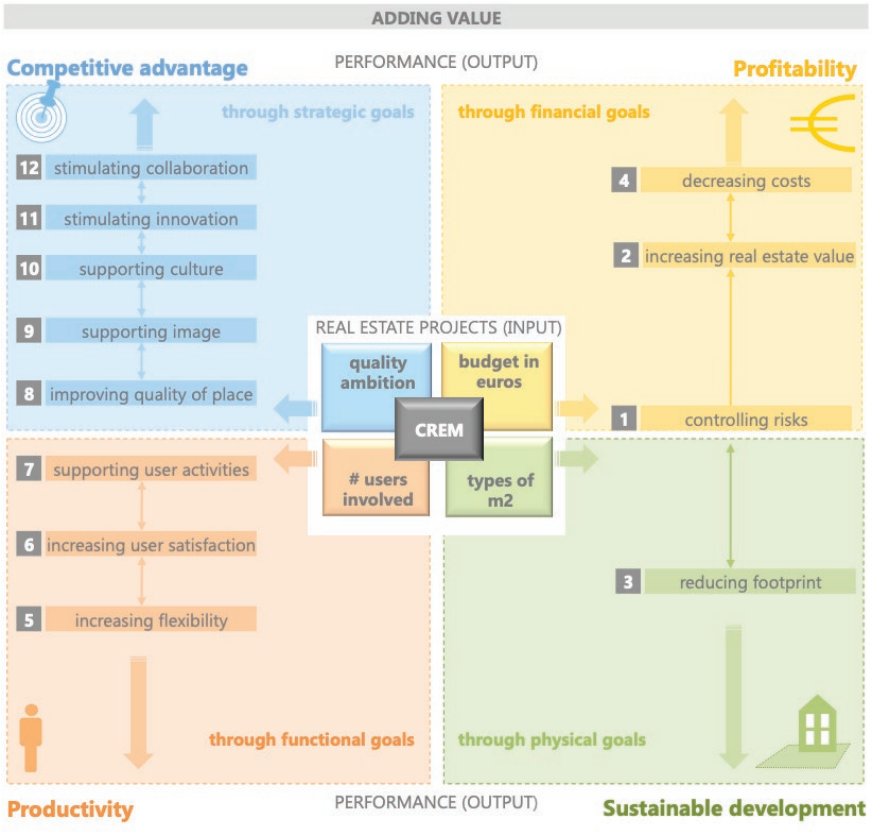


Figure 2.37 Twelve themes in campus strategies. The first ten themes in this list were identified in campus research about Dutch universities (TU Delft, 2016). Theme 11 is recognised as a theme in a research studying stimulating innovation as a campus strategy (Curvelo Magdaniel, 2017) and theme 12 has been identified in a review of the press by members of the Campus Research team at TU Delft during a strategy meeting in 2018.

Campus strategies in themes		
1 Rethinking the academic workplace	2 Creating a flexible learning environments with more study places	3 Replacing or renovating old faculty buildings as home base
4 Investing in state-of-the-art laboratories	5 Enriching the campus with non-academic functions	6 Giving new life to old buildings, including heritage buildings
7 Extending opening hours (evenings, weekends, summer schools)	8 Using circulation space - inside and outside – more effectively	9 Implementing 'smart tools' for campus navigation
10 Stimulating sustainable behaviour and testing innovative technology	11 Clustering in one place for regional consolidation in the knowledge-based economy	12 Rethinking the campus as a safe and healthy place to be

Some of the themes described above interrelates different aspects such as health, technology, sustainability and circularity, agility, liveability, location and branding. For example, theme 12 'Rethinking the campus as a safe and healthy place to be' deals with a) health through users' tolerance and/or balance of solitude and interaction; b) technology through the balanced use of offline and online ways of working; and c) liveability through the users' convenience to work in- or off-campus.

These themes are also interrelated and involve interventions at different physical and functional levels (i.e. City, portfolio, building, place and services). For instance, theme 12 'Rethinking the campus as a safe and healthy place to be' can be implemented at (workplaces and study places as well as in the public space in order to find a balance between solitude and interaction demanded by particular users' activities.

The following paragraphs illustrate with examples of campus projects at different scales how the European campus is currently being transformed and how these transformations relate to themes, trends and models analysed in this chapter.

2.5.2. Scanning campus projects in Europe

This section presents a scan of campus projects documented in existing research, the press and institutional websites that can be considered the projects defining the current transformation of the campus. The many examples found in this scan are categorised in eight labels and linked to:

- The themes in campus strategies described in section 2.5.1
- The trends in the demand drivers described in section 2.3.2
- The models for the campus described in section 2.4

The eight labels introduced in this scan are only used to group examples of projects and interventions that address different themes, rather than offering a new classification of campus strategies. These are:

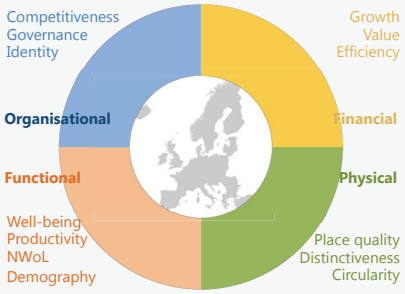
- Co-Campuses
- Wow-Campuses
- Eco-Campuses
- Open-Campuses
- Urban-Campuses
- Home-Campuses
- Smart-Campuses
- Zen-Campuses

The examples of campus projects are presented in a rich way with the use of texts, photos and captions from the press and websites. Furthermore, the following pages use icons and figures that build upon the previous aspects presented in this chapter. Accordingly, Table 2.6 presents the legend used in the following pages in reference to the trends, uncertainties, campus models and strategic themes when describing the campus projects.

CO	WOW	ECO	OPEN	URBAN	HOME	SMART	ZEN

Strategic themes

Demand drivers



Campus models

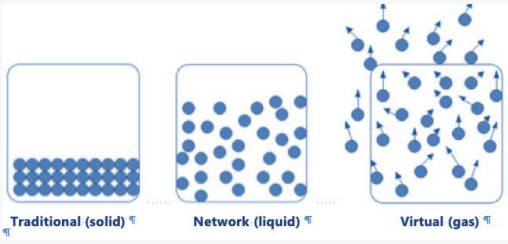


Table 2.6 Readers' guide to campus projects grouped in campus labels (Top) in reference to campus strategic themes, university drivers (demand side) and campus models (supply side).

Co-Campuses

Many HEIs are not only merging but also co-locating or moving to one location to consolidate their regional position in the knowledge-based economy (Figure 2.38). The theoretical assumption that physical proximity stimulates innovation and the success of high-tech agglomerations in particular regions has promoted clustering as one of the themes in campus strategies (Theme 11). Similarly, developing co-campuses as large-scale interventions is often combined with 'investing in state-of-the-art laboratories' (Theme 4), which requires large infrastructures that can be developed in cooperation among the partnering HEIs.

Figure 2.38 Clustering via mergers in one location or co-location of HEIs for regional consolidation

The Conversation
Why France is building a mega-university at Paris-Saclay to rival Silicon Valley
By Jean-Claude Thoenig. May 27, 2015

"After decades of planning, a new generation of students and researchers will start their first full academic year in September 2015 at the University of Paris-Saclay, a huge, ambitious project to bring together a group of 19 higher education institutions alongside a business cluster on the outskirts of the French capital. It has been dubbed the French Silicon Valley."

Nordic Property News
Construction Begins at Albano Campus in Stockholm
By Nicklas Tollesson. December 4, 2015

"The kick-off for the Albano campus has now taken place. Once completed, Albano will be a scientific hub connecting Stockholm University and KTH with each other and with the city. A unique socio-ecological campus will be created here for 15,000 students and researchers with university facilities, approximately 1,000 student housing units and room for commercial services."

On the demand side, Co-campuses reinforce competitiveness and identity as organisational drivers and distinctiveness as a physical one due to their national and regional commitment to stimulate innovation.

On the supply side, Co-campuses strengthen the idea of the campus as a community of people and institutions that requires physical proximity to function. Therefore, it matches a combination of traditional (solid laboratories) and network (fluid shared spaces) as campus models. Nonetheless, co-campuses tend to locate outside the city because they demand large space that is expensive and often unavailable in the inner city. If too dispersed and/or not well connected in terms of transportation, Co-campuses can also create the need for virtual (gas) campuses.

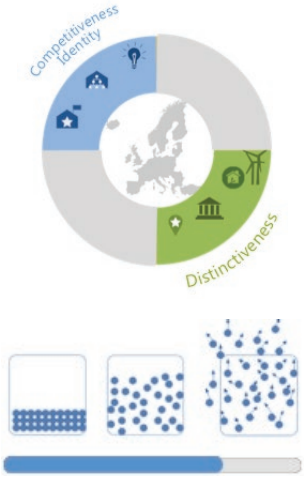


Figure 2.39 Adaptive re-use of heritage buildings and campus landmarks to support image and identity as well as promote sustainability.

Wow-Campuses

Universities with heritage buildings are giving new life to them through renovation and adaptive re-use (Figure 2.39). They are enhancing their historical roots in the city and promoting sustainable development through circular principles by giving new life to old buildings as campus strategy (Theme 6). This strategic theme tends to focus on interventions that maintain a balance between old and new buildings in the portfolio.

Another example of projects in Wow-campuses is replacing old buildings with iconic facilities and/or state-of-the-art laboratories (Themes 3 and 4). In turn, this is expected to increase the attractiveness of students and staff towards the campus adding value to the competitiveness of the university. Figure 2.40 and 2.41 illustrate how universities are hiring renowned architects to design the buildings that will represent them. In this way, the campus is used as a university brand and the buildings as faculty brands.

Architizer
Aalto University Espoo, Finland
Year 2016; Size 300,000 sqft - 500,000 sqft
Budget $50M - 100M

"The main building was originally completed in two stages in 1964 and 1974. The entire building was in need of renovation to bring it up to a modern-day university's needs, including improved accessibility and flexible educational spaces. Some facilities were repurposed as they no longer served their original function. The HVAC systems, safety exits and fixtures were also in need of modernization."

KU Leuven
University & City icons
New life to old buildings
Shared facility & campus-city users
Flexible study places

Figure 2.40 Replacement of outdated faculty buildings and investing in state-of-the-art and iconic facilities to enhance the campus image, competitiveness and distinctiveness.

Archdaily
Architecture Education is Unhealthy, Expensive, and Ineffective. Could Online Learning Change That?
By Ross Brady.
November 29, 2017

Archdaily
12 Projects Win 2017 AIA Education Facility Design Awards
By Patrick Lynch.
September 15, 2017

Architectural Digest
The 9 Best New University Buildings Around the World
By Lacy Morris. February 21, 2017

"Just as education around the world continues to evolve and innovate, so do the campuses that house the brightest future artists, scholars, and financiers. This year's best university buildings were erected as far away as Norway and China, and some are brand-new builds engineered to accommodate tiny footprints. These new structures make the grade for state-of-the-art technology, adherence to historic detailing, and architecturally significant design."

Archdaily
Mecanoo's Design for the University of Manchester's Engineering Campus Eyes the Future
By Vladimir Gintoff,. June 3, 2016

"Manchester Engineering Campus Development (MECD), the project will be the UK's largest, single construction endeavors ever conducted by a higher education institution.
-The campus will help demonstrate how UK engineering is one of the most creative industries in the world – a key feature on the ground floor of the main hall will be a dedicated 'maker space' which will provide dynamic workshops for students and academics to share ideas and innovate- says Mecanoo."

The University of Manchester
About the MECD project
Diana Hampson, Director of Estates and Facilities

"MECD will create facilities that will put the University at the forefront of engineering globally, helping attract even more world-class talent to the institution. We are proud to provide such an exceptional space for our exceptional people."

On the demand side, Wow-campuses reinforce identity and competitiveness as organisational drivers and distinctiveness and circularity as physical ones. Additionally, Wow-campuses are increasing real estate value as one financial driver.

On the supply side, Wow-campuses strengthen the idea of the campus as the place to be. Therefore, it matches more a combination of traditional (fixed structures) and network (meeting spaces) as ideal campus models rather than a virtual one (off-campus spaces).

Figure 2.41 Investing in state-of-the-art facilities while using the 'campus brand' to enhance faculties' image as attractive magnets for students and staff

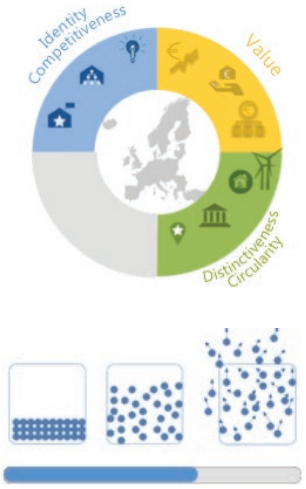


Figure 2.42 Investing in energy efficient buildings to enhance sustainability and circularity while distinguishing as environmentally responsible institutions.

Eco-Campuses

Universities are investing in iconic energy efficient infrastructures at building level (Figure 2.42) and at portfolio level (Figure 2.43). Eco-campuses tend to apply circular principles in campus interventions including smart systems and green infrastructure. These interventions stimulate sustainable behaviour and testing innovative technologies (Theme 10) stressing the universities' commitment to address sustainability challenges in their own campuses and enhancing their image as environmentally responsible institutions. Eco-campuses target not only new facilities but also existing ones, including heritage buildings (Theme 6).

De Techniek Achter Nederland

Atlas TU/e: the most sustainable education building in the world

As soon as the renovation of the Atlas building of Eindhoven University of Technology is completed, this building dating back to 1963 may be called the most sustainable educational building in the world. Construction company Van Wijnen South, technical service provider Unica and co-makers realized a working and learning environment in which CO2 emissions dropped by about 80 percent while the number of users doubled.

By Paolo Bouman, October 31, 2018

TU Delft

Zero Energy Design: Pulse

Pulse is the first energy neutral education building at the TU Delft campus, a perfect example of Zero Energy Design.

January 10, 2019

"Thirteen teaching roomd, 1020 teaching spaces, a food market, 750 ,m^2 of PV cells and the highest energy label of A++++. The new Pulse building is already being put to good use."

Figure 2.43 Investing in energy efficient systems and promoting sustainable principles at wide campus level to enhance circularity while distinguishing as environmentally responsible institutions.

ETH Zurich

The energy of tomorrow

Energy concept Anergy Grid ETH Hönggerberg

November 2018

"The underground storage project will cost CHF37 million, spread over 15 years. Only CHF17 million of these costs are in fact additional costs, because ETH Zurich would have had to refurbish the existing heating system anyway. The university is expecting annual energy savings of CHF1 million thanks to the innovative underground storage system. CO2 emissions will decrease by 50 percent by 2020."

Akademiska Hus

Albano will be Sweden's first campus certified to Citylab standards

Hayar Gohary. December 10, 2018

"CEU's new campus design earned 'Very Good' status from BREEAM, the world's leading assessment method for sustainable buildings. CEU is the first institution of higher education in Central and Eastern Europe to receive this distinction and the second in continental Europe."

On the demand side, Eco-campuses reinforce identity (of an environmental responsible institution) as an organisational driver and distinctiveness and circularity as physical ones. Additionally, Eco-campuses are increasing universities' resource-efficiency as one financial driver since these investments will save utility cost in the future.

On the supply side, Eco-campuses can be an optimal combination of traditional (solid), network (fluid) and virtual (gas). Nevertheless, the entire idea of investing in energy efficiency projects for environmental sustainability do not support the concept of a virtual campus, in which people working from their homes may be increasing their carbon footprint.

Open-Campuses

The open-plan designs of educational, laboratories and office facilities have gained popularity in universities and beyond (Figure 2.44). The basic assumption is that atriums, wide corridors and ample halls where activities can be accommodated enable spontaneous interaction between building users and potentially smooth knowledge creation and diffusion.

Certainly, this facilitates the new ways of learning and working of increasingly mobile users. These interventions take place not only at the building level but also at portfolio since in many projects the open-plan design extent to the public space by opening the plinths of the buildings with transparent elements and adding supporting functions inviting external users and creating a sense of urban integration, which adds to the quality of place.

Figure 2.44 Open-plan learning studios, labs and offices to facilitate spontaneous encounters and interactions aimed to stimulate innovation.

Architizer

University College North, Aalborg, Denmark

Type: Educational › University
Status: Built
Year: 2015
Size: 25,000 sqft - 100,000 sqft
Budget: $10M - 50M

December, 2016

"UCN Campus in Aalborg (DK) is a vision of an educational hub bringing together several specialized study programs under one roof. Faced with the demands for an alternative and sustainable learning environment, ADEPT and Friis & Moltke have worked closely with both staff and students to design a building that merges innovative spaces and new synergy. UCN Campus is education in three dimensions."

Architizer

Lab City CentraleSupélec, Gif-sur-Yvette, France

Type:Commercial › Office |Educational › Library University | Hospitality + Sport › Restaurant |Transport + Infrastructure › Parking . Status: Built | Year: 2017

September 2017

"In an era of privatization, cities are facing a major challenge: investment in the public domain depends increasingly on the private sector. As a result of this reframing of the collective agreement, the role of architecture is often reduced to the visual impact of its shape and surface rather than contributing to a new educational, social and civic dimension. The competition launched by the Ecole Centrale Paris for the design of a new engineering school has become the perfect opportunity to explore ways to answer this demanding challenge."

Architizer

O|2 Lab and Research Building, Amsterdam, Netherlands

Type: Educational › University |Industrial › Laboratory Research Facility |
Status: Built
Year: 2017
Size: 300,000 sqft - 500,000 sqft |Budget: Undisclosed

December, 2018

"Encounters', 'collaboration' and 'sharing knowledge' are the main objectives of the design of the O|2 Lab Building. The remarkable building at the VU Campus on Amsterdam's famous south axis more than fulfils this ambition. It facilitates scientific research in Human Life Sciences and is the first university building in the Netherlands designed especially for multi-institutional research. EGM architects is responsible for the design of the sustainable laboratory building."

UCL News

Key infrastructure milestone reached for UCL East campus

UCL has appointed Mace under a pre-construction agreement for Marshgate I, the largest building in the first phase of the new UCL East campus on Queen Elizabeth Olympic Park.

August 30, 2018

"UCL Estates Assistant Director, Keith Butler, said: "We look forward to working together with Mace to deliver UCL's landmark 35,000 square metre development in Stratford and starting to build our vibrant new campus.[...]
UCL East will be part of East Bank, the capital's new powerhouse of culture, education, innovation and growth. The UCL East campus will be located alongside some of London's greatest cultural and creative institutions, including the Victoria and Albert Museum in collaboration with the Smithsonian Institution, UAL's London College of Fashion, BBC Music and Sadler's Wells."

In this context, Open-campuses cover multiple themes: rethinking the academic workplace (Theme 1), creating a flexible learning environments with more study places (Theme 2), enriching the campus with non-academic functions (Theme 5), and using circulation space - inside and outside – more effectively (Theme 8).

On the demand side, Open-campuses reinforce new-ways-of-learning and productivity as functional drivers and quality of place as a physical one.

On the supply side, Open-campuses are more inclined to a combination of network ('fluid' halls and corridors) and virtual ('gas' digital structures) as ideal campus model. Nevertheless, Open-campuses tend to increase spatial flexibility on campus where the balance between individual and collective work needs attention. For instance, a lack of balance can create pressures on the health of campus users, and thus affect universities productivity. Knowing the preferences of individual users and their particular activities may help campus managers to determine ideal spatial ratios for activities that require solitude and interaction. In this context, it can generate the need for traditional (fixed and territorial space) campus model.

Urban-Campuses

Many universities (including UTs) have historical ties with their hosting cities. These bonds are also visible by their physical presence in the historical city centres. In many cities, historic urban areas have declined as the result of the co-evolution of social, economic and technological developments experienced by industrialised countries in adopting the knowledge-based economy. Conversely, some researchers argue that these areas have been brought back to life precisely to accommodate the new and knowledge-based economic activities (Van Oort & Lambooy, 2014). Herein, innovation is seen potentially as a new driver of urban regeneration in historical urban areas (including industrial sites and waterfront areas).

Local community participation and multi-stakeholder governance are two important success factors identified in the literature of urban regeneration of historic urban landscapes (Curvelo Magdaniel et al., 2018). Undoubtedly, universities are seen as key actors in these processes as they are both part of the local community as users and governance as owners of large portfolios in these areas (Fernández-Esquinas & Pinto, 2014; Habiby, 2003). Examples of these are illustrated in Figure 2.45.

Urban-campuses in the 'inner city' is a large-scale intervention that tends to focus on 1) liveability by distributing university functions in- and off-campus and on 2) location by strengthening the university presence in the city.

The integration of campus and urban development goes beyond the inner city centre since the space to accommodate universities' growth is scarce in these locations (See Figure 2.46). Universities not only co-locate in one place to strength their competitiveness (Theme 11) but also to share resources in developing distinctive campuses. In many cases, this takes place by collaborating with municipalities and third parties through

Figure 2.45 Integration of campus and urban developments in the inner city to enhance quality of place, strengthen image in the city and support user's activities while involving external stakeholders to allocate resources efficiently.

Archdaily

Bergen University College, Norway

Architects: Cubo Arkitekter, HLM Arkitektur
Category: University. Area: 51750.0 sqm . Year: 2014

March 4, 2015

"Bergen University College brings together the engineer, teacher and health educations in one new building complex. The college is built on a former railway depot site, where new buildings blend in, regards being taken to the layout of the rails, with the original structures. [...] The project is named Linking (Kobling). Referring to the building linking the area of Kronstad to the center of Bergen ,- infra structurally with the recently established tram. – The project links the new and the old built environment and it links the inhabiting institutions, which were separated before. The University College of Bergen will be visible in the cityscape with a new front square, where existing railway buildings converted into student facilities and cantina emerges in constellation with the new building complex. [...] The old railway deposit buildings contains social functions uniting the ca. 5000 students in the new "campus town". -Student house, cantina, library and gymnasium is thus placed in the 4 restored brick buildings."

ETH Zurich

Zurich City university district, Switzerland

ETH Zurich is working with University Hospital Zurich, the University of Zurich, and the canton and city of Zurich to develop the Zurich City university district (HGZZ). The vision is of a modern and open university and hospital district to support the sciences, health care, and the general public.

"The university district that is home to the joint University Hospital Zurich, University of Zurich, and ETH Zurich research and health cluster is located in the centre of Zurich. The close proximity of the three institutions offers unique opportunities for close collaboration across teaching, research and medical care. This promotes innovation and facilitates the rapid transfer of research findings to hospitals. One of the drivers behind the development of this site is the desire to exploit this potential.

The aim of the further spatial development is to secure teaching, research and medical care in the university district, to strengthen it further, to increase the urban quality and to create a lively university quarter."

formal partnerships. Herein, the involved parties share resources, risks and benefits that can be related to organisational, financial, physical and functional drivers.

Besides the tendency to focus on liveability and location, Urban-campuses in the 'periphery' tend to focus on branding, which is more needed than in the inner city as its image is already established. This is particularly important to attract students and researchers. Thus, some universities adopt the opposite strategies if their location is outside the cities. Take the case of CornellTech and its state-of-the-art laboratories (Theme 4), learning and working facilities (Figure 2.47). Cornell University partnered with the city of New York to establish a technology campus that is expected to generate jobs for the city and attract more students and staff for the university as this location -next to Manhattan- seems to be more competitive than their campus in Ithaca. This example illustrates as well the tendencies to focus on liveability, location and branding.

Figure 2.46 Integration of campus and urban developments in the periphery of cities to enhance distinctiveness and support user's activities while making partnerships to share resources and remain competitive.

UCL (Accessed December 2018)
UCL East campus in Queen Elizabeth Olympic Park, London

"- **180,000 sqm** – UCL East is spread across 4.63 hectares with capacity for around 180,000 sqm of space – equivalent to around 25 Wembley football pitches, or around 40% of our current Bloomsbury campus;

- **50,000 sqm** – Our two Phase 1 buildings provide 50,000 sqm of space – equivalent to around 7 Wembley football pitches – across academic and research space, student accommodation, and retail, community and engagement uses;

- **£100million** – Government has confirmed that UCL will received £100million towards UCL East from the £151million government investment for East Bank;

- **Eight faculties** – Phase 1 will bring together eight UCL faculties, with around 4,000 students and around 260 academic staff when fully operational;

- **Open to all** – The ground and first floor of our buildings are designed to welcome in visitors and the public, as well as UCL staff and students;

- **Excellent transport connections** – UCL East will be served by bus, underground, overground, DLR, high-speed rail and future crossrail services;

- **Work underway** – Academic programmes are being developed, detailed planning (Reserved Matters) applications have been submitted for our buildings, and construction will start in 2019."

Figure 2.47 'Back to the city' as strategy to enhance distinctiveness and support user's activities while making partnerships to share resources in the construction of state-of-the-art laboratories and remain competitive in the attraction of talent.

BBC News
New York's Roosevelt Island to get technology campus
June 26, 2012

"Cornell University plans to build a high-tech research centre on New York City's Roosevelt Island, a piece of land in the East River that has been used in the past to house the mentally ill.
Seth Pinsky of the New York City Economic Development Corp says he hopes the campus will help grow the local economy and reduce the city's dependence on Wall Street as a source for business growth."

From the Grapewine
Will this new campus turn New York into the new Silicon Valley?
Cornell Tech is combining research, business and sustainability to usher in a new era.
By Ilana Strauss. September 14, 2017

From the Grapewine
How an Israeli school was a magnet for Amazon choosing New York
Cornell Tech's Roosevelt Island campus will supply the talent for the retail giant's new headquarters.
By Benyamin Cohen. November 15, 2018

On the demand side, these interventions enhance the image of the university as local engaged actor (organisational driver); quality of place and distinctiveness by helping improving the campus' surroundings (physical drivers), increase universities' resource-efficiency as they engage in partnerships to share resources (financial driver) and ultimately, it can indirectly support the university productivity as the city provides complementary functions supporting the diverse activities of campus users (functional driver).

On the supply side, Urban-campuses can be an optimal combination of traditional (solid), network (fluid) and virtual (gas). Nevertheless, the entire idea of integrating the campus with the city supports mainly the idea of a networked campus where the spaces shared by the campus and the city strengthen the connections between campus users and citizens in general.

Figure 2.48 Combining living and studying facilities to support users' activities and improve the quality of place and attractiveness of campus

Home-campuses

The provision of facilities with mixed functions in university campuses is taking place also in student housing complexes. Examples of universities planning and implementing residential concepts that combine living, studying and relaxing, as main activities, are becoming popular (Figure 2.48). These complexes are not only supporting new ways of learning but also enhancing the sense of community in campus that can have effects on the well being of students and researchers.

The design of these complexes also involves opening the buildings plinths and offering mixed-functions such as catering and sport facilities. This creates more quality of place and integration with their immediate urban context. Home-campuses tend to focus on health, flexibility and livability in campus development.

Lifschutz Davidson Sandilands
UCL East, Future Living Institute
"Our competition-winning scheme for Pool Street West lies on the southern edge of the Queen Elizabeth Olympic Park (QEOP). It comprises two residential towers, containing over 500 student rooms, raised above 4,600m2 of flexible multi-functional space that houses the Future Living Institute with teaching and experimental laboratories, including UCL's Centre for Robotics & Autonomous Systems, the Global Disability Innovation Hub, the Culture Lab, Nature-Smart Cities Labs and the Urban Room."

dezeen
Pool Street in Queen Elizabeth Olympic Park
16.500m2 in total - 4,600m2 of flexible multi-functional space that houses teaching and experimental laboratories. | Expected: 2021 / 16.500 m2 / 524 student bedrooms | Develop the idea of the 'Fluid Zone' on lower levels | 24/7 facilities
August 2016

Leiden University College
Residential Concept
Living together in a residential setting adds another dimension to this learning, as our students have to learn to live with others who may not share the same daily routines or standards.
"The building incorporates both teaching facilities and housing accomodation for nearly 400 first- and second-year students. All residing students have their own studio appartement including private facilities."

Home-campuses covers projects that relate to multiple campus strategic themes including rethinking the academic workplace (Theme 1), creating a flexible learning environments with more study places (Theme 2), enriching the campus with non-academic functions (Theme 5), extending opening hours (Theme 7) and rethinking the campus as a safe and healthy place to be Theme 12).

On the demand side, Home-campuses reinforce new-ways-of-learning and well being as functional drivers and quality of place as a physical one.

On the supply side, Home-campuses support the idea of communities. Thus, projects are more inclined to a combination of network (fluid spaces) and virtual (gas digital structures) as ideal campus model. Nevertheless, Home-campuses can also generate the opportunity for territorial and fixed spatial structures (people wanting to study/work on their own units for solitude) in line with traditional (solid) model.

Smart-Campuses

Universities' rapid growth is also putting pressure on the supply of space on their campuses. The increase in the number of students and staff means more campus users. This calls for more space or at least, its more efficient use to allocate their various activities. For instance, the insufficient supply of study spaces during peak hours and at specific places is common in some universities. Moreover, the use of the space at universities is often territorial – i.e. the space is reserved for groups or individuals but not always in use. For instance, when campus users are looking for a place to study, to work or to have a meeting, all the space on campus seems to be in use: education spaces are booked for a lecture and desks are claimed by books on the table or a coat on the chair. However, for large parts of the day they are not in use, which becomes a major annoyance when space is scarce.

Research exploring smart solutions to this issue in campuses, called it a paradox: whilst students and professors demand more space on campus, campus managers know that the available spaces are not used to their full capacity (Valks et al., 2016). Herein, digital smart tools available to universities are currently being explored to tackle the issue of space scarcity in peak hours (Figure 2.49).

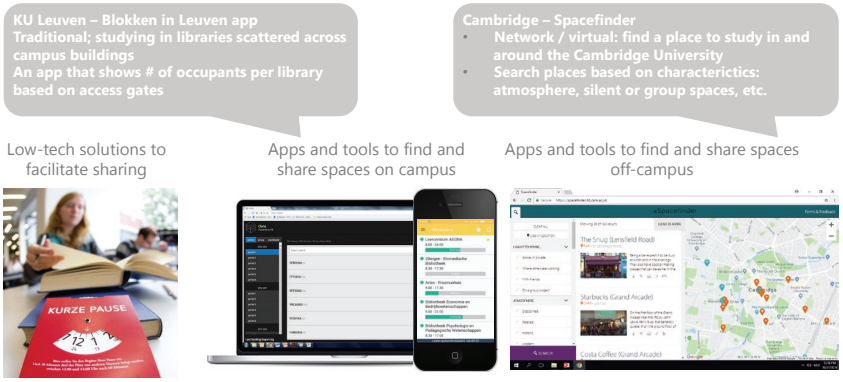


Figure 2.49 Implementing smart tools to effectively support users' activities and improve the quality of place.

Implementing smart tools (Theme 9) is interrelated with 'rethinking the academic workplace' (Theme 1) and 'creating flexible learning environments with more study places' (Theme 2). Smart-campuses tend to illustrate the focus on technology and flexibility to intervene the campus as portfolio, building and workplace level.

On the demand side, Smart -campuses support new ways of learning (e.g. mobile and tech-driven studying and working) and may increase productivity in universities as users' annoyances and the interruption of their activities can be diminished (functional drivers). Simultaneously, this can lead to better quality of place as vacancy is reduced and the use of the spaces is optimised (physical drivers).

On the supply side, Smart-campus can facilitate the implementation of the projects that combine 'solid', 'fluid' and 'gas' spatial arrangements. In this sense, it matches the balanced combination of traditional, network and virtual campus models.

Zen-Campuses

The well being of campus users and the productivity of universities are at risk with the increase of stress and other mental health issues affecting students and staff in universities. The awareness on these issues is increasing and some HEIs are looking for ways to provide a healthy and safe environment for them through programmes but also through the physical environment (Figure 2.50). Recent research looking into employee happiness in an activity-based work environment (Köhler, 2019) pointed out the important role of sufficient acoustic privacy. Herein, other categories such as visual privacy as well as visual and acoustic distractions are distinguished as influencing the happiness and productivity of employees.

Figure 2.50 Rethinking the campus as a safe and healthy environment for its users.

Archives of Psychiatric Nursing
The silence of mental health issues within university environments: a quantitative study
By D. Winaden et al., Volume 28, Issue 5, October 2014

The conversation
More academics and students have mental health problems than ever before
By Paul Gorczynski, February 22, 2018

Times Higher Education
Half of UK academics 'suffer stress-linked mental health problems'

The University of Edinburgh
Pet therapy offers students home comforts
A dog welfare charity is helping students reduce stress levels during exam time.

wbcafesheffield
Wellbeing Cafe
A communal space in your su with a pay as you feel meal and a proactive focus on your wellbeing.
Sheffield Students' Union

Increasing quality of place on campus with well being in mind tend to focus on liveability and the healthy balance between solitude and interaction spaces for individual or collective work as well as between offline and online modes in using technologies for study and working. In this context, Zen-campuses interrelates strategic themes such as 'Rethinking the campus as a safe and healthy place to be' (Theme 12), 'enriching the campus with non-academic functions' (Theme 5) and 'implementing smart tools for campus navigation' (Theme 9).

On the demand side, Zen-campuses enhance the well being and productivity of campus users (functional driver) and the quality of place (physical driver).

On the supply side, Home-campuses support also the idea of communities. However, in find a balance and supporting the needs of these communities, projects are inclined to a combination of the three types of structures (solid, fluid and gas). In this way, Zen-campuses generate the opportunity for fixed spatial structures when solitude is a demand (traditional) as well as shared facilities (network) and digital platforms (virtual) when social interaction is required.

2.5.3. Concluding remarks

The repertoire of examples presented in this section provided a comprehensive and rich overview of the strategic themes and projects that are transforming the current campus. Herein, it can be said that the current campus projects are rather heterogeneous in their themes (between 2 and 7 themes each). Accordingly, investing in state-of-the-art laboratories (Theme 4) and rethinking the academic workplace (Theme 1) are the most popular strategic themes present in at least four categories of campus projects (See Table 2.7).

	Campus strategies in themes	CO	WOW	ECO	OPEN	URB	HOME	SMART	ZEN	
1	Rethinking the academic workplace				■	■	■	■		4x
2	Creating a flexible learning environments with more study places				■		■	■		3x
3	Replacing or renovating old faculty buildings as home base		■							1x
4	Investing in state-of-the-art laboratories	■	■		■	■				4x
5	Enriching the campus with non-academic functions					■	■		■	3x
6	Giving new life to old buildings, including heritage buildings		■	■		■				3x
7	Extending opening hours (evenings, weekends, summer schools)					■	■			2x
8	Using circulation space - inside and outside – more effectively				■	■				2x
9	Implementing 'smart tools' for campus navigation							■	■	2x
10	Stimulating sustainable behaviour and testing innovative technology		■	■						2x
11	Clustering in one place for regional consolidation in the knowledge-based economy	■				■				2x
12	Rethinking the campus as a safe and healthy place to be						■		■	2x
	Number of themes in groups	**2**	**4**	**2**	**4**	**7**	**5**	**3**	**3**	

Table 2.7 Overview of campus themes per campus project categories

Similarly, these findings show that these projects are supporting diverse demand drivers in universities (Figure 2.51). Most of them address multiple drivers in two of the four perspectives. However, depending on the scale of the intervention, some of them can be addressing three (i.e. Wow-campuses and Eco-campuses) and even all four organisational, financial, functional and physical drivers (i.e. Urban-campuses). Overall, the physical driver of quality of place is the most common supported by five project categories, followed by distinctiveness also as physical driver, identity as organisational driver and productivity as functional drivers.

Figure 2.51 Overview of demand drivers per campus projects categories

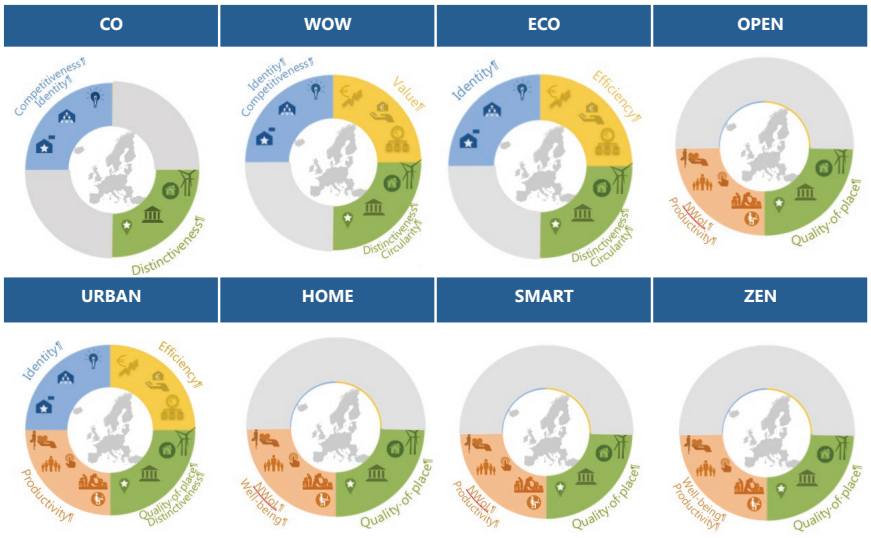
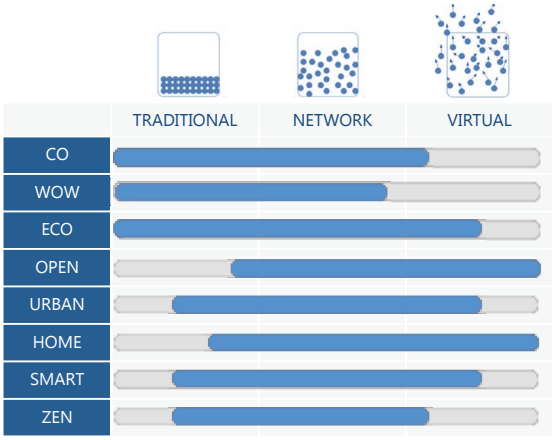


Figure 2.52 Overview of campus projects categories in relation to campus models (Den Heijer 2011 and TU Delft, 2016)

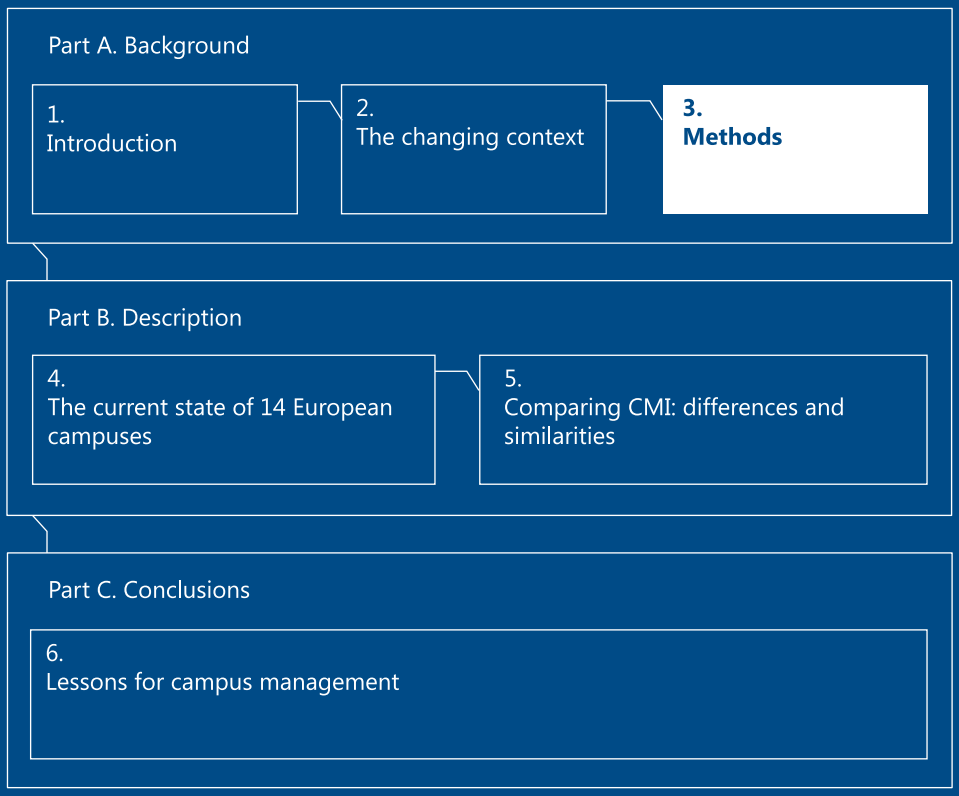


Finally, this review of projects that are transforming the current campus also confirmed the proposition that the campus of the future will be a combination of traditional, network and virtual spatial arrangements as suggested by Den Heijer (2011) Figure 2.25.

All in all, the comprehensive analysis in this chapter (throughout the second, third and fourth tasks of campus management) provides a context to underpin the relevance of assessing the current state of the university campus: first task in the campus decision process. The following chapters introduce the empirical research conducted on fourteen European UTs.

Managers' participation in research is essential to advance the current understanding of campus management and its improvement.

Methods


Part A. Background
1.
Introduction
2.
The changing context
3.
Methods
Part B. Description
4.
The current state of 14 European campuses
5.
Comparing CMI: differences and similarities
Part C. Conclusions
6.
Lessons for campus management

3. Methods

3.1. Approach and scope

This study uses a stratified sample of UTs located in Europe's most innovative regions to collect multi-perspective CMI. The choice for stratified sampling is based on the assumption that analysing UTs operating in comparable socio-economic context will minimised limitations found in previous campus management research at European level (Den Heijer & Tzovlas, 2014). The choice for this particular context is based on the expectation that this study will call the attention of many leaders and campus-decision makers that already aim to stimulate innovation in campuses and cities.

This study identified Europe's most innovative by using the Regional Innovation Scorecard map (European Commission, 2017b) indicating the regional performance groups at NUTS 2 level (See Figure 3.1). Herein, the sampling focuses in those regions classified as 'Leader' and 'Strong'.

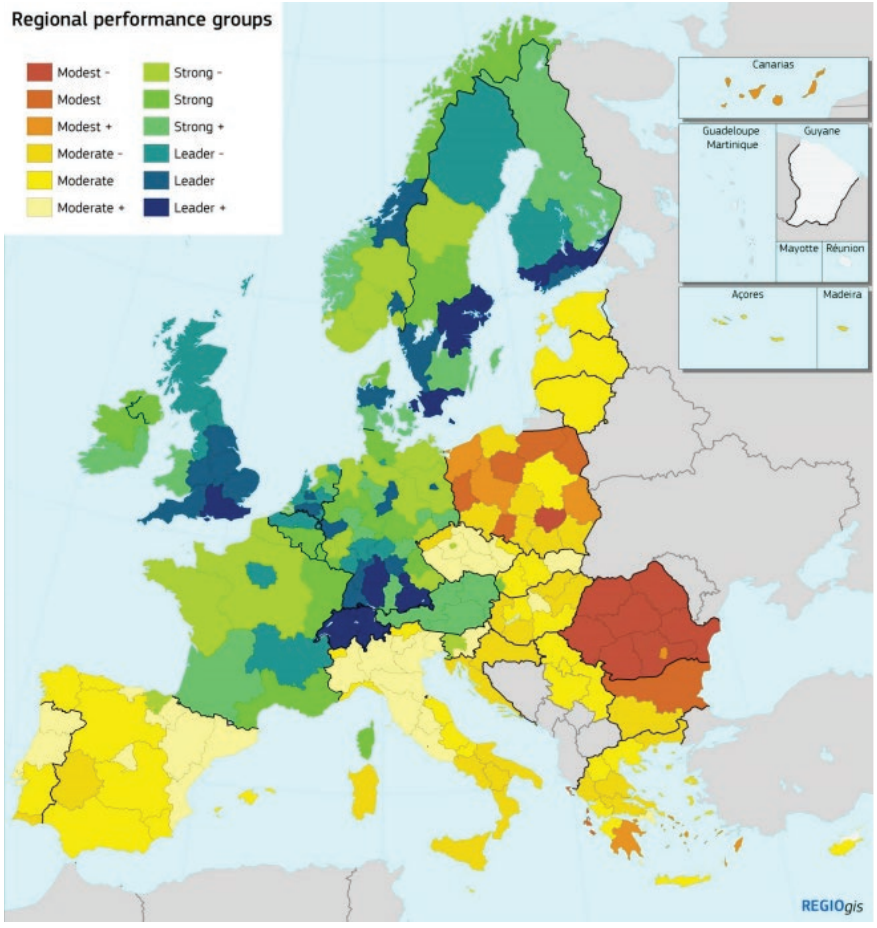


Figure 3.1 Regional Innovation Scorecard map indicating the regional performance groups at NUTS 2 level (European Commission, 2017b)

With this map, the definition of UTs given in this research (See sections 1.6 and 2.1) and the CESAER member list, this research identified 62 European UTs across 12 countries (see Figure 3.2 and Table 3.1).

Figure 3.2 Stratified sample of 62 UTs in 186 sites located in Europe's most innovative regions. Note: The UK is not part of the study since former Polytechnics changed their profile to comprehensive universities after the Further and Higher Education Act 1992. Base-map: Esri from ArcMap 10.3.

Country	University name
Austria	Graz University of Technology
	Vienna University of Technology*
	University of Leoben
	University of Natural Resources and Life Science^
Czech Republic	Czech Technical University in Prague*
	University of Chemistry and Technology, Prague
	Czech University of Life Sciences Prague^
Denmark	Technical University of Denmark - DTU
	Aalborg University*
Finland	Aalto University*
	Tampere University of Technology - TUT
	Lappeenranta University of Technology

France	École Polytechnique
	École polytechnique de l'université de Nantes
	Grenoble Institute of Technology*
	AgroParisTech*
	Arts et Métiers ParisTech*
	Chimie ParisTech*
	École des Ponts ParisTech*
	École Nationale Supérieure de Techniques Avancées ENSTA ParisTech*
	École Supérieure de Physique et de Chimie Industrielles ESPCI ParisTech*
	Institut d'Optique Graduate School*
	Telecom ParisTech*
	CentraleSupélec*
	Université de technologie de Belfort-Montbéliard
	ENSSAT - École Nationale Supérieure des Sciences Apliquées et de Technologie
	Polytech Nice Sophia
	INSA - Institut National des Sciences Appliquées de Lyon*
	University of Technology of Compiègne
	University of Technology of Troyes
	Toulouse Institute of Technology
Germany	Karlsruhe Institute of Technology*
	Technical University of Munich – TUM*
	Hamburg University of Technology TUHH*
	Darmstadt University of Technology - TU Darmstadt*
	Technische Universität Dortmund - TU Dortmund
	Technische Universität Berlin - TU Berlin*
	Clausthal University of technology - TU Clausthal
	Technische Universität Ilmenau - TU Ilmenau
	Chemnitz University of Technology - TU Chemnitz
	Technische Universität Dresden - TU Dresden*
	Technische Universität Braunschweig - TU Braunschweig*
	Technische Universität Kaiserslautern - TU Kaiserslautern
	Technische Universität Bergakademie Freiberg - TU Freiberg
	Brandenburgische Technische Universität Cottbus–Senftenberg - BTU
	RWTH Aachen University
Ireland	Dublin Institute of Technology - DTI
The Netherlands	Technische Universiteit Delft - TU Delft*
	Technische Universiteit Eindhoven - TU/e*
	Universiteit Twente*
	Wageningen University & Research - Wageningen UR^
Norway	Norwegian University of Science and Technology - NTNU
	Norwegian University of Life Sciences
Slovakia	Slovak University of Technology in Bratislava
Sweden	Swedish University of Agricultural Sciences – SLU^
	Karolinska Institutet KI^
	Chalmers University of Technology*
	Royal Institute of Technology KTH*
	Luleå University of Technology*
	Blekinge Institute of Technology
Switzerland	Swiss Federal Institute of Technology Lausanne EPFL*
	Swiss Federal Institute of Technology Zurich ETH*

Table 3.1 List of 62 identified UTs in 12 European countries with Leading and Strong innovative regions.

Overall, Germany and France account for more than half of the UTs identified in this research with 15 and 19 UTs each, respectively. Other countries have between one (i.e. Slovakia and Ireland) up to ten UTs (i.e. Sweden). An overview of the distribution of the sample per country is illustrated in Figure 3.3.

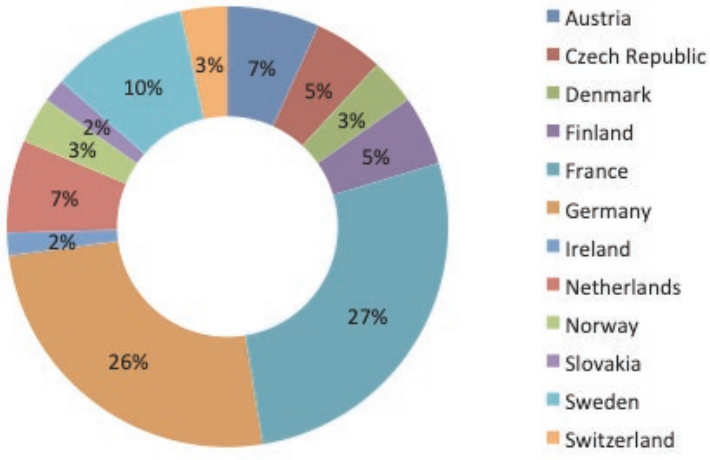


Figure 3.4 Requested data fields in the survey categorised by campus perspectives.

3.2. Data collection and analysis

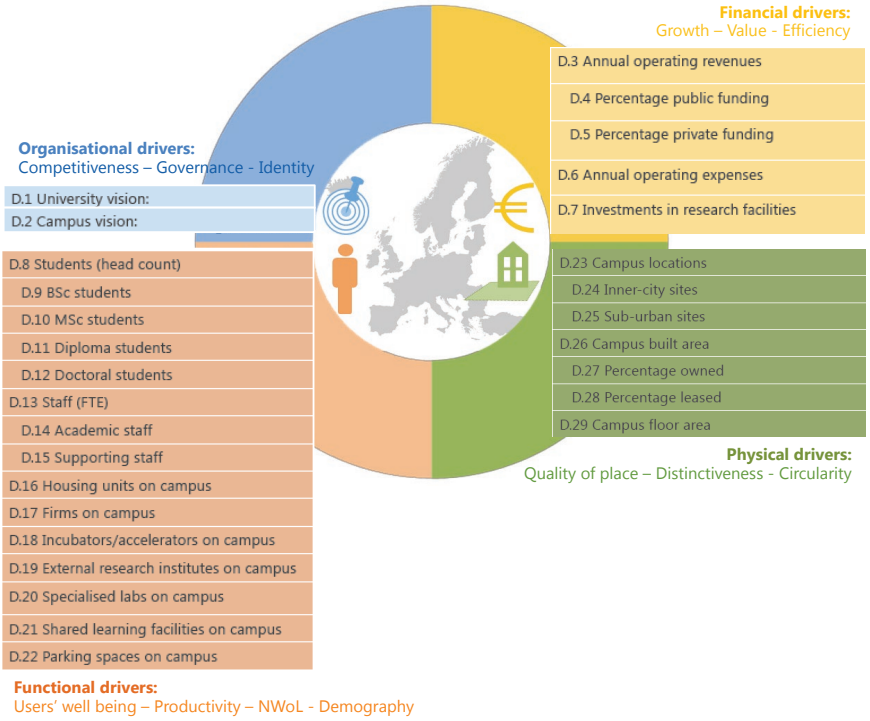
This study combined two data collection techniques. On the one hand, it uses a survey sent via email to the campus managers of 62 UTs and university country organisations. On the other hand, it uses documentation of primary sources through desk research.

3.2.1. Survey

This study uses the perspectives on campus management to develop a structured survey divided in four categories of data variables. Accordingly, a comprehensive survey containing 29 data fields distinguished into organisational, financial, functional and physical were sent to campus managers (See table 3.2). These are linked to the contemporary organisational, financial, functional and financial drivers influencing HEIs, which have been identified in the previous chapter.

The number of data fields varied per perspective. In the organisational perspective, two variables were used to identify the goals addressed by UTs and their campus managers. In the financial perspective, five variables were used to identify the capital resources available to spend on campus and on research infrastructure. In the functional perspective, fifteen variables were used to identify the end-users accommodated on campus of UTs and the particular functions supporting research, education and valorisation as their main activities. In the physical perspective, seven variables were used to explore how these activities are accommodated in particular places and in the available space. Definitions for these variables are further explained in the descriptive part of this report (see Section 4.1.1).

Figure 3.3 Distribution of this study sample of European UTs per country.



The data requested in the financial, functional and physical perspectives are metrics while the data in the organisational perspective are words. The data fields requested were made available to managers and country organisations[11] in spreadsheets to be filled directly by them. For some variables, preliminary input for verification was filled-in by using three main data sources publicly available: statistical datasets generated by country organisations, the websites of the universities and Google and Esri maps.

[11] A list of country organisations contacted is provided in Appendix I.

The data collection process took nine months starting in June 2017 and ending in March 2018. The contact was made in two periods. UTs outside the Netherlands were contacted in June 2017 and additional reminders were sent between August and October of the same year. For Dutch universities, the survey was sent in December 2017 and January 2018. Additional reminders were sent between February and March 2018. Fourteen universities in nine countries agreed to participate and disclosed the data with us (22,5% response rate)[12]. During the revision of the data, one of the fourteen universities changed its mind regarding their participation in the study. Therefore, their data was used in the analysis and comparison but remains anonymous.

[12] One of the fourteen universities that agreed to participate in this research distinguishes itself as a comprehensive university of science and technology. Although this university is listed in the CESAER network, the campus managers acknowledge that half of the students at this university are connected to the Faculty of Social Sciences and Faculty of Humanities while only 35% of the staff at the five faculties is employed at these two faculties. This shows that the university has a higher allocation of resources (i.e. personnel) to the more technology oriented part of the university. This university is kept in the sample since the campus managers showed interested in participating in this study.

Figure 3.5 illustrate the countries and the number of participant UTs in each of them. Surprisingly, none of the UTs in the country with more UTs in the sample responded to the survey.

Most universities filled-in the fields in the survey by themselves but few of them provided links to official documents or webpages to retrieve them. Between July and November 2018, UTs verified the data providing explanations and corrections for particular variables. When consistent with the research approach, these were incorporated. However, those related to updating the information were not considered in order to provide a comparable dataset with the same period for all UTs.

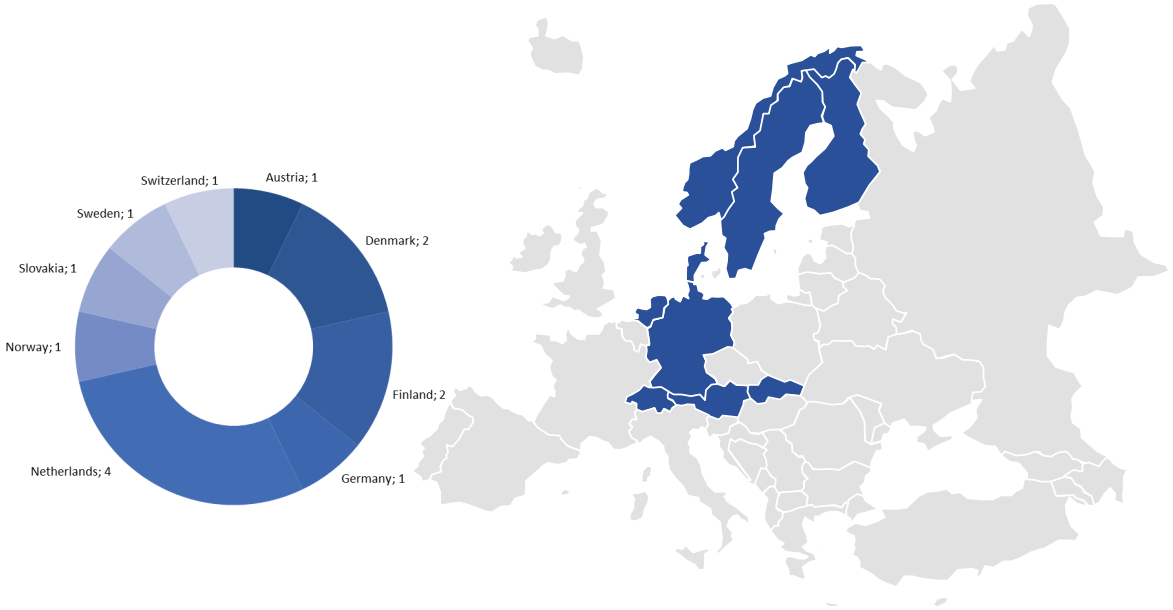


Figure 3.5 Participation rate of UTs per country

Organisational variables were analysed using deductive codes based on campus management research linking real estate goals and university performance (Den Heijer, 2011). Metrics were analysed using descriptive statistics, from which performance indicators were derived.

3.2.2. Documentation

Additionally, this study gathered generic information for the participant universities. This information entailed text describing the profile of the university, maps illustrating the location of the campus and organigrams showing the UTs' governance- and campus management structures. The latter two indicated the organisation of campus management, its more or less autonomous position within the overall governance of the university and the stakeholders who participate in this process.

This information was collected using online documentation publicly available at the universities' websites. In the case of location, the addresses available at universities websites were confirmed by using open access maps. Data collected on university governance structure was analysed by using deductive codes based on existing models of university governance (EUA, 2017). The analysis of data on campus management structure involved inductive coding emerging from patterns in the data.

3.3. Available CMI

Available data in the four perspectives provided substantial and homogeneous CMI to describe the current state of the campus at fourteen European UTs (Figure 3.6). When looking in detail at the variables, only two of them in the functional perspective had about 65% availability. Instead, for most variables the availability is around and above 80% (See Figure 3.7). This shows an increase on available CMI per perspective using a survey as a main data collection technique compared to previous research using desk research and open data only.

Figure 3.6 Availability of CMI collected in the survey per perspective. Note: when strategic data was not provided by campus managers in the survey, it was collected using universities ' websites. In the end the availability of strategic in this research is 100%

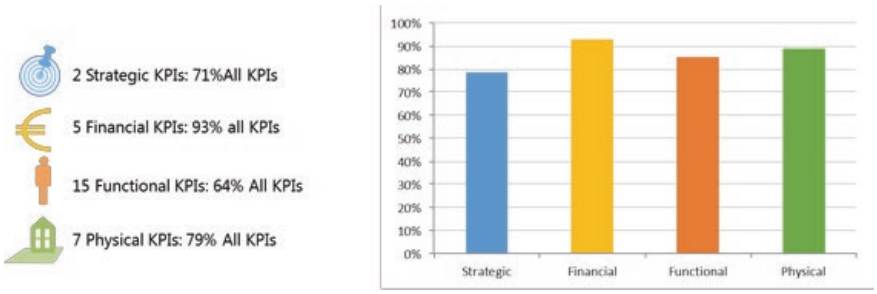
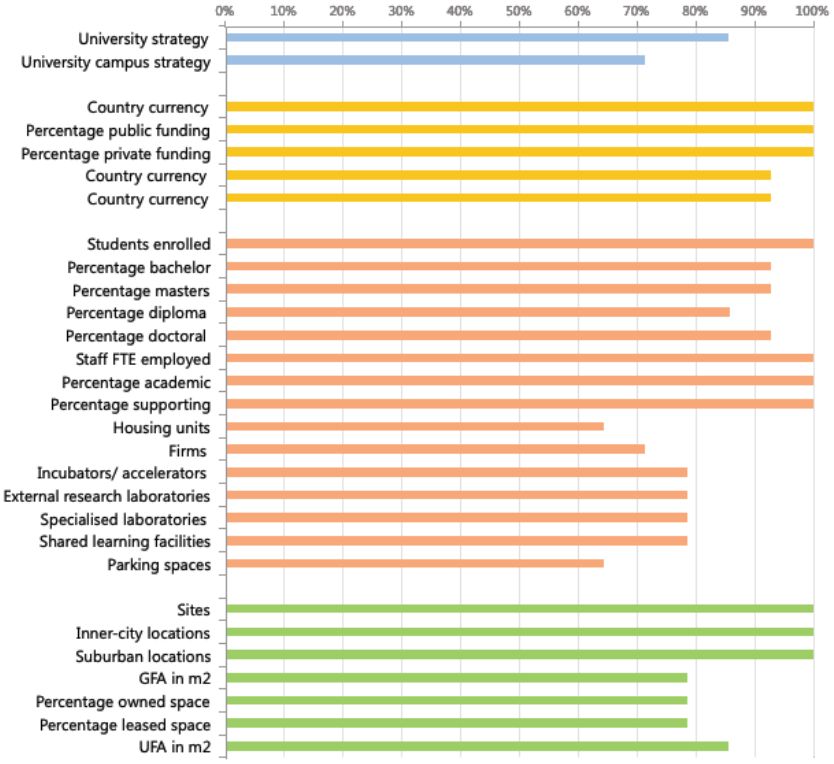


Figure 3.5 Overview of CMI collected per categories and variables. Note: strategic data not provided by campus mangers in the survey was collected using universities ' websites.



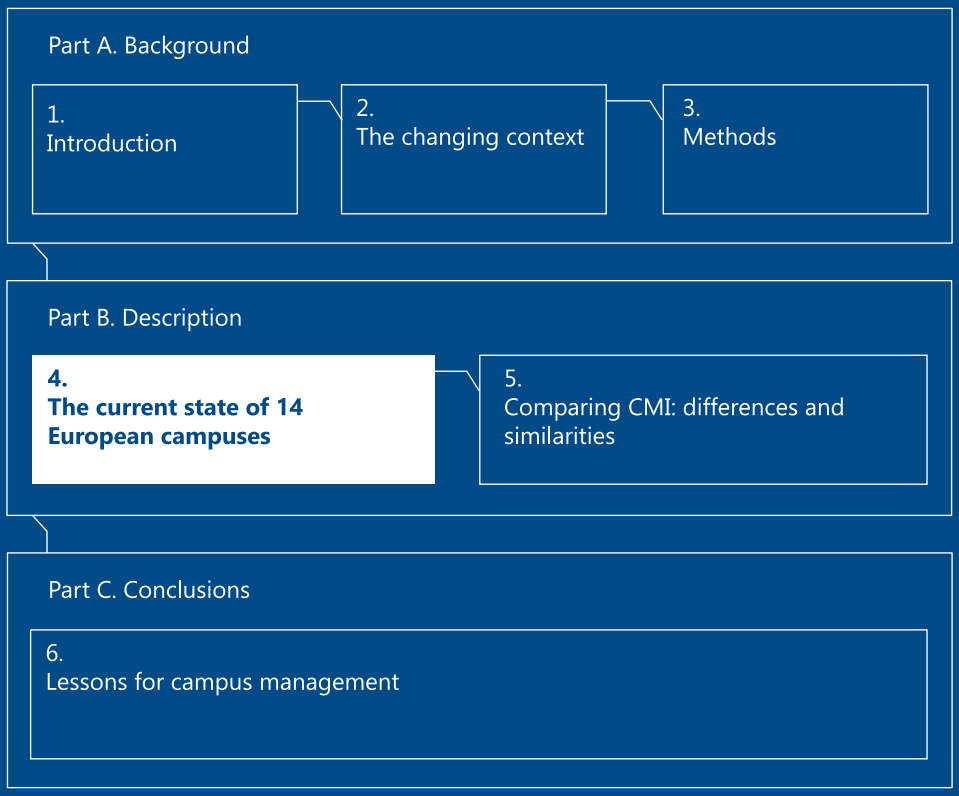
For instance, non-available data about university- and campus strategies from the survey was easy to find through the universities websites when campus managers did not provide this. Generic information including data about university governance structure and campus management structure was publicly available for all participant UTs.

The following Chapter provide more detail descriptions and explanations about the data collected in this research and how it is used to describe the current state of the campus in the fourteen participant UTs.

B. Description

Multi-perspective data overviews offer comprehensive pictures to various campus decision makers.

The current state of 14 European campuses



4. The current state of 14 European campuses

This chapter provides a comprehensive assessment of the current campus in fourteen European UTs. The information displayed in the following pages does not attempt to be explanatory but rather descriptive. Thus, readers of this study can have a transparent and thorough picture of the campus management information collected per each university and used in the next chapter to identify patterns in the alignment between the strategies of UTs and their campuses. The readers' guide to the descriptive data in this chapter is detailed in the next paragraphs.

4.1. Readers' guide to descriptive data

This chapter contains two pages of campus management information for each of the fourteen European UTs participating in this study. The information is distinguished into two types.

First, it describes generic information such as a code assigned in this research to each UT, the profiles of the university and the campus as well as the governance of the university and the management structures of the campus. This information includes facts, narrative texts, maps and photos. Most of this information can be found on the left page of the overview.

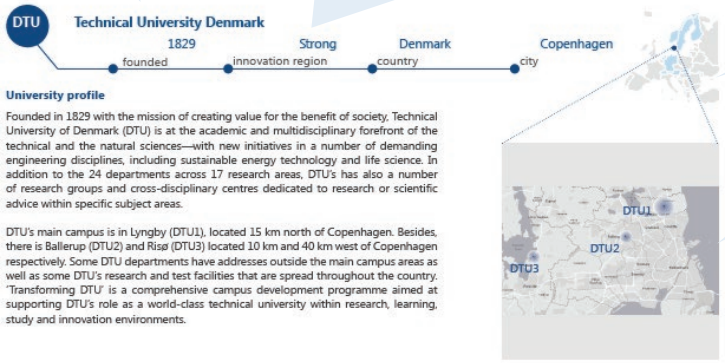
Second, it summarizes campus management information (CMI) from four different perspectives – organisational, financial, functional and physical. The data in the organisational perspective are words while the data in the last three perspectives are metrics and have been used to derive key performance indicators. The CMI is visualised in tables located on the right page of the overview. The sources and periods of data collection are indicated per each university. Because the retrieval of all data spanned over a year (i.e. June 2017 to March 2018), the current state of the campuses described in this research correspond mainly to available data from the years 2016 and 2017. Notwithstanding, this study acknowledges the dynamic context shaping campuses since several changes in the data were outlined by some campus managers during the verification period up to November 2018. Some of these changes are mentioned separately but were not considered in the data set for comparison because not all universities registered changes.

Figure 4.1 and 4.2 illustrate how the data is organised. The participant UTs has revised the overview of data. Additional explanatory notes have been used when a particular feedback on the data was provided.

The innovation region is used as a context to select an homogenous sample based on the European Innovation Scoreboard (European Commission, 2017). Accordingly, there are four types of innovators in Europe: MODEST; MODERATE, STRONG and LEADERS.

UT official name

UT code



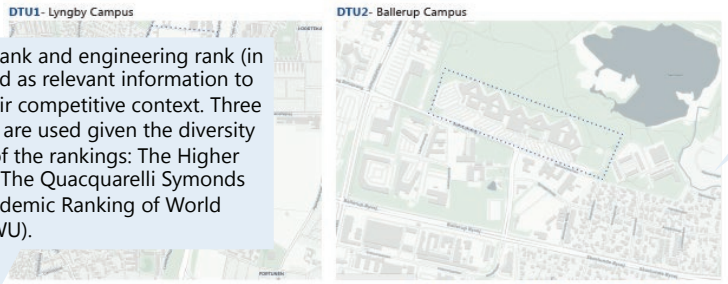
Location in EU

About the university

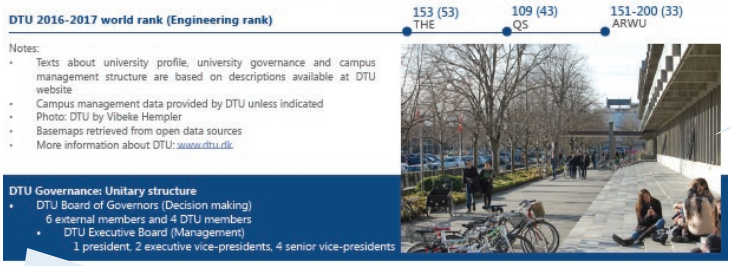
Location(s) in the city with campus codes

About the campus

Campus map(s) with reference to campus codes



The 2017 world rank and engineering rank (in brackets) are used as relevant information to profile UTs in their competitive context. Three different sources are used given the diversity in the methods of the rankings: The Higher Education (THE); The Quacquarelli Symonds (QS) and the Academic Ranking of World Universities (ARWU).



Main sources

Campus photo

University governance is used to identify the decision-making bodies influencing campus management in UTs. These are coded according to three existing models in Europe (EUA, 2017):

- Unitary structure
- Traditional dual structure
- Asymmetric dual structure

Figure 4.1 Readers' guide to descriptive information on the left page of the data overview per each UT

Organisational CMI summarises qualitative data about UTs goals, vision and/or strategies (D.1) and campus goals, visions and/or strategies (D.2). Both are retrieved from UTs official documents and websites. The latter are coded based on campus management research linking real estate goals and university performance (See note below).

Financial CMI summarises the capital resources available to spend on campus and research infrastructure and ensuring universities' fiscal sustainability (D.1-7).

Functional CMI summarises the users accommodated on campus (D. 8-15) and the multiple functions and facilities supporting research, education and valorisation as the primary processes in UTs (D.15-22)

Physical CMI summarises the way in which the main UTs' activities are accommodated in particular places and available spaces.

Main sources and explanatory notes

KPIs derived from the available financial, functional and physical data (KPI.1-12)

Period data

Strategic[1]

D.1 University vision: • Enabler of an innovative society with breakthrough discoveries • Research excellence for academic and societal impact • Renewing society by art, creativity and design • Educating game changers • Excellence
D.2 Campus vision: 1. Stimulating collaboration - Stimulating innovation 2. Supporting image (attractiveness) 3. Supporting user activities (supporting the production of new knowledge)

Functional

D.8 Students (headcount)[2]	17.345
D.9 BSc students	44%
D.10 MSc students	40%
D.11 Diploma students	not applicable
D.12 Doctoral students	16%
D.13 Staff (FTE)	3.989
D.14 Academic staff	69,2%
D.15 Supporting staff	30,8%
D.16 Housing units on campus[3]	0
D.17 Firms on campus[4]	70
D.18 Incubators/accelerators on campus	2
D.19 External research institutes on campus	1
D.20 Specialised labs on campus[5]	580
D.21 Shared learning facilities on campus[6]	not available
D.22 Parking spaces on campus[7]	c.1.200

Financial

D.3 Annual operating revenues	€ 358,0 Million
D.4 Percentage public funding	89%
D.5 Percentage private funding	11%
D.6 Annual operating expenses	€ 358,0 Million
D.7 Investments in research facilities	not available

Physical

D.23 Campus locations	3
D.24 Inner-city sites	3
D.25 Sub-urban sites	0
D.26 Campus built area[8]	386.762 m² GFA
D.27 Percentage owned	86%
D.28 Percentage leased	14%
D.29 Campus floor area[9]	303.304 m² UFA

Notes:
1. Available at www.aalto.fi/en/about/strategy/
2. AU provided this metric also in FTE (12.113)
3. AU does not own housing units. Students associations and private companies own c. 1900 and c.240 units next to the campus.
4. Includes tenants and subtenants firms
5. Individual rooms designated for laboratory use, including laboratories for education, but excluding all auxiliary/supportive laboratory rooms (88 rooms)
6. All premises are more or less open to shared use. This is gradually being made visible by the application Aalto Space
7. Currently, 739 parking spaces are in use for customers.
8. This consists of the gross floor area of AU buildings, plus only the net area of the leased-to-university areas
9. This number includes the tenants of the university and empty space.

Key performance indicators (KPIs)

KPI.1 Students per academic staff	6,3
KPI.2 Parking spaces per staff	0,3
KPI.3 Investments in research facilities as percentage of annual operating expenses	not available
KPI.4 UFA/GFA	78%
KPI.5 Share of inner-city sites from portfolio	100%
KPI.6 Annual expenses per student	€20.640
KPI.7 Annual expenses per students and staff	€16.781
KPI.8 Investment in research facilities per student	not available
KPI.9 m² GFA per student	22,3
KPI.10 m² UFA per student	17,5
KPI.11 m² UFA per students and staff	14,2
KPI.12 Annual expenses per m² UFA	€1.180

Table 1.1. AU Campus management information.
Information collected: 29 data variables on four perspectives (D.1-29); Information derived: 12 campus-related KPIs.
Period data collection 2016-2017. Period data access: fall 2017.

AU Campus Management structure: External centralised
- Campus development (Vice-president)
- Aalto University Properties Ltd
  - Aalto University Campus & Real Estate (ACRE)
    - Leasing
    - Property and Campus services
    - Construction Development
    - Workplaces and Sustainability
    - Administration and Finance
    - Management

Campus management structure is used to describe the arrangements of multiple stakeholders involved in campus decisions in each UTs. These are coded according to patterns emerging from the data:
- Internal Centralised structure
- Internal Decentralised structure
- External Centralised structure

Figure 4.2 Readers' guide to descriptive information on the right page of the data overview per each UT

Note: UTs expressed their campus goals and visions in different ways. To standardise the data collection and analysis of this information (D.2), this research used Den Heijer's (2011) twelve real estate goals: 1) improving quality of place, 2) supporting image, 3) supporting culture, 4) stimulating innovation and 5) stimulating collaboration as organisational goals contributing to competitive advantage; 6) decreasing costs, 7) increasing real estate value and 8) controlling risks as financial goals contributing to profitability; 9) reducing footprint, as physical goals contributing to sustainable development; and 10) supporting users' activities, 11) increasing users' satisfaction and 12) increasing flexibility as functional goals contributing to productivity.

4.1.1. Collected and verified CMI

The CMI used in this study was collected and verified by campus managers. The comprehensive set of 29 data variables was handed to campus managers without definitions. The researchers prepared definitions in case campus managers asked questions (Table 4.1). Simultaneously, this approach allowed identifying differences in accountability culture in campus management between participant UTs. While some UTs wanted to be more specific about the way they track and define particular CMI, other UTs did not provide references and/or enquire about the variables requested. Although these differences provided interesting insights, it challenged the homogeneity of the data description because the definitions used by each UT for some of these variables differ widely. These differences became an evident issue during the data verification process by campus managers.

	Data	Indicator	Definition in this research	Comments
	Organisational			
D.1	University strategy/vision	Vision	Universities' statements or plans of action intended to achieve their long-term ambitions in line with their missions.	Not enquired by UTs.
D.2	University campus strategy/vision	Type of goals	Universities' statements or plans of action intended to achieve their ambitions through their campuses (i.e. land, buildings and facilities). These were coded using 12 existing campus strategies and goals.	Some UTs were more explicit than others in providing this data. During the verification, one UT found the coding used in this research limiting to describe their campus ambitions.
	Financial			
D.3	Annual operating revenues	Country currency (Millions)	Total amount of income generated by UTs in a year before any expense.	Most UTs called this variable 'total income'.
D.4	Source of revenues	Percentage public funding	The share of the annual operating revenue that comes from public funds.	Not enquired by UTs.
D.5		Percentage private funding	The share of the annual operating revenue that comes from sources other than public funds.	Some UTs specified these sources as income from third parties, tuition fees and other income.
D.6	Annual operating expenses	Country currency (Millions)	Total amount of expenditure incurred by UTs in a year to carry out their activities (e.g. payroll, pension contributions, rent, maintenance, utilities, etc.)	One UT enquired about this definition during the data revision.
D.7	Investments in research facilities	Country currency (Millions)	The capital expenses incurred by UTs in a year to buy new or add value to their existing research infrastructure.	Most UTs enquired about this and provided clarifications of the data provided. Their definitions differ.
	Functional			
D.8	Students population	Headcount enrolled	The number of students enrolled in all classes offered by UTs. This considers full- and part time students.	One UT provided both data on headcount and full time equivalent (FTE) students.
D.9	Types of student population	Percentage bachelor students	Share of students enrolled in classes at undergraduate level to obtain a bachelor's degree.	During the verification most UTs outlined this data has changed.
D.10		Percentage masters students	Share of students enrolled in classes at graduate level to obtain a master's degree.	During the verification most UTs outlined this data has changed.

D.11	Types of student population	Percentage diploma students	If applicable, share of students enrolled in classes at other higher education qualifications.	Some UTs filled in this category students enrolled in premaster's and postmaster's studies as well as other categories including MAS/ MBA students and visiting/exchange students.
D.12		Percentage doctoral students	Share of students enrolled in classes at doctoral/PhD level	Some UTs do not consider PhDs as students but as academic staff.
D.13	Staff population	FTE (full-time equivalent) employed	The amount employees working full-time at UTs	Not enquired by UTs.
D.14	Types of staff population	Percentage academic staff	Share of FTE employed in education and research activities	One UT clarified this data because its structure distinguishes university from research institute. Therefore, for the sake of developing KPIs, the data of the university is used.
D.15		Percentage supporting staff	Share of FTE employed in activities supporting education and research (e.g. administrative, valorisation and technical staff)	
D.16	Residential function	Number of housing units on campus	Total amount of housing units built on campus land. These are not necessarily owned by the UTs.	At least 6 UTs enquired clarified the data provided in this variable.
D.17	Related business function	Number of firms on campus	Total amount of firms accommodated on campus land and/or buildings. These are not necessarily collaborating with UTs.	Some UTs provided details about the different types of firms.
D.18		Number of incubators/ accelerators on campus	Total amount of facilities developed to facilitate the growth of start-ups, spin-offs and SMEs initiated by students, staff and/or third parties.	Three UTs provided explanatory notes about this data during the collection period. One UT outlined the data has changed during the verification.
D.19	Research function	Number of external research institutes on campus	Total amount of independent research institutes located on campus land and/or buildings. These are not necessarily collaborating with UTs.	Some UTs enquired about this definition and provided explanatory notes about this data.
D.20	Education and research function	Number of specialised laboratories on campus	Total amount of laboratory facilities developed to house education and/or research activities that requires unique and/or specialised infrastructure.	Most UTs enquired about this data and provide data with notes. Some provided the information in m^2 as well. The available data varies widely across UTs.
D.21		Number of shared learning facilities on campus	Total amount of shared facilities accommodating education activities that can be used by different faculties.	Most UTs enquired about this data and provide data with notes. Some provided the information in m^2 as well. The available data varies widely across UTs.
D.22	Infrastructure function	Number of parking spaces on campus	Total amount of parking spaces in use on campus regardless the actual users.	One UT provided an explanatory note on this.
	Physical			
D.23	Campus portfolio	Number of sites and campus locations	Total amount of sites used by UTs to accommodate their core activities of education, research and valorisation as indicated in the UTs' websites.	During the verification, one UT indicated this data has changed due to recent relocation developments.
D.24	Campus locations	Number of inner-city sites	Share of UTs' sites located within the urban fabric and/or city centres.	Not enquired by UTs.
D.25		Number of suburban sites	Share of UTs' sites located in the periphery of cities and/or surrounded by areas that are not built-up.	Not enquired by UTs.

D.26	Campus built area	GFA (gross floor area) in square meters	Total floor area of all campus buildings and measured to the external face of the external walls.	Not enquired by UTs.
D.27		Percentage owned space	Share of the campus built area that is owned by UTs. Both UTs and tenant companies can use this space.	Not enquired by UTs.
D.28		Percentage leased space	Share of the campus built area that is rented by UTs from other parties. Both UTs and sub-tenant companies can use this space.	One UT enquired about this.
D.29	Campus floor area	UFA (usable floor area) in square meters	Total floor area of all campus buildings measured to the internal face of the external walls less the floor areas taken up by lobbies, enclosed machinery rooms on the roof, stairs and escalators, mechanical and electrical services, lifts, columns, toilet areas (other than in domestic property), ducts, and risers.	Some UTs enquired about this variable and provided a note of what they counted as UFA. In some cases, their measurements align with our definition. Notes are provided since the available explanations differ in some cases.

Table 4.1 Overview of collected and verified CMI with definitions

4.1.2. List of abbreviations

The overview of data provided in this chapter uses abbreviations that are listed alphabetically as follows:

- ARWU: Academic rankings of world universities
- CO2: Carbon dioxide
- FTE: Full time equivalent
- GFA: Gross floor area
- KPIs: Key performance indicators
- M2: Square meters
- QS: The Quacquarelli Symonds university rankings
- THE: Times Higher Education university rankings
- UFA: Usable floor area

4.2. Outlook of CMI in fourteen European UTs

The following pages provided a two-page overview per each of the thirteen participant UTs that agreed to display their campus management information. The descriptive data of one of the fourteen UTs has been removed on request by this university. The overview is presented according to the alphabetical order of the code given to each in this research (See Table 4.2).

Code	University name	Est.	Country	Innovation region*
AAU	Aalborg University	1974	Denmark	Strong
AU	Aalto University	1849	Finland	Leader
DTU	Technical University Denmark	1829	Denmark	Strong
ETHZ	ETH Zurich	1855	Switzerland	Leader
LUT	Lappeenranta University of Technology	1969	Finland	Leader
NTNU	Norwegian University of Science and Technology	1910	Norway	Leader
SLU	Swedish University of Agricultural Sciences	1977	Sweden	Leader
STUB	Slovak University of Technology in Bratislava	1937	Slovakia	Strong
TUD	Delft University of Technology	1842	The Netherlands	Leader
TUE	Eindhoven University of Technology	1956		Leader
TUG	Graz University of Technology	1811	Austria	Strong
UT	University of Twente	1961	The Netherlands	Leader
WUR	Wageningen University & Research	1918		Leader

Table 4.2 List of participant UTs in alphabetical order based on their given code. Notes:
*The innovation region is based on the campus location in the Regional Innovation Scorecard map that covers NUTS 2 level regions. NUTS classification (Nomenclature of territorial units for statistics) is a hierarchical system for dividing the economic territory of the EU.

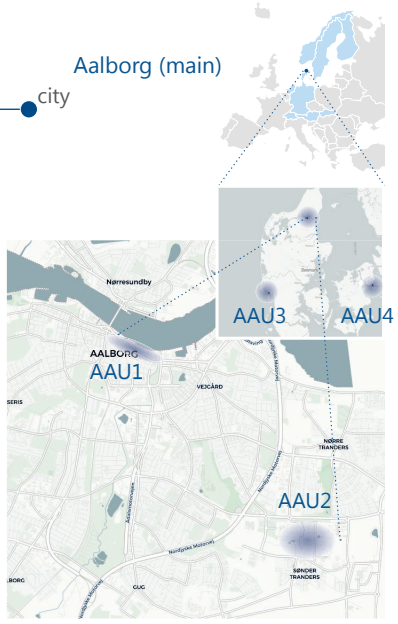
Aalborg University

1974 founded

Strong innovation region

Denmark country

Aalborg (main) city



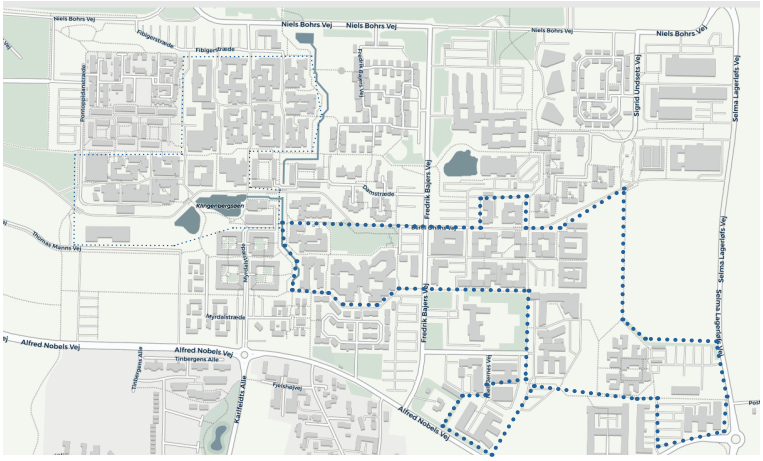
University profile

Aalborg University (AAU) has been providing students with academic excellence, cultural engagement and personal development since its inception in 1974. Education and research at AAU are organised in five scientific main areas (faculties): Humanities, Engineering and science; Medicine; Social Sciences; and IT and Design. AAU currently consolidates and further develops its profile as a dynamic and innovative research and educational institution oriented towards the surrounding world. AAU is characterised by combining a keen engagement in local, regional, and national issues with an active commitment to international collaboration.

AAU has campus areas in Aalborg (AAU1-2), Esbjerg (AAU3) and Copenhagen (AAU4). AAU's main campus is in Aalborg. AAU Esbjerg is a research department with a range of research activities and study programmes and AAU Copenhagen accommodates research and teaching activities engaging in close cooperation with companies located on campus.

AAU1- Campus Aalborg City

AAU2- Campus Aalborg Øst



AAU 2016-2017 world rank (Engineering rank)

201-250 (96) THE

374 (71) QS

201-300 (39) ARWU

Notes:

- Texts about university profile, university governance and campus management structure are based on descriptions available at AAU website
- Campus management data provided by AAU unless indicated
- Photo: Aalborg University Press
- Basemaps retrieved from open data sources
- More information about AAU: www.en.aau.dk

AAU Governance: Unitary structure

- The Aalborg University Board (Decision making)
  - 6 external members and 5 AAU members
  - The AAU's Rectorate (Management)
    - 1 rector, 1 pro-rector, 1 university director's tasks

Organisational

D.1 University vision: • International recognition as excellent in research with a problem and solution oriented perspective • Educating students for the society of the future • Being an attractive collaboration partner for private companies, public authorities and institutions to share knowledge in mutual focus areas.
D.2 Campus vision: 1.Stimulating collaboration (interaction and synergies) 2. Supporting users' activities (focus on activities and buildings) 3. Improving quality of space (physical connections, parking facilities)

Functional

D.8 Students (headcount)	2.0743
D.9 BSc students	58%
D.10 MSc students	41%
D.11 Diploma students	not applicable
D.12 Doctoral students[3]	not applicable
D.13 Staff (FTE)	3.309
D.14 Academic staff	62,9%
D.15 Supporting staff	37,1%
D.16 Housing units on campus[4]	not available
D.17 Firms on campus	16
D.18 Incubators/accelerators on campus	1
D.19 External research institutes on campus	0
D.20 Specialised labs on campus	564
D.21 Shared learning facilities on campus	62
D.22 Parking spaces on campus	2.000

Financial[1]

D.3 Annual operating revenues	€ 382,9 Million
D.4 Percentage public funding	95,2%
D.5 Percentage private funding	4,8%
D.6 Annual operating expenses	€ 367,9 Million
D.7 Investments in research facilities[2]	€ 3,6 Million

Physical

D.23 Campus locations	4
D.24 Inner-city sites	2
D.25 Sub-urban sites	2
D.26 Campus built area	288.612,8 m² GFA
D.27 Percentage owned	0%
D.28 Percentage leased	100%
D.29 Campus floor area	253.610,4 m² UFA

Notes:
1. Data from 2016 provided in Danish Krone (DKK) and converted to Euro using price tables from December 31, 2016 at www.xe.com.
2. Number includes university investments in laboratory buildings in 2016. Moreover, the Danish Building & Property Agency as well as private building owners have built research buildings for the university to lease after completion. In 2010 the Danish Ministry for Education & Research granted the Danish universities 6 billion DKK to renovate laboratories. 469 million DKK of these were granted Aalborg University in connection to specific building projects. The last of these projects will be completed in 2020.
3. According to data from Universities Denmark - DKUNI, PhDs are not count as students.
4. There are 8000 student housing units in the city of Aalborg not owned by AAU but serving AAU's students as well as other HEIs.

Key performance indicators (KPIs)

KPI.1 Students per academic staff	10
KPI.2 Parking spaces per staff	0,6
KPI.3 Investments in research facilities as percentage of annual operating expenses	1%
KPI.4 UFA/GFA	88%
KPI.5 Share of inner-city sites from portfolio	50%
KPI.6 Annual expenses per student	€17.740
KPI.7 Annual expenses per students and staff	€15.299
KPI.8 Investment in research facilities per student	€175
KPI.9 m² GFA per student	13,9
KPI.10 m² UFA per student	12,2
KPI.11 m² UFA per students and staff	10,5
KPI.12 Annual expenses per m² UFA	€1.451

Table 4.3. AAU Campus management information.
Information collected: 29 data variables on four perspectives (D.1-29); Information derived: 12 campus-related KPIs.
Period data collection 2015-2017. Period data access: fall 2017.

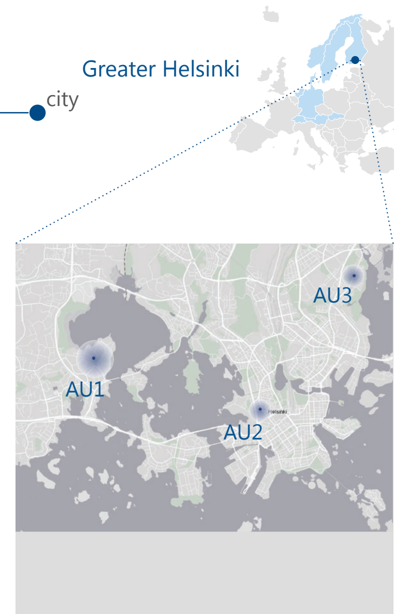
AAU Campus Management structure: Internal centralised

- AAU Shared services
  - Campus director(s)
    - Campus services*
      - Administration & Planning
      - Construction & Operation
      - Facility Service

*The structure of the campus services differs per each AUU site. The one indicated here corresponds to the site in Aalborg (AUU1-2). The campus services in Esbjerg (AAU3) and Copenhagen (AAU4) have more divisions.

AU Aalto University

1849	Leader	Finland	Greater Helsinki
founded	innovation region	country	city

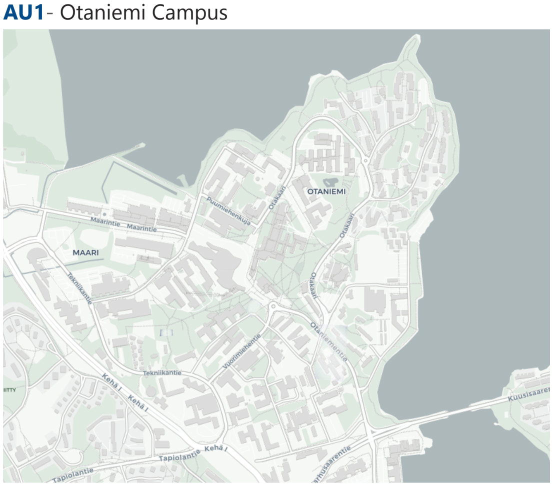


University profile

Aalto University (AU) was established as a priority project in the Finnish university renewal consisting of the merging between the former Helsinki University of Technology (est. 1849), Helsinki School of Economics (est. 1911) and the University of Art and Design (est. 1871). The idea of the merger dates back to 2005 to create an innovative university leading in science and technology, design and art , and business and economics. AU consists of six schools (Arts, Design and Architecture; Science; Chemical Engineering; Electrical Engineering; Business; and Engineering). AU is a foundation based university, which capital is formed by donations including the Finnish government and industries as wells as other financiers.

The core of the AU is Otaniemi (AU1); a campus over 50 years old planned by well-known architect Alvar Aalto and which contains buildings designed by him and other remarkable Finnish architects including Reima and Raili Pietilä and Heikki and Kaija Sirén. Besides, the university campus entails two more sites (Töölö - AU2 and Arabia - AU3) in the Greater Helsinki metropolitan area. By 2021 all AU core activities are expected to be located in Espoo's Otaniemi campus, which supports the AU vision for building an innovative society.

AU1- Otaniemi Campus



AU3- Arabia Campus

AU 2016-2017 world rank (Engineering rank)

190 (not listed)	133 (155)	401-500 (151-200)
THE	QS	ARWU

Notes:
- Texts about university profile, university governance and campus management structure are based on descriptions available at AU website
- Campus management data provided by AU unless indicated
- Photo: Aalto University (retrieved from AU material bank)
- Basemaps retrieved from open data sources
- More information about AU: www.aalto.fi

AU Governance: Dual asymmetric structure
- Aalto Unversity Board (7 external members)
- Academic Affairs Committee (19 members)
- Professors' council (4 members)
- Management team (18 members)

Organisational[1]

D.1 University vision: • Enabler of an innovative society with breakthrough discoveries • Research excellence for academic and societal impact • Renewing society by art, creativity and design • Educating game changers • Excellence
D.2 Campus vision: 1. Stimulating collaboration - Stimulating innovation 2. Supporting image (attractiveness) 3. Supporting user activities (supporting the production of new knowledge)

Financial

D.3 Annual operating revenues	€ 358,0 Million
D.4 Percentage public funding	89%
D.5 Percentage private funding	11%
D.6 Annual operating expenses	€ 358,0 Million
D.7 Investments in research facilities	not available

Functional

D.8 Students (headcount)[2]	17.345
D.9 BSc students	44%
D.10 MSc students	40%
D.11 Diploma students	not applicable
D.12 Doctoral students	16%
D.13 Staff (FTE)	3.989
D.14 Academic staff	69,2%
D.15 Supporting staff	30,8%
D.16 Housing units on campus[3]	0
D.17 Firms on campus[4]	70
D.18 Incubators/accelerators on campus	2
D.19 External research institutes on campus	1
D.20 Specialised labs on campus[5]	580
D.21 Shared learning facilities on campus[6]	not available
D.22 Parking spaces on campus[7]	c.1.200

Physical

D.23 Campus locations	3
D.24 Inner-city sites	3
D.25 Sub-urban sites	0
D.26 Campus built area[8]	386.762 m² GFA
D.27 Percentage owned	86%
D.28 Percentage leased	14%
D.29 Campus floor area[9]	303.304 m² UFA

Notes:
1. Available at www.aalto.fi/en/about/strategy/
2. AU provided this metric also in FTE (12.113)
3. AU does not own housing units. Students associations and private companies own c. 1900 and c.240 units next to the campus.
4. Includes tenants and subtenants firms
5. Individual rooms designated for laboratory use, including laboratories for education, but excluding all auxiliary/supportive laboratory rooms (88 rooms)
6. All premises are more or less open to shared use. This is gradually being made visible by the application Aalto Space
7. Currently, 739 parking spaces are in use for customers.
8. This consists of the gross floor area of AU buildings, plus only the net area of the leased-to-university areas
9. This number includes the tenants of the university and empty space.

Key performance indicators (KPIs)

KPI.1 Students per academic staff	6,3
KPI.2 Parking spaces per staff	0,3
KPI.3 Investments in research facilities as percentage of annual operating expenses	not available
KPI.4 UFA/GFA	78%
KPI.5 Share of inner-city sites from portfolio	100%
KPI.6 Annual expenses per student	€20.640
KPI.7 Annual expenses per students and staff	€16.781
KPI.8 Investment in research facilities per student	not available
KPI.9 m² GFA per student	22,3
KPI.10 m² UFA per student	17,5
KPI.11 m² UFA per students and staff	14,2
KPI.12 Annual expenses per m² UFA	€1.180

Table 4.4. AU Campus management information.
Information collected: 29 data variables on four perspectives (D.1-29); Information derived: 12 campus-related KPIs.
Period data collection 2016-2017. Period data access: fall 2017.

AU Campus Management structure: External centralised
- Campus development (Vice-president)
- Aalto University Properties Ltd
  - Aalto University Campus & Real Estate (ACRE)
    - Leasing
    - Property and Campus services
    - Construction Development
    - Workplaces and Sustainability
    - Administration and Finance
    - Management

DTU

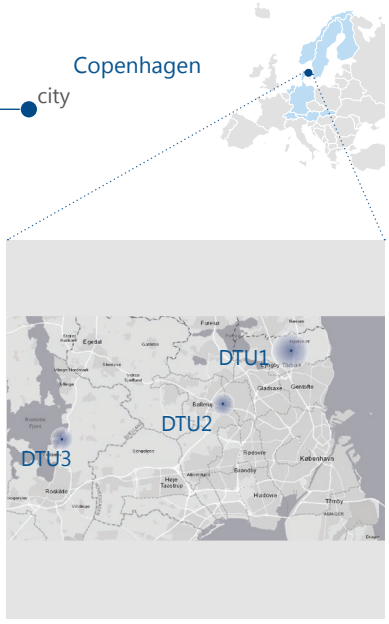
Technical University Denmark

1829 founded

Strong innovation region

Denmark country

Copenhagen city



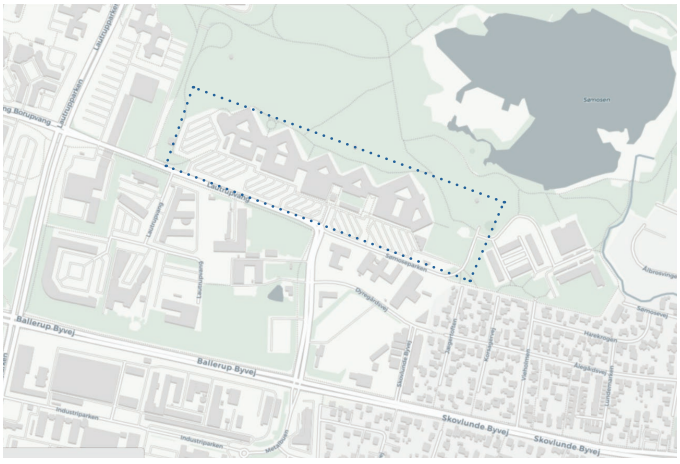
University profile

Founded in 1829 with the mission of creating value for the benefit of society, Technical University of Denmark (DTU) is at the academic and multidisciplinary forefront of the technical and the natural sciences—with new initiatives in a number of demanding engineering disciplines, including sustainable energy technology and life science. In addition to the 24 departments across 17 research areas, DTU's has also a number of research groups and cross-disciplinary centres dedicated to research or scientific advice within specific subject areas.

DTU's main campus is in Lyngby (DTU1), located 15 km north of Copenhagen. Besides, there is Ballerup (DTU2) and Risø (DTU3) located 10 km and 40 km west of Copenhagen respectively. Some DTU departments have addresses outside the main campus areas as well as some DTU's research and test facilities that are spread throughout the country. 'Transforming DTU' is a comprehensive campus development programme aimed at supporting DTU's role as a world-class technical university within research, learning, study and innovation environments.

DTU1- Lyngby Campus

DTU2- Ballerup Campus



DTU 2016-2017 world rank (Engineering rank)

153 (53) THE

109 (43) QS

151-200 (33) ARWU

Notes:

- Texts about university profile, university governance and campus management structure are based on descriptions available at DTU website
- Campus management data provided by DTU unless indicated
- Photo: DTU by Vibeke Hempler
- Basemaps retrieved from open data sources
- More information about DTU: www.dtu.dk

DTU Governance: Unitary structure

- DTU Board of Governors (Decision making)
  6 external members and 4 DTU members
  - DTU Executive Board (Management)
    1 president, 2 executive vice-presidents, 4 senior vice-presidents

Organisational[1]

D.1 University vision:
- Continuing to interact closely with society at both national and international levels so as to generate value.
- Acting as a driving force for welfare and sustainable value creation in the Danish society and internationally
- Sustaining its recognition as an elite technical university

D.2 Campus vision:
1. Support users' activities (education, research, science and innovation)
2. Supporting image (attractive competitive facilities/infrastructure)
3. Stimulating innovation (world-class research facilities)

Functional

D.8 Students (headcount)	11.031
D.9 BSc students	65%
D.10 MSc students	35%
D.11 Diploma students	not applicable
D.12 Doctoral students[4]	not applicable
D.13 Staff (FTE)	5.895,0
D.14 Academic staff	82,1%
D.15 Supporting staff	17,9%
D.16 Housing units on campus	not available
D.17 Firms on campus	not available
D.18 Incubators/accelerators on campus	not available
D.19 External research institutes on campus	not available
D.20 Specialised labs on campus[5]	not available
D.21 Shared learning facilities on campus	not available
D.22 Parking spaces on campus	not available

Financial[2]

D.3 Annual operating revenues	€ 671,2 Million
D.4 Percentage public funding	54%
D.5 Percentage private funding	35%
D.6 Annual operating expenses	€ 654,1 Million
D.7 Investments in research facilities[3]	not available

Physical

D.23 Campus locations	3
D.24 Inner-city sites	2
D.25 Sub-urban sites	1
D.26 Campus built area	689.098 m² GFA
D.27 Percentage owned	75%
D.28 Percentage leased	25%
D.29 Campus floor area	616.512 m² UFA

Notes:
1. Available at www.dtu.dk/english/about/organization/strategy
2. Data from 2016 provided in Danish Krone (DKK) and converted to Euro using price tables from December 31, 2016 at www.xe.com.
3. In 2018 DTU is investing more than DKK 4 billion in a comprehensive transformation of the university's buildings and infrastructure. Source: www.dtu.dk/english/about/campuses/transforming-our-campus
4. According to data from Universities Denmark - DKUNI, PhDs are not count as students.
5. DTU has a number of unique research facilities and contributes to several joint European facilities. A small selection of 12 specialised labs can be found at www.dtu.dk/english/research/research-facilities.

Key performance indicators (KPIs)

KPI.1 Students per academic staff	2,3
KPI.2 Parking spaces per staff	not available
KPI.3 Investments in research facilities as percentage of annual operating expenses	not available
KPI.4 UFA/GFA	89%
KPI.5 Share of inner-city sites from portfolio	67%
KPI.6 Annual expenses per student	€59.303
KPI.7 Annual expenses per students and staff	€38.649
KPI.8 Investment in research facilities per student	not available
KPI.9 m² GFA per student	62,5
KPI.10 m² UFA per student	55,9
KPI.11 m² UFA per students and staff	36,4
KPI.12 Annual expenses per m² UFA	€1.061

Table 4.5. DTU Campus management information.
Information collected: 29 data variables on four perspectives (D.1-29); Information derived: 12 campus-related KPIs.
Period data collection 2016. Period data access: 2017.

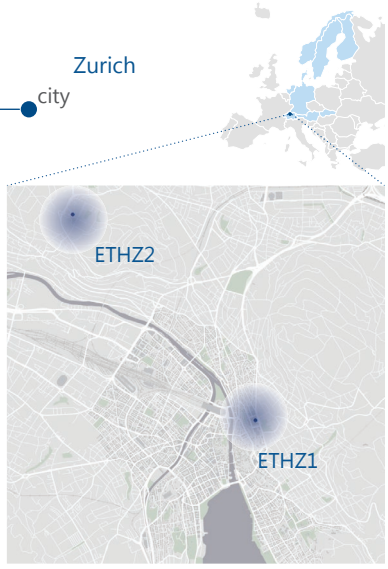
DTU Campus Management structure: Internal centralised

- Executive board
  - Campus services*
    - Operation
    - Development
    - Maintenance

*Campus Service supervises all locations and has permanent staffing in six of DTU's locations: Lyngby, Risø, Mørkhøj (Søborg), Frederiksberg, Ballerup, and Lindholm Island.

ETH Zürich

1855	Leader	Switzerland	Zurich
founded	innovation region	country	city

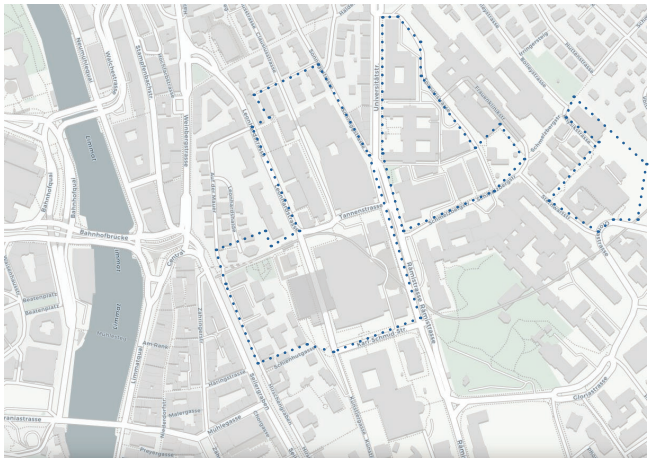


University profile

ETH Zurich is a Swiss university for science and technology founded in 1855 as a centre of innovation and knowledge. ETH Zurich regards itself as an institution with regional and national roots that is fully integrated in the international academic community. It measures itself in all respects against the world's leading universities – from its education and research to its management. With its 16 departments -each composed of institutes or laboratories, professorships and department-specific bodies- ETH Zurich covers a broad academic spectrum. In addition, ETH Zurich concentrates on several main focus areas in response to societal needs – be that at a local, national or global level (i.e. Medicine, data, sustainability, manufacturing technologies and critical thinking initiative).

ETH Zurich operates in two main locations in the Zurich area: Zentrum (ETHZ1) and Hönggerberg (ETHZ2), as well as other locations for specific collaborative activities with partners focusing on specific fields. Currently, ETH Zurich is concentrating its spatial and structural development in the Zurich area on its two main locations, which are home to a wide range of teaching and research offerings and services. They each offer a centralised space for 9 departments in Zentrum and 7 in Hönggerberg.

ETHZ1- ETH Zurich Zentrum



ETHZ2- ETH Zurich Hönggerberg Campus

ETH Zurich 2016-2017 world rank (Engineering rank)

10 (9)	8 (5)	19 (27)
THE	QS	ARWU

Notes:

- Texts about university profile, university governance and campus management structure are based on descriptions available at ETH Zurich's website
- Campus management data retrieved from links provided by ETH Zurich
- Photo retrieved from open source with permission to reuse
- Basemaps retrieved from open data sources
- More information about ETH Zurich: www.ethz.ch

ETH Zurich Governance: Dual asymmetric structure

- Executive Board (5 main internal members)
  - 4 Vice-rectors and 4 delegates
- Ombudspersons (2 advisory members)
- Trusted intermediaries (2 advisory members)

Organisational[1]

D.1 University vision:
- Training highly qualified professionals by imparting knowledge and practical skills and ethical and cultural values in education.
- Responding to changing conditions, identifying new problems and assuming a leading role in seeking solutions to societal challenges.
- Internationalisation, collaboration and attractiveness.

D.2 Campus vision:
1. Stimulating quality of place
2. Stimulating innovation
3. Increasing flexibility and controlling risks (future growth)

Functional

D.8 Students (headcount)	19.815
D.9 BSc students	45,1%
D.10 MSc students	29,5%
D.11 Other students[4]	5,2%
D.12 Doctoral students	20,2%
D.13 Staff (FTE)	9.100
D.14 Academic staff	71%
D.15 Supporting staff	29%
D.16 Housing units on campus[5]	889
D.17 Firms on campus[6]	6
D.18 Incubators/accelerators on campus[7]	2
D.19 External research institutes on campus	not available
D.20 Specialised labs on campus[8]	7
D.21 Shared learning facilities on campus[9]	168
D.22 Parking spaces on campus	not available

Financial[2]

D.3 Annual operating revenues	€ 1.583,0 Million
D.4 Percentage public funding	73%
D.5 Percentage private funding	27%
D.6 Annual operating expenses	€ 1.529,0 Million
D.7 Investments in research facilities[3]	€ 110,8 Million

Physical

D.23 Campus locations	2
D.24 Inner-city sites	1
D.25 Sub-urban sites	1
D.26 Campus built area	not available
D.27 Percentage owned	not available
D.28 Percentage leased	not available
D.29 Campus floor area	462.600 m² UFA

Notes:
1. Available at www.ethz.ch/en/the-eth-zurich/portrait/Strategy.html
2. Data from 2016 available in Swiss Franc (CHF) and converted to Euro using price tables from December 31, 2016 at www.xe.com.
3. Accounts for investments in all ETH facilities and infrastructure. In 2017, ETH Zurich invested about 60 Mio CHF in research equipment excluding service contracts (i.e. about 8 Mio CHF annually)
4. It distinguishes MAS/MBA student and visiting/exchange students.
5. Accounts for units at Hönggerberg. Over 3000 private rooms are available throughout Zurich and Winterthur. The majority are conveniently located near one of the university campuses.
6. Accounts for 6 spin-offs accommodated at main incubator (ieLab)
7. The Innovation & Entrepreneurship Lab - ieLab has locations in the two campuses. ETH Zurich uses the Technopark Zurich as a platform for knowledge and technology transfer.
8. Accessed at www.ethz.ch/en/research/research-infrastructure.html
9. These are centrally bookable teaching facilities (about 30.000m²). Besides, there are another 7.500m² of decentralised facilities. These numbers exclude the libraries and open study areas.

Key performance indicators (KPIs)

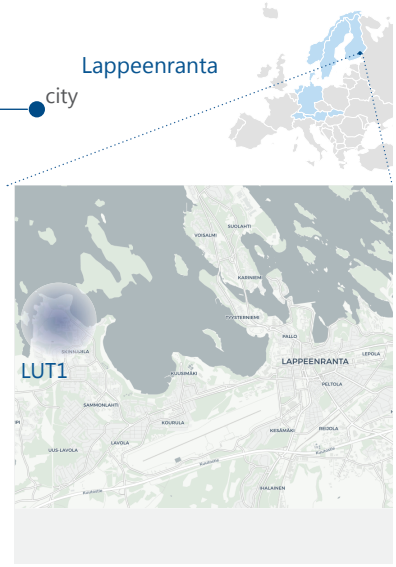
KPI.1 Students per academic staff	3,1
KPI.2 Parking spaces per staff	not available
KPI.3 Investments in research facilities as percentage of annual operating expenses	7%
KPI.4 UFA/GFA	not available
KPI.5 Share of inner-city sites from portfolio	50%
KPI.6 Annual expenses per student	€77.164
KPI.7 Annual expenses per students and staff	€52.879
KPI.8 Investment in research facilities[3] per student	€5.592
KPI.9 m² GFA per student	not available
KPI.10 m² UFA per student	23,3
KPI.11 m² UFA per students and staff	16
KPI.12 Annual expenses per m² UFA	€3.305

Table 4.6. ETH Zurich Campus management information.
Information collected: 29 data variables on four perspectives (D.1-29); Information derived: 12 campus-related KPIs.
Period data collection 2015-2017. Period data access: Dec 2017; Jul 2018.

Campus Management structure: Int./Dec.
- Vice President for HR and Infrastructure
  - Real Estate Management
    - Portfolio Management
    - Federal Construction Projects
    - Asset Management
      - Zentrum
      - Hönggerberg
      - External sites
    - Finance/Controlling
    - Business Development & Support
  - Facility Management
    - Management
    - Facility Management
      - Zentrum
      - Hönggerberg
      - External sites
    - Business Support
    - Systems and Technical Support
    - Consulting Facility Management

Lappeenranta University of Technology

1969 founded | Leader innovation region | Finland country | Lappeenranta city

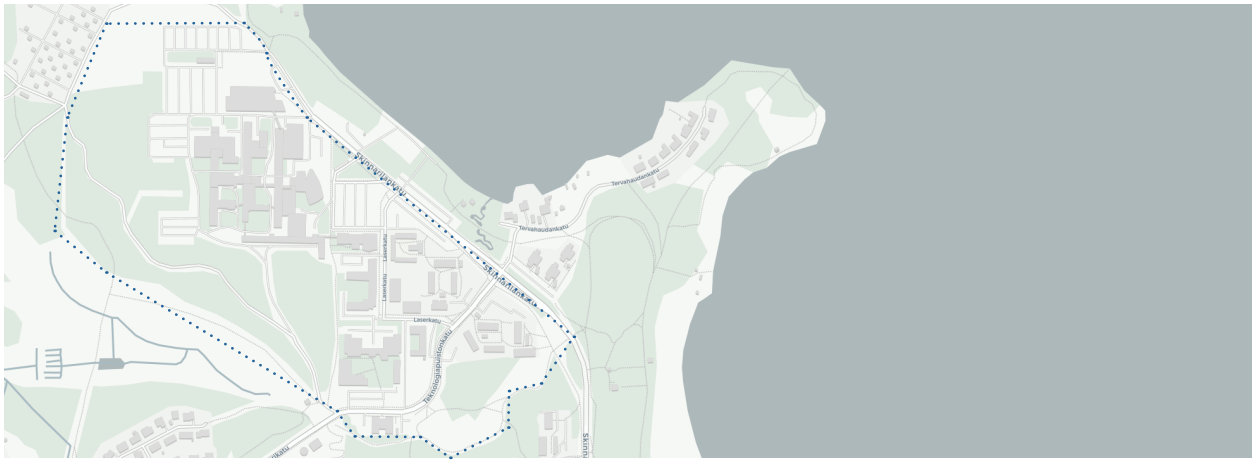


University profile

Lappeenranta University of Technology (LUT) is a pioneering science university in Finland, bringing together the fields of science and business since 1969. Clean energy and water, circular economy and sustainable business are the key questions of humankind to which LUT seeks solutions through technology and business. LUT has several research platforms and three schools (Energy systems, Engineering Science and Business and Management). LUT is the first Finnish entrepreneurial university which meets OECD and the European Commission criteria.

LTU expertise in energy is reflected in LUT's Green Campus located in Skinnarila, Lappeenranta (LUT1). LUT' s Green Campus is a unique research and educational environment, where the university's expertise in energy as well as its own innovations are put to practical use. This allows LUT to set an example on how science and technology can be used to solve environmental problems. LTU campus and its environs offer a wide range of services from student restaurants to health care and sports. The campus is also home to a number of micro businesses. LTU campus is currently undergoing renovation. Scheduled for completion in winter 2019, the students and the faculty will have improved and more versatile facilities for more productive learning and research.

LUT1- LUT Campus



LUT 2016-2017 world rank (Physical sciences rank)

501-600 (401-500) THE | 471-480 (not listed) QS | Not listed (not listed) ARWU

Notes:

- Texts about university profile, university governance and campus management structure are based on descriptions available at LUT website
- Campus management data provided by Universty Properties of Finland Ltd unless indicated
- Photo © Teemu Leinonen, LUT and Ville Jahn, LUT.
- Basemaps retrieved from open data sources by OpenStreetMap®
- More information about LUT: www.lut.fi
- More information about LTU campus: www.sykoy.fi

LUT Governance: Dual asymmetric structure

- The University Board (5 external members and 4 LUT members)
- The University administration (4 presidents; 3 deans; 9 committee members)
- Advisory Board (12 external members)
- The University Collegium (Universities Act 21 §)

Organisational[1]

D.1 University vision: • Alternative path to energy solutions that favour renewable, waste-free world, and clean water for all. • Committed to sustainable and smart business models • Committed to the promotion of new green-collar entrepreneurship to boost growth in Europe
D.2 Campus vision: 1. Reducing footprint (environmental responsibility), 2. Stimulating collaboration (cross-disciplinary research), 3. Stimulating innovation

Functional

D.8 Students (headcount)	4.831
D.9 BSc students	50%
D.10 MSc students	41%
D.11 Diploma students	0%
D.12 Doctoral students	9%
D.13 Staff (FTE)	851
D.14 Academic staff	61%
D.15 Supporting staff	39%
D.16 Housing units on campus[2]	not available
D.17 Firms on campus	c. 100
D.18 Incubators/accelerators on campus	1
D.19 External research institutes on campus	1
D.20 Specialised labs on campus	79
D.21 Shared learning facilities on campus	20
D.22 Parking spaces on campus	1.200

Financial

D.3 Annual operating revenues	€ 76,0 Million
D.4 Percentage public funding	61%
D.5 Percentage private funding	39%
D.6 Annual operating expenses	€ 74,7 Million
D.7 Investments in research facilities	€ 3,0 Million

Physical

D.23 Campus locations[3]	1
D.24 Inner-city sites	0
D.25 Sub-urban sites	1
D.26 Campus built area	70.350 m² GFA
D.27 Percentage owned	0%
D.28 Percentage leased	100%
D.29 Campus floor area	42.031 m² UFA

Notes:
1. Available at www.lut.fi and www.sykoy.fi
2. Students housing is managed by a separate foundation. More info at www.loas.fi/en
3. Besides the main campus, LUT operates in other small regional units, which are not count as campuses: Lahti, Savo and Kouvola. More info: www.lut.fi/web/en/lut-lahti

Key performance indicators (KPIs)

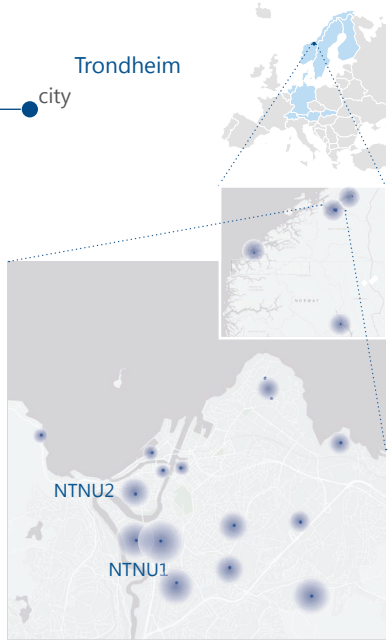
KPI.1 Students per academic staff	9,4	KPI.7 Annual expenses per students and staff	€13.147
KPI.2 Parking spaces per staff	1,4	KPI.8 Investment in research facilities per student	€621
KPI.3 Investments in research facilities as percentage of annual operating expenses	4%	KPI.9 m² GFA per student	14,6
KPI.4 UFA/GFA	60%	KPI.10 m² UFA per student	8,7
KPI.5 Share of inner-city sites from portfolio	0%	KPI.11 m² UFA per students and staff	7,4
KPI.6 Annual expenses per student	€15.463	KPI.12 Annual expenses per m² UFA	€1.777

Table 4.7. LUT Campus management information.
Information collected: 29 data variables on four perspectives (D.1-29); Information derived: 12 campus-related KPIs.
Period data collection 2016-2017. Period data access: 2017.

LUT Campus Management structure: External centralised
- University Properties of Finland Ltd -SYK (Campus ownership and development)
  - Campus development
  - Property development and maintenance
  - Customer Relations and Services
  - Research, development and innovation
- LTU Service units
  - Facility Services
    - Property director
    - Property manager

Norwegian University of Science and Technology

1910	Leader	Norway	Trondheim
founded	innovation region	country	city

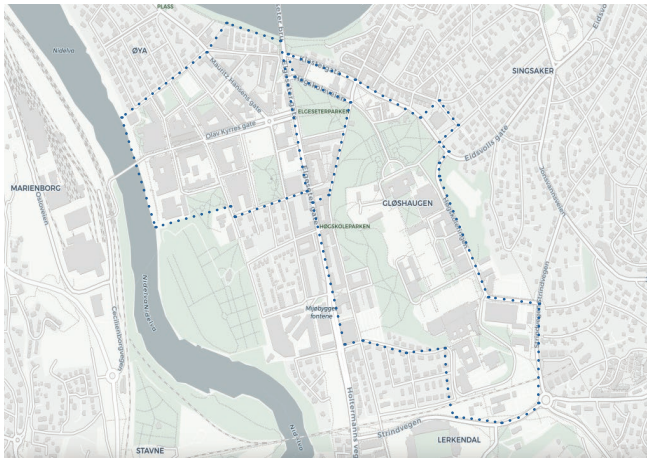


University profile

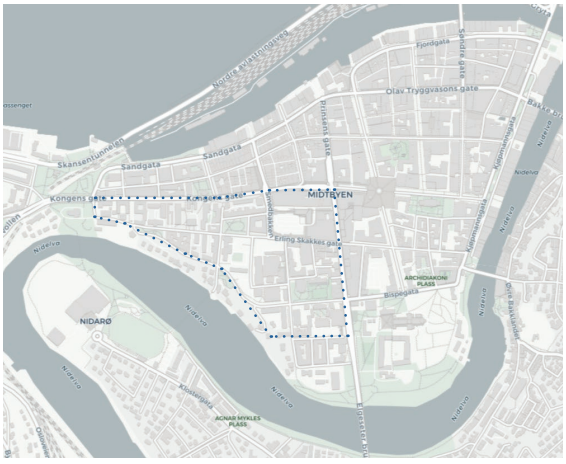
The Norwegian University of Science and Technology (NTNU) is the largest university in Norway today, with a history dating back to 1910 and a tradition going back to 1767 and the Royal Norwegian Society of Sciences and Letters (DKNVS). NTNU has the main responsibility for higher education in technology in Norway, and is the country's premier institution for the education of engineers. NTNU is a university with an international focus with eight faculties in addition to units such as the NTNU University Museum and the NTNU University Library.

NTNU has headquarters in Trondheim (incl. NTNU 1-2) and campuses in Ålesund and Gjøvik. NTNU has a main profile in science and technology, a variety of programmes of professional study, and great academic breadth that also includes the humanities, social sciences, economics, medicine, health sciences, educational science, architecture, entrepreneurship, art disciplines and artistic activities. NTNU has four strategic areas of research in 2014–2023: sustainability, energy, oceans, and health. NTNU's social mission is to create knowledge for a better world and deliver solutions that can change and improve everyday life.

NTNU1- Øya and Gløshaugen



NTNU2- Kalvskinnet



NTNU 2016-2017 world rank (Engineering rank)

251-300 (not listed)	259 (145)	101-150 (151-200)
THE	QS	ARWU

Notes:
- Texts about university profile, university governance and campus management structure are based on descriptions available at NTNU website
- Campus management data provided by NTNU unless indicated
- Photo: Gunnar K. Hansen, NTNU Komm.avd.
- Basemaps retrieved from open data sources
- More information about NTNU: www.ntnu.edu

NTNU Governance: Unitary structure
- The Board of NTNU (Decision making)
  4 external members and 7 NTNU members
  - Executive board (Management)
    1 rector, 3 pro-rectors, 2 directors and 2 vice-rectors

Organisational

D.1 University vision:
- Develop knowledge for a better world in a creative, critical, constructive and respectful way.
- Promote internationalisation, interdisciplinary collaboration
- Improve campus community's career and skills, working environment and students' welfare.

D.2 Campus vision:
1. Improving quality of place and image (A unifying/urban, network of hubs, talent attraction)
2. Stimulating innovation (Effective Living laboratory)
3. Reducing footprint (Sustainable campus)

Functional

D.8 Students (headcount)	40.180
D.9 BSc students	46%
D.10 MSc students	46%
D.11 Diploma students[2]	1%
D.12 Doctoral students	7%
D.13 Staff (FTE)	7.135
D.14 Academic staff	65%
D.15 Supporting staff	35%
D.16 Housing units on campus	not available
D.17 Firms on campus	34
D.18 Incubators/accelerators on campus	3
D.19 External research institutes on campus	4
D.20 Specialised labs on campus	984
D.21 Shared learning facilities on campus	743
D.22 Parking spaces on campus	3.778

Financial[1]

D.3 Annual operating revenues	€ 902,2 Million
D.4 Percentage public funding	73%
D.5 Percentage private funding	3%
D.6 Annual operating expenses	€ 929,2 Million
D.7 Investments in research facilities	€ 17,5 Million

Physical

D.23 Campus locations	12
D.24 Inner-city sites	5
D.25 Sub-urban sites	7
D.26 Campus built area	720.717 m² GFA
D.27 Percentage owned	63%
D.28 Percentage leased	37%
D.29 Campus floor area[3]	383.268 m² UFA

Notes:
1. Financial data from 2016 provided in Norwegian krone and converted to Euro using price tables from December 31, 2016 at www.xe.com.
2. About one quarter of master studies are reserved for diploma dissertation. The number of diploma thesis in 2016 was 3.330.
3. This number does not include technical rooms, shelters, corridors/ common traffic areas. This last item represents 188.816 m².

Key performance indicators (KPIs)

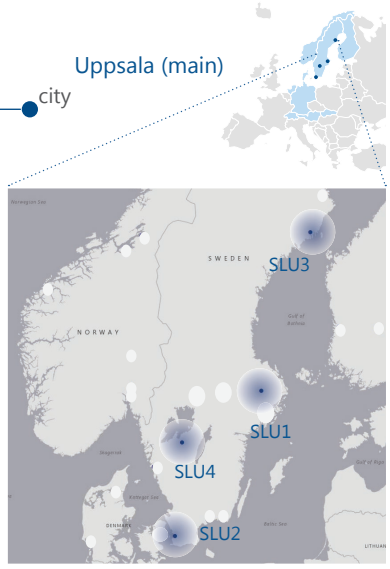
KPI.1 Students per academic staff	8,7
KPI.2 Parking spaces per staff	0,5
KPI.3 Investments in research facilities as percentage of annual operating expenses	2%
KPI.4 UFA/GFA	53%
KPI.5 Share of inner-city sites from portfolio	42%
KPI.6 Annual expenses per student	€23.126
KPI.7 Annual expenses per students and staff	€19.639
KPI.8 Investment in research facilities per student	€437
KPI.9 m² GFA per student	17,9
KPI.10 m² UFA per student	9,5
KPI.11 m² UFA per students and staff	8,1
KPI.12 Annual expenses per m² UFA	€2.424

Table 4.8. NTNU Campus management information.
Information collected: 29 data variables on four perspectives (D.1-29); Information derived: 12 campus-related KPIs.
Period data collection 2016-2017. Period data access: January 2018.

NTNU Campus Management structure: Internal decentralised
- Director of Finances and Property
  - Property Division
  - Campus services Division
    - Building Management Section
    - Technical Management Section
    - Section for Project Implementation
    - Property Service Centre
    - Campus Services Division Staff

SLU — Swedish University of Agricultural Sciences

1977 (founded) · Strong/Leader innovation region · Sweden (country) · Uppsala (main) (city)



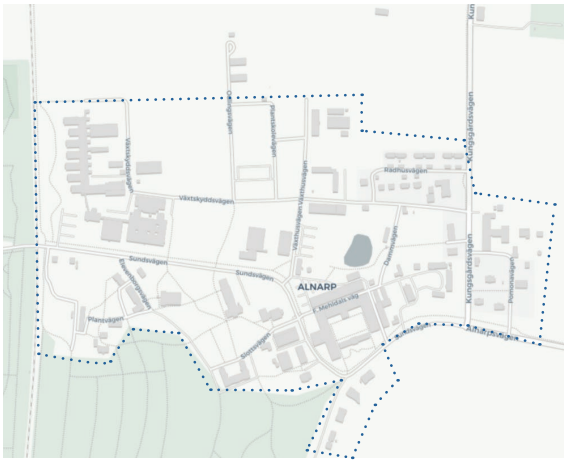
University profile

The Swedish University of Agricultural Sciences (SLU) is a is a world-class university in the fields of life and environmental sciences. It was founded in 1977 out of the agricultural, forestry and veterinary university colleges, the Veterinary School (est. 1775) at Skara and the Forestry School (est. 1813) at Skinnskatteberg. SLU has 34 departments and units organised in four faculties (Forest Sciences; Landscape Architecture, Horticulture and Crop Production Science; Natural resources and Agricultural Sciences; and Veterinary Medicine and Animal Science). SLU has a unique role among Swedish universities through its commission to perform environmental monitoring and assessment. This is based on society's needs, as expressed in national environmental targets, international commitments and the overall objective of long-term sustainable development.

SLU is mainly located at Uppsala (SLU1), Alnarp (SLU2), Umea (SLU3) and Skara (SLU4). Research activities and environmental monitoring and assessment are carried out throughout the country. SLU´s main campus is Ultuna (SLU1), six kilometres south of Uppsala. Many of SLU's degree programmes are given here. Sweden's only University Animal Hospital is situated at SLU Uppsala, where newest research is combined with practice.

SLU1- Uppsala campus

SLU3- Alnarp campus



SLU 2016-2017 world rank (Life Sciences rank)

251-300 (101-125) THE · Not listed (325) QS · 201-300 (101-150) ARWU

Notes:

- Texts about university profile, university governance and campus management structure are based on descriptions available at SLU website
- Campus management data provided by SLU unless indicated
- Photo: Mark Harris, SLU Media Bank
- Basemaps retrieved from open data sources
- More information about SLU: www.slu.se

SLU Governance: Unitary structure

- The University Board (reports to Ministry of Enterprise and Innovation)
  - 9 external members; 13 SLU members
  - University Management (5 vice-chancellors; 2 heads of administration)
  - Internal Auditing (3 officers)

Organisational[1]

D.1 University vision:
- Sustaining its profile as a world-class university in the fields of life and environmental sciences
- Putting science to the test and solving real problems for a thriving world
- Ensuring an attractive and stimulating workplace for our current and future employees

D.2 Campus vision:
1. Improve quality of place (attractive workplace for staff)
2. Stimulating innovation (access to excellent research infrastructure)
3. Stimulating collaboration and culture (increase commitment to SLU)

Financial[2]

D.3 Annual operating revenues	€ 350,7 Million
D.4 Percentage public funding	92%
D.5 Percentage private funding	8%
D.6 Annual operating expenses	€ 339,8 Million
D.7 Investments in research facilities	€ 150,8 Million

Functional

D.8 Students (headcount)	6.562
D.9 BSc students	55%
D.10 MSc students	36%
D.11 Diploma students	0%
D.12 Doctoral students	9%
D.13 Staff (FTE)	2.774
D.14 Academic staff	52%
D.15 Supporting staff	48%
D.16 Housing units on campus	78
D.17 Firms on campus	40
D.18 Incubators/accelerators on campus	1
D.19 External research institutes on campus	1
D.20 Specialised labs on campus[3]	1.284
D.21 Shared learning facilities on campus[4]	93
D.22 Parking spaces on campus	not available

Physical[5]

D.23 Campus locations	32
D.24 Inner-city sites	4
D.25 Sub-urban sites	28
D.26 Campus built area	446.605 m² GFA
D.27 Percentage owned	35%
D.28 Percentage leased	65%
D.29 Campus floor area	257.939 m² UFA

Notes:
1. SLU vision and strategy available at www.slu.se
2. Financial data from 2016 provided in Swedish Krona and converted to Euro using price tables from December 31, 2016 at www.xe.com.
3. This number is the total amount of all facilities stated as laboratories in all campus locations. It also includes laboratories at the university animal hospital.
4. This numbers accounts for the total number of lecture rooms.
5. Includes all campus locations and spaces including facilities for the university animal hospital and stables for animals.

Key performance indicators (KPIs)

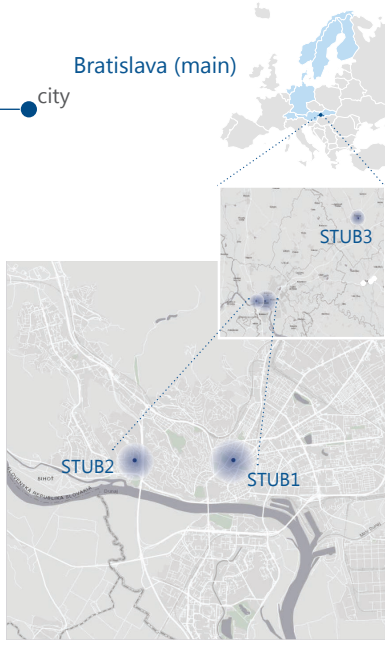
KPI.1 Students per academic staff	4,6	KPI.7 Annual expenses per students and staff	€36.398
KPI.2 Parking spaces per staff		KPI.8 Investment in research facilities per student	€22.989
KPI.3 Investments in research facilities as percentage of annual operating expenses	44%	KPI.9 m² GFA per student	68,1
KPI.4 UFA/GFA	58%	KPI.10 m² UFA per student	39,3
KPI.5 Share of inner-city sites from portfolio	13%	KPI.11 m² UFA per students and staff	27,6
KPI.6 Annual expenses per student	€51.784	KPI.12 Annual expenses per m² UFA	€1.317

Table 4.9. SLU Campus management information.
Information collected: 29 data variables on four perspectives (D.1-29); Information derived: 12 campus-related KPIs.
Period data collection 2016-2017. Period data access: June - September 2017.

SLU Campus Management structure: Internal decentralised
- University administration
  - Division of Estate Management
    - Real Estate Management
    - Forestry and Agricultural Operations
  - Division of Facility Management (Infra)
    - Administrative Services Office
    - Economics and rental Management
    - Environment
    - Services
    - Security
    - Space Management

STUB Slovak University of Technology in Bratislava

1937 founded | Strong innovation region | Slovakia country | Bratislava (main) city

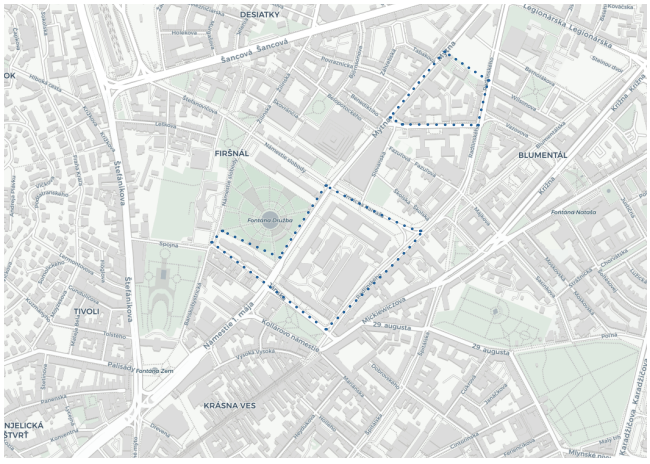


University profile

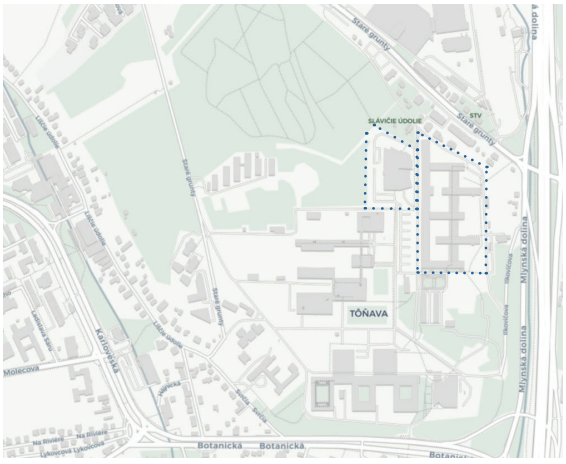
Slovak University of Technology in Bratislava (STUB) is a modern educational and scientific institution offering university education in engineering disciplines. Founded in 1937, STUB is regarded as the largest and most significant university of technology in the Slovak Republic. It consists of seven faculties based in Bratislava and Trnava (Civil Engineering; Mechanical Engineering; Electrical Engineering and Information Technology; Chemical and Food Technology; Architecture; Materials Science and Technology; and Informatics and Information Technologies). STUB education system is based on scientific research, as well as on artistic, engineering and other creative activities. STUB faculties, departments, institutes and experts cooperate directly with industrial companies and social organisations, actively taking part in international cooperation.

STUB main activities are clustered by faculties at two main locations in Bratislava's city centre (STUB1) and Bratislava's Ilkovicova 2 and 3 (STUB2). Besides, one faculty located in Trnava (STUB3) about 59 km northeast of Bratislava. STUB has dedicated workplace facilities such as the university Science Park, the Know-How Centre where STUB's incubator operates as well as other institutes and centres.

STUB1- Inner-city campus



STUB2- Ilkovicova 2-3



STUB 2016-2017 world rank (Engineering rank)

801-1000 (not listed) THE | Not listed (not listed) QS | Not listed (not listed) ARWU

Notes:

- Texts about university profile, university governance and campus management structure are based on descriptions available at STUB website
- Campus management data provided by STUB unless indicated
- Photo retrieved from open source with permission to reuse
- Basemaps retrieved from open data sources
- More information about STUB: www.stuba.sk

STUB Governance: Dual traditional structure

- Rectorate
- Rector's Advisory Board (17 members);
- Scientific Board (38 members) & Academic Senate (71 members)
- Administrative Board (15 members);

Organisational

D.1 University vision[1]:
- Strengthening international position as research-oriented university.
- Provide high-quality education in promising fields based on independent and critical thinking, entrepreneurship and creativity with practical application.
- Contribute to the socioeconomic development of the region.

D.2 Campus vision[2]:
1. Support users' activities (research and education)
2. Stimulating innovation (investment in labs)
3. Supporting image (attract internationally researchers)

Financial

D.3 Annual operating revenues	€ 102,69 Million
D.4 Percentage public funding	90%
D.5 Percentage private funding	10%
D.6 Annual operating expenses	€ 102,06 Million
D.7 Investments in research facilities	€ 8,95

Functional

D.8 Students (headcount)	14.286
D.9 BSc students	63%
D.10 MSc students	30%
D.11 Diploma students	not applicable
D.12 Doctoral students	7%
D.13 Staff (FTE)	2495,7
D.14 Academic staff	39,9%
D.15 Supporting staff	60,1%
D.16 Housing units on campus[3]	not available
D.17 Firms on campus	not available
D.18 Incubators/accelerators on campus	1
D.19 External research institutes on campus	0
D.20 Specialised labs on campus	141
D.21 Shared learning facilities on campus	8
D.22 Parking spaces on campus	not available

Physical

D.23 Campus locations	3
D.24 Inner-city sites	1
D.25 Sub-urban sites	2
D.26 Campus built area	not available
D.27 Percentage owned	not available
D.28 Percentage leased	not available
D.29 Campus floor area	not available

Notes:
1. Retrieved from STUB's mission available at www.stuba.sk
2. No explicit campus vision was found. The information deduced here is retrieved from an STUB document presenting research infrastructure and available online.
3. There are 5.900 places at student houses of the Slovak University of Technology in Bratislava.

Key performance indicators (KPIs)

KPI.1 Students per academic staff	14,4
KPI.2 Parking spaces per staff	not available
KPI.3 Investments in research facilities as percentage of annual operating expenses	9%
KPI.4 UFA/GFA	not available
KPI.5 Share of inner-city sites from portfolio	33%
KPI.6 Annual expenses per student	€7.144

KPI.7 Annual expenses per students and staff	€6.081
KPI.8 Investment in research facilities per student	€626
KPI.9 m^2 GFA per student	not available
KPI.10 m^2 UFA per student	not available
KPI.11 m^2 UFA per students and staff	not available
KPI.12 Annual expenses per m^2 UFA	not available

Table 4.10. STUB Campus management information.
Information collected: 29 data variables on four perspectives (D.1-29); Information derived: 12 campus-related KPIs.
Period data collection 2015-2016. Period data access: June - August 2017.

STUB Campus Management structure: Internal decentralised
- Bursar
  - University Workplaces
  - Special purposes facilities

Note: the information about campus management is structure is based on STUB organigram. The information availbe about campus at STUB website is limited.

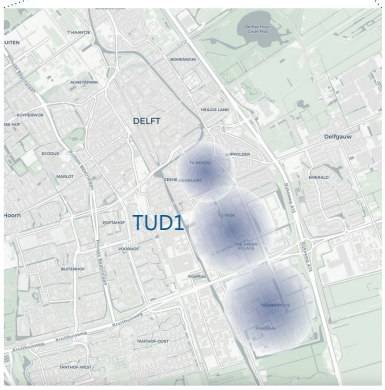
TUD Delft University of Technology

1842	Leader	The Netherlands	Delft
founded	innovation region	country	city

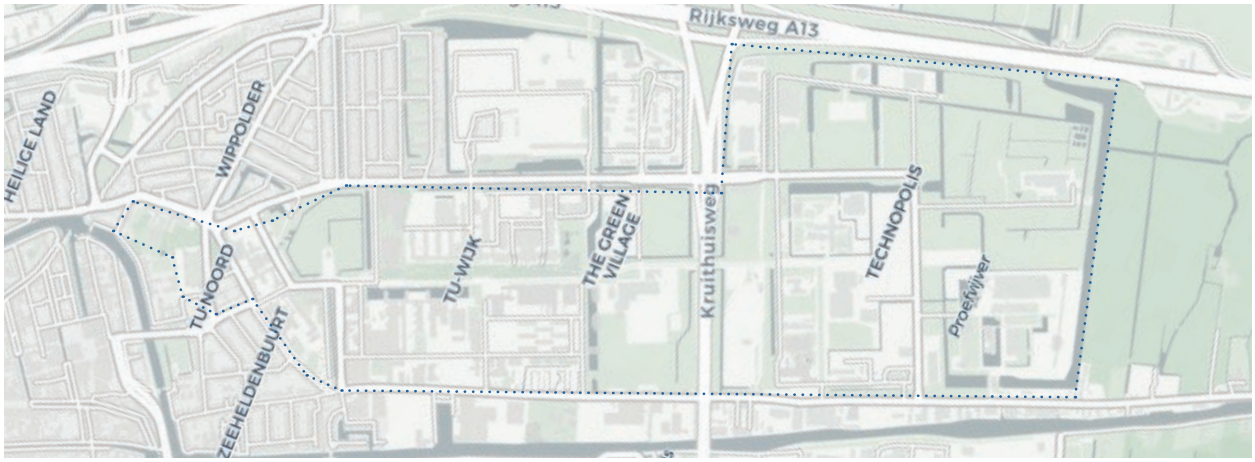
University profile

Delft University of Technology (TUD) was founded in 1842 as the 'Royal Academy' for the education of civilian engineers. Today TUD contributes to solving global challenges by educating new generations of socially responsible engineers and expanding the frontiers of the engineering sciences. 'Impact for a better society' is the motto that will guide TUD in the coming years according to its Strategic Framework 2018-2024. TUD's education and research covers a broad range of engineering disciplines throughout eight faculties (Aerospace Engineering; Applied Sciences; Architecture and the Built Environment; Civil Engineering and Geosciences; Electrical Engineering, Mathematics and Computer Science; Industrial Design Engineering; Mechanical, Maritime and Materials Engineering; and Technology, Policy and Management).

TUD activities are concentrated in one campus located in the southeast of Delft (TUD1 distinguishes three areas as to North, Central and South or Technopolis). TUD's campus vision have nine themes guiding the further development and layout of the campus (i.e. Accessibility; Sustainability; Living Campus; Education; Research; Public space; Pleasant working environment; Valorisation; and Safe and efficient campus).



TUD1- TU-District



TUD 2016-2017 world rank (Engineering rank)

63 (20)	62 (20)	151-200 (101-150)
THE	QS	ARWU

Notes:

- Texts about university profile, university governance and campus management structure are based on descriptions available at TUD website
- Campus management data provided by TUD unless indicated
- Photo retrieved from open source with permission to reuse
- Basemaps retrieved from open data sources
- More information about TUD: www.tudelft.nl

TUD Governance: Dual asymmetric structure

- Executive Board (3 members);
- Supervisory Board (5 external members in two terms)
- Works Council; Student Council; Board of Professors

Organisational

D.1 University vision:
- World's leader training engineers.
- Societal role as solution's provider towards sustainability and healthy economy.
- Open academic community internationally represented and rooted in its regional and national, social and economic environment.

D.2 Campus vision:
1. Support users activities (quality research and education)
2. Reducing footprint; increasing flexibility and controlling risks
3. Reducing costs

Functional

D.8 Students (headcount)	22.199
D.9 BSc students	54%
D.10 MSc students	46%
D.11 Other students	not applicable
D.12 Doctoral students	not applicable
D.13 Staff (FTE)	4.670,3
D.14 Academic staff	57,6%
D.15 Supporting staff	42,4%
D.16 Housing units on campus[3]	2.560
D.17 Firms on campus[4]	245
D.18 Incubators/accelerators on campus	4
D.19 External research institutes on campus	3
D.20 Specialised labs on campus[5]	697
D.21 Shared learning facilities on campus[6]	157
D.22 Parking spaces on campus	3.825

Financial

D.3 Annual operating revenues	€ 644,4 Million
D.4 Percentage public funding	59%
D.5 Percentage private funding[1]	41%
D.6 Annual operating expenses	€ 625,0 Million
D.7 Investments in research facilities[2]	€ 12,5 Million

Physical

D.23 Campus locations	1
D.24 Inner-city sites	1
D.25 Sub-urban sites	0
D.26 Campus built area	538.230 m² GFA
D.27 Percentage owned	97%
D.28 Percentage leased	3%
D.29 Campus floor area	438.488 m² UFA

Notes:
1. This number accounts for revenues from work with third parties, tuition fees and other income (TU Delft annual report 2016)
2. This number is based on a total costs of ownership calculation, which estimates the annual cost necessary for the research infrastructure on campus.
3. Although there are housing units on TUD campus they are not operated by TU Delft
4. From this number 150 are spin-offs and 50 start-ups.
5. This number accounts for 37.062 m² UFA
6. This number accounts for 21.100 m² UFA

Key performance indicators (KPIs)

KPI.1 Students per academic staff	8,2	KPI.7 Annual expenses per students and staff	€23.261
KPI.2 Parking spaces per staff	0,8	KPI.8 Investment in research facilities per student	€563
KPI.3 Investments in research facilities as percentage of annual operating expenses	2%	KPI.9 m² GFA per student	24,2
KPI.4 UFA/GFA	81%	KPI.10 m² UFA per student	19,8
KPI.5 Share of inner-city sites from portfolio	100%	KPI.11 m² UFA per students and staff	16,3
KPI.6 Annual expenses per student	€28.154	KPI.12 Annual expenses per m² UFA	€1.425

Table 4.12. TUD Campus management information.
Information collected: 29 data variables on four perspectives (D.1-29); Information derived: 12 campus-related KPIs.
Period data collection 2015-2018. Period data access: June 2017 - January 2018.

TUD Campus Management structure: Internal centralised
- The University Corporate Office
  - Campus and Real Estate (CRE)
    - Strategic Campus Management (SCM)
    - Campus Development (CD)
    - Science Park Development (SPD)
    - Projects (http://campusdevelopment.tudelft.nl/)
    - Maintenance and Management (M&M)
      - Services, Planning and Support

TUE

Eindhoven University of Technology

1956 founded

Leader innovation region

The Netherlands country

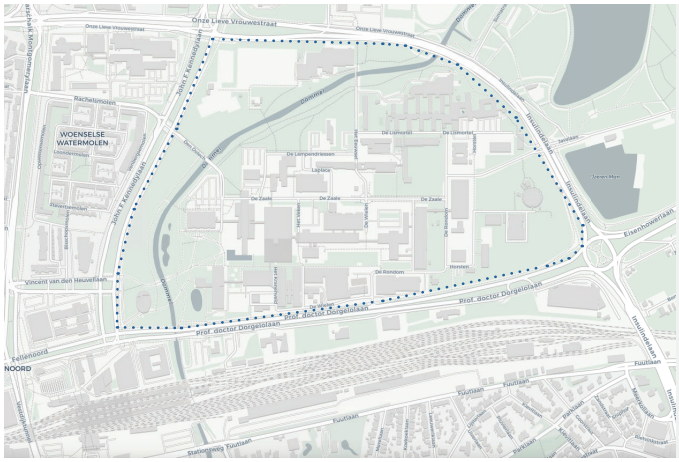
Eindhoven city

University profile

Eindhoven University of Technology (TUE) is a research university specialising in engineering science & technology, which comprises nine departments (Biomedical Engineering; Built Environment; Electrical Engineering; Industrial Design; Industrial Engineering & innovation Sciences; Chemical Engineering and Chemistry; Applied Physics; Mechanical Engineering; and Mathematics and Computer Sciences). TUD's impact on scientific and societal issues is measured by delivering excellent ground breaking research, often in close collaboration with industry, and by providing the education that turns TUE students into engineers for the future. TUE focuses on three strategic areas: energy, health and smart mobility.

TUE campus covers an area of 75 hectares situated in the heart of the high-tech Brainport region and equipped with high-quality lab facilities. The TUE Campus is not only a place of study and work, but also a home for hundreds of students and staff from different nationalities who are resident here, turning the campus into a lively and very dynamic place. In the near future, TUE will develop the campus within four main zones: compact campus (university buildings), residential zone, companies and education zones (external users) and Dommel zone (urban park).

TUE1- TU/e Science Park



TUE 2016-2017 world rank (Engineering rank)

141 (64) THE

121 (88) QS

301-400 (51-75) ARWU

Notes:

- Texts about university profile, university governance and campus management structure are based on descriptions available at TUE website
- Campus management data provided by TUE unless indicated
- Photo retrieved from open source with permission to reuse
- Basemaps retrieved from open data sources
- More information about TUE: www.tue.nl

TUE Governance: Dual asymmetric structure

- Executive Board (3 members);
- Supervisory Board (4 external members)
- Departmental Boards (3-4 members for each of the nine departments)

Organisational

D.1 University vision: • Strong, distinctive position in the higher education market. • Leading position in strategic research areas. • Major source of knowledge, technology and new business in the knowledge economy, by encouraging entrepreneurship. • Cooperation with industry
D.2 Campus vision: 1. Increase quality of place (Green oasis) 2. Stimulate innovation ('digital university') 3. Supporting users' activities (good physical and digital facilities)

Functional

D.8 Students (headcount)	10.764
D.9 BSc students	62%
D.10 MSc students	38%
D.11 Diploma students	not applicable
D.12 Doctoral students	not applicable
D.13 Staff (FTE)	2.857,4
D.14 Academic staff	65,2%
D.15 Supporting staff	34,8%
D.16 Housing units on campus[2]	750
D.17 Firms on campus	c. 80
D.18 Incubators/accelerators on campus[3]	5
D.19 External research institutes on campus[4]	8
D.20 Specialised labs on campus[5]	31.000 m² UFA
D.21 Shared learning facilities on campus[6]	316
D.22 Parking spaces on campus	1150

Financial

D.3 Annual operating revenues	€ 319,0 Million
D.4 Percentage public funding	60%
D.5 Percentage private funding	40%
D.6 Annual operating expenses	€ 315,0 Million
D.7 Investments in research facilities[1]	€ 15,5 Million

Physical

D.23 Campus locations	1
D.24 Inner-city sites	1
D.25 Sub-urban sites	0
D.26 Campus built area	330.000 m² GFA
D.27 Percentage owned	100%
D.28 Percentage leased	0%
D.29 Campus floor area	157.000 m² UFA

Notes:
1. This number is based on a total costs of ownership calculation, which estimates the annual cost necessary for the research infrastructure on campus. TUE distinguishes average investments in heavy labs (€12,5 Million) and light labs (€3 Million).
2. These number accounts for Aurora and Luna, new residential towers managed by an external housing corporation operating in the region.
3. This is the number of buildings for incubators on campus.
4. This includes a number of research institutes with TUE participation.
5. This number accounts for 51.000 m² GFA in over 17 buildings.
6. This includes 162 group project rooms, 53 work lecture rooms, 48 practical rooms, 32 lecture rooms, 20 colloquium rooms and 1 computer room, used between faculties and occupying a total of 29.661 m2 UFA.

Key performance indicators (KPIs)

KPI.1 Students per academic staff	5,8
KPI.2 Parking spaces per staff	0,4
KPI.3 Investments in research facilities as percentage of annual operating expenses	5%
KPI.4 UFA/GFA	48%
KPI.5 Share of inner-city sites from portfolio	100%
KPI.6 Annual expenses per student	€29.264
KPI.7 Annual expenses per students and staff	€23.125
KPI.8 Investment in research facilities per student	€1.440
KPI.9 m² GFA per student	30,7
KPI.10 m² UFA per student	14,6
KPI.11 m² UFA per students and staff	11,5
KPI.12 Annual expenses per m² UFA	€2.006

Table 4.13. TUE Campus management information.
Information collected: 29 data variables on four perspectives (D.1-20); Information derived: 12 campus-related KPIs.
Period data collection 2013-2016. Period data access: June 2017 - January 2018.

TUE Campus Management structure: Internal centralised

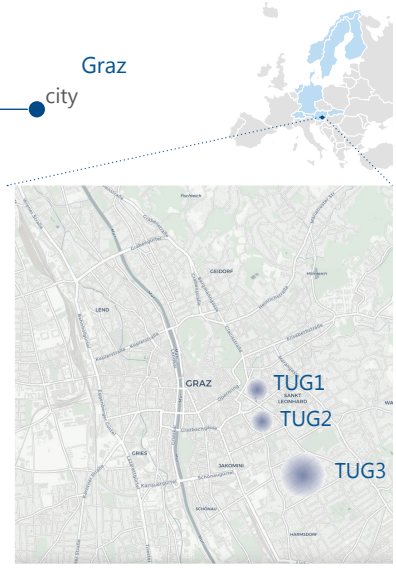
- Support Services
  - Real Estate Management
  - Quality team (4 members)

Real Estate Development
Park Management

TUG

Graz University of Technology

1811 founded | Strong innovation region | Austria country | Graz city

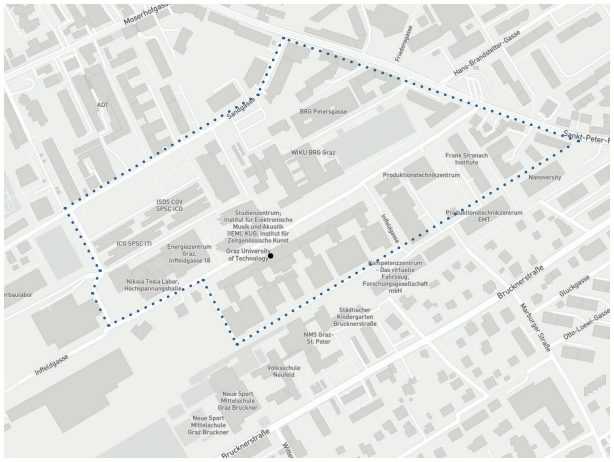


University profile

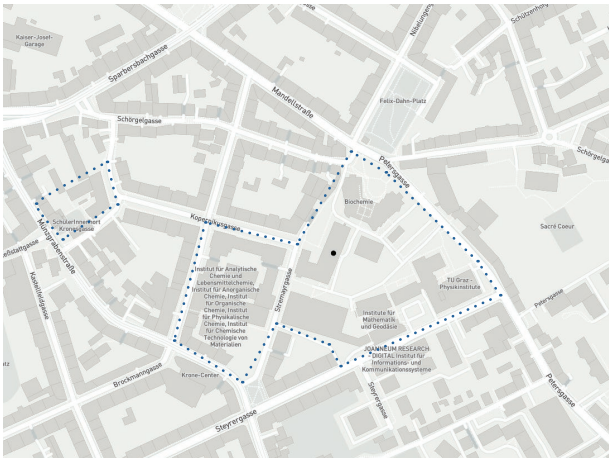
Founded by Archduke Johann in 1811, Graz University of Technology (TUG) looks back on more than 200 years of science, passion and technology as core principles. Throughout its seven faculties, TUG research focuses on five fields of expertise in which researchers work in an interdisciplinary way (Advanced Materials, Sustainable systems; Mobility & Production; Information, Communication & Computing; and Human Biotechnology). Accordingly, TUG maintains a balanced relationship between basic, scientific and applied research.

TUG activities are concentrated in three main campus locations: the 'Alte Technik' Campus (TUG1) from 1884; the 'Neue Technik' Campus (TUG2) from 1921; and 'Inffeldgasse' Campus (TUG3) from 1970. TUG as a place of research and teaching – and also as an employer – is under a threefold challenge to create optimum conditions for this steady change. TUG is treading the path to the digital university.

TUG3 - Campus Inffeldgasse



TUG2 - Campus Neue Technik



TUG 2016-2017 world rank (Engineering rank)

401-500 (not listed) THE | Not listed (215) QS | Not listed (not listed) ARWU

Notes:

- Texts about university profile, university governance and campus management structure are based on descriptions available at TUG website
- Campus management data retrieved from links provided by TUG
- Photo: © Lunghammer - TU Graz
- Basemaps retrieved from open data sources
- More information about TUG: www.tugraz.at

TUG Governance: Dual traditional structure

- University Council (7 members - 3 appointed by the Federal Government)
- Rectorate (1 rector and 4 vice-rectors)
- Senate (26 representatives of academic and nonacademic staff)

Organisational

D.1 University vision[1]: • Positioning as a preferred co-operation partner of science, business and especially industry. • Balancing relationship between basic and applied research • Increase location attractiveness as a scientific gateway to Southeastern Europe.
D.2 Campus vision[2]: 1. Stimulating innovation (focus on research infrastructure) 2. Supporting users' activities 3. Increasing flexibility and controlling risks (accommodate growth)

Functional

D.8 Students (headcount)	13.454
D.9 BSc students	not available
D.10 MSc students	not available
D.11 Diploma students	not available
D.12 Doctoral students	not available
D.13 Staff (FTE)	3.251
D.14 Academic staff	70,9%
D.15 Supporting staff	29,1%
D.16 Housing units on campus	not available
D.17 Firms on campus[4]	c.14
D.18 Incubators/accelerators on campus	1
D.19 External research institutes on campus	not available
D.20 Specialised labs on campus	not available
D.21 Shared learning facilities on campus	11
D.22 Parking spaces on campus	not available

Financial[3]

D.3 Annual operating revenues	€ 232,0 Million
D.4 Percentage public funding	60,6%
D.5 Percentage private funding	39,4%
D.6 Annual operating expenses	€ 224,9 Million
D.7 Investments in research facilities	not available

Physical

D.23 Campus locations	3
D.24 Inner-city sites	3
D.25 Sub-urban sites	0
D.26 Campus built area	not available
D.27 Percentage owned	not available
D.28 Percentage leased	not available
D.29 Campus floor area	162.107 m² GFA

Notes:
1. Available at www.tugraz.at/en/tu-graz/university/mission-statement/
2. No explicit campus vision was found but deduced from descriptions of infrastructure developments in TUG's Annual report 2017.
3. Available data from TUG's Annual Report 2017.
4. Data from 14 selected firms housed at TUG's incubator.

Key performance indicators (KPIs)

KPI.1 Students per academic staff	5,8	KPI.7 Annual expenses per students and staff	€13.468
KPI.2 Parking spaces per staff	not available	KPI.8 Investment in research facilities per student	not available
KPI.3 Investments in research facilities as percentage of annual operating expenses	not available	KPI.9 m² GFA per student	not available
KPI.4 UFA/GFA	not available	KPI.10 m² UFA per student	12
KPI.5 Share of inner-city sites from portfolio	100%	KPI.11 m² UFA per students and staff	9,7
KPI.6 Annual expenses per student	€16.722	KPI.12 Annual expenses per m² UFA	€1.388

Table 4.14. TUG Campus management information.
Information collected: 29 data variables on four perspectives (D.1-29); Information derived: 12 campus-related KPIs.
Period data collection 2016-2017. Period data access: December 2017 - June 2018.

TUG Campus Management structure: Internal centralised
- Service Departments
  - Buildings and Technical Support*
    - Infrastructure quality Control
    - Space design
    - Space management
    - Safety
    - Maintenance
    - Cost efficiency

*Note: the bullet list to the right displays the main tasks of the Service Department Buildings and Technical Support rather than official units.

UT

University of Twente

1961 founded

Leader innovation region

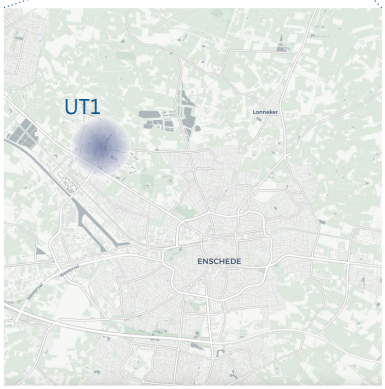
The Netherlands country

Enschede city

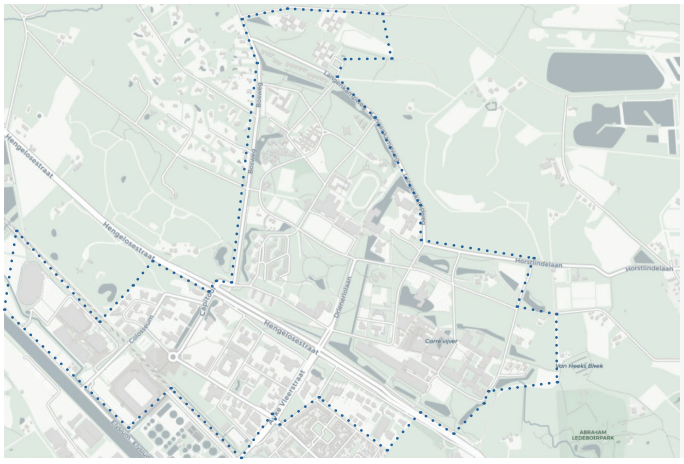
University profile

The University of Twente (UT) was founded in 1961 as the Twente Technological University of Applied Sciences after the House of Representatives agreed to the establishment of a third technical university of applied sciences in Enschede. Today UT is regarded as a catalyst to many high-tech communities and sectors with strong partnerships in a wide range of industries and societal domains. UT's education and research is at the intersection of various fields of study across five faculties (Behavioural, Management and Social sciences; Engineering Technology; Electrical Engineering, Mathematics and Computer Science; Science and Technology ; and Geoinformation Science & Earth Observation) and three institutes.

The campus of UT is located on the outskirts of Enschede, at fifteen minutes cycling from the city centre (UT1). All education and research buildings can be found here. Besides, the campus has student residences and staff accommodation, sports fields, shops, conference and meeting centres, a pub and a library. Having started life as an experiments in the woods, the UT campus has recently undergone a transformation to become a key component of the Twente Network City Knowledge Park.



UT1- Kennispark



UT 2016-2017 world rank (Engineering rank)

179 (not listed) THE

177 (229) QS

301-400 (151-200) ARWU

Notes:

- Texts about university profile, university governance and campus management structure are based on descriptions available at UT website
- Campus management data provided by UT unless indicated
- Photo retrieved from open source with permission to reuse
- Basemaps retrieved from open data sources
- More information about UT: www.utwente.nl

UT Governance: Dual asymmetric structure

- Executive Board (3 members);
- Supervisory Board (5 external members)
- University Council (18 members: 9 staff and 9 students)

Organisational

D.1 University vision: • Societal impact - making a real difference • Synergy - excellence in combinations • Entrepreneurship and innovation - the best in Europe • Internationalization - tomorrow's global citizens
D.2 Campus vision: 1. Stimulate collaboration 2. Stimulate innovation (knowledge) 3. Supporting image (Internationalisation)

Functional

D.8 Students (headcount)	10.435
D.9 BSc students	53%
D.10 MSc students	38%
D.11 Other students[2]	9%
D.12 Doctoral students	not applicable
D.13 Staff (FTE)	2.610
D.14 Academic staff	58,3%
D.15 Supporting staff	41,7%
D.16 Housing units on campus	2.125
D.17 Firms on campus[3]	48
D.18 Incubators/accelerators on campus[4]	3
D.19 External research institutes on campus[5]	6
D.20 Specialised labs on campus[6]	343
D.21 Shared learning facilities on campus[7]	175
D.22 Parking spaces on campus[8]	2.339

Financial

D.3 Annual operating revenues	€ 320,9 Million
D.4 Percentage public funding	62%
D.5 Percentage private funding	38%
D.6 Annual operating expenses	€ 310,5 Million
D.7 Investments in research facilities[1]	€ 10,0 Million

Physical

D.23 Campus locations	1
D.24 Inner-city sites	0
D.25 Sub-urban sites	1
D.26 Campus built area	232.787 m² GFA
D.27 Percentage owned	97%
D.28 Percentage leased	3%
D.29 Campus floor area	173.387 m² UFA

Notes:
1. This number accounts for the expected investments in all real estate for 2017 according to UT's annual report 2016 (p.78).
2. UT distinguishes premaster and postmaster students.
3. Source: Dutch Chamber of Commerce (2017)
4. This number accounts for the buildings accommodating 19 spin-offs and start-ups in 2016.
5. These are TNO iBotics; Fraunhofer; Max Planck; Roessingh RD; CBS Big Data Statistics; and Boeing TenCate Stork TPRC
6. These labs occuppy 16.328 m²
7. This accounts for education rooms occupying 12.459 m²
8. From which 2.286 spaces are for particulars; 33 for permit holders; 12 for handicapped; and 8 for electric cars.

Key performance indicators (KPIs)

KPI.1 Students per academic staff	6,9
KPI.2 Parking spaces per staff	0,9
KPI.3 Investments in research facilities as percentage of annual operating expenses	3%
KPI.4 UFA/GFA	74%
KPI.5 Share of inner-city sites from portfolio	0%
KPI.6 Annual expenses per student	€29.756
KPI.7 Annual expenses per students and staff	€23.802
KPI.8 Investment in research facilities per student	€958
KPI.9 m² GFA per student	22,3
KPI.10 m² UFA per student	16,6
KPI.11 m² UFA per students and staff	13,3
KPI.12 Annual expenses per m² UFA	€1.791

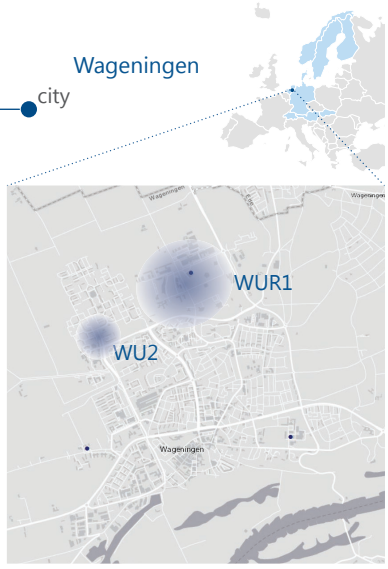
Table 4.15. UT Campus management information.
Information collected: 29 data variables on four perspectives (D.1-29); Information derived: 12 campus-related KPIs.
Period data collection 2015-2017. Period data access: June 2017 - January 2018.

UT Campus Management structure: internal centralised

- Service Departments
  - Campus & Facility Management
    - Policy & Projects
    - Finance & Control
    - HR Management
      - Facility services
      - Purchase Department
      - Culture & Events
      - Sports
      - Maintenance & Real Estate
        - Facility Services teams
        - Security Department team
        - Facility services, Mail & Logistic team

Wageningen University & Research

1918 founded | Leader innovation region | The Netherlands country | Wageningen city



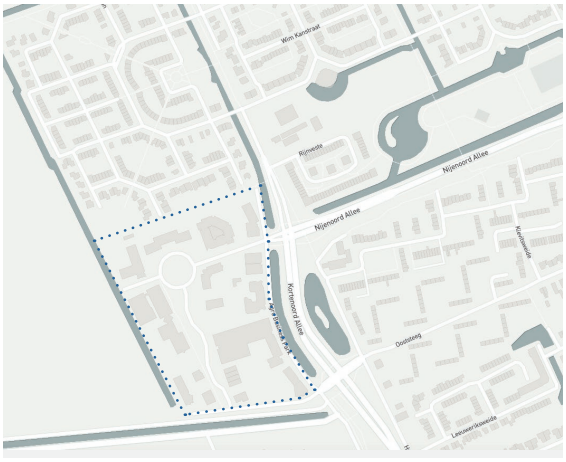
University profile

Wageningen University & Research (WUR) is an education and research institution that focuses on the domain 'healthy food and living conditions'. WUR is a partnership between Wageningen University and Wageningen Research, formerly the DLO Foundation. The association is organised into five sciences groups, each consisting of a Wageningen University department that is organisationally integrated with one or more application-oriented Wageningen Research institutes (Agrotechnology & Food Sciences; Animal Sciences; Plant Sciences; Social Sciences; and Environmental Sciences).

WUR has branches all over The Netherlands and abroad. A large number of lecturers, researchers and other employees are based at Wageningen Campus, which consists of two locations: the WUR buildings for research and education (WUR1) and the Business & Science Park Wageningen (WUR2), which is privately exploited. WUR Campus is focused on meeting and contact between knowledge organisations, educational institutions, the business community and start-ups, by offering a range of facilities and amenities including top-quality labs, an incubator, an Expat Center Expat Center, numerous meeting places, cafes and restaurants, sports facilities and shops.

WUR1- Wageningen campus

WUR2- Business & Science Park Wageningen



WUR 2016-2017 world rank (Life Sciences rank)

64 (20) THE | 119 (71) QS | 101-150 (36) ARWU

Notes:

- Texts about university profile, university governance and campus management structure are based on descriptions available at WUR website
- Campus management data provided by WUR unless indicated
- Photo retrieved from open source with permission to reuse
- Basemaps retrieved from open data sources
- More information about WUR: www.wur.nl

WUR Governance: Dual asymmetric structure

- Executive Board (3 members);
- Supervisory Board (6 external members)
- Student Council, Student Staff Council and Central Works Council
- Directors of Science Groups (2 members per each of the 5 groups)

Organisational

D.1 University vision:
- Develop high-level knowledge in healthy food and living environment and put it into practice
- Train professionals capable to generate breakthroughs in knowledge and technology in the future
- Maintain WUR position as a leading supplier of applied scientific research in the green domain.

D.2 Campus vision:
1. Reduce footprint (CO^2 emissions) (campus ecosystem, Helix, green infrastructure)

Functional

D.8 Students (head count)	11.278
D.9 BSc students	47%
D.10 MSc students	49%
D.11 Other students	4%
D.12 Doctoral students	not applicable
D.13 Staff (FTE)[1]	2.530
D.14 Academic staff	60,8%
D.15 Supporting staff	39,2%
D.16 Housing units on campus	4.653
D.17 Firms on campus[2]	196
D.18 Incubators/accelerators on campus[3]	2
D.19 External research institutes on campus[2]	10
D.20 Specialised labs on campus[2]	644
D.21 Shared learning facilities on campus[2]	701
D.22 Parking spaces on campus[2]	5.000

Financial

D.3 Annual operating revenues	€ 329,2 Million
D.4 Percentage public funding	55%
D.5 Percentage private funding	45%
D.6 Annual operating expenses	€ 322 Million
D.7 Investments in research facilities	not available

Physical

D.23 Campus locations	2
D.24 Inner-city sites	1
D.25 Sub-urban sites	1
D.26 Campus built area[4]	200.283 m^2 GFA
D.27 Percentage owned	64%
D.28 Percentage leased	36%
D.29 Campus floor area[5]	158.224 m^2 UFA

Notes:
1. Together with Wageningen Research the total staff number at WUR is 4.700 FTE. For comparison in teaching capacity we use the staff of Wageningen University only.
2. Accounts for both Wageningen University and Wageningen Research
3. Besides, there are other 6 collective buildings at WUR
4. Together with Wageningen Research the total GFA at WUR is 425.000 m^2. For comparison in built space per student we use the GFA of Wageningen University only.
5. Together with Wageningen Research the total UFA at WUR is 350.000 m^2. For comparison in floor space per student we use the GFA of Wageningen University only.

Key performance indicators (KPIs)

KPI.1 Students per academic staff[1]	7,0
KPI.2 Parking spaces per staff[2]	1,1
KPI.3 Investments in research facilities as percentage of annual operating expenses	not available
KPI.4 UFA/GFA	79%
KPI.5 Share of inner-city sites from portfolio	67%
KPI.6 Annual expenses per student	€30.102
KPI.7 Annual expenses per students and staff[1]	€24.344
KPI.8 Investment in research facilities per student	not available
KPI.9 m^2 GFA per student	18,7
KPI.10 m^2 UFA per student	14,8
KPI.11 m^2 UFA per students and staff[1]	12
KPI.12 Annual expenses per m^2 UFA	€2.035

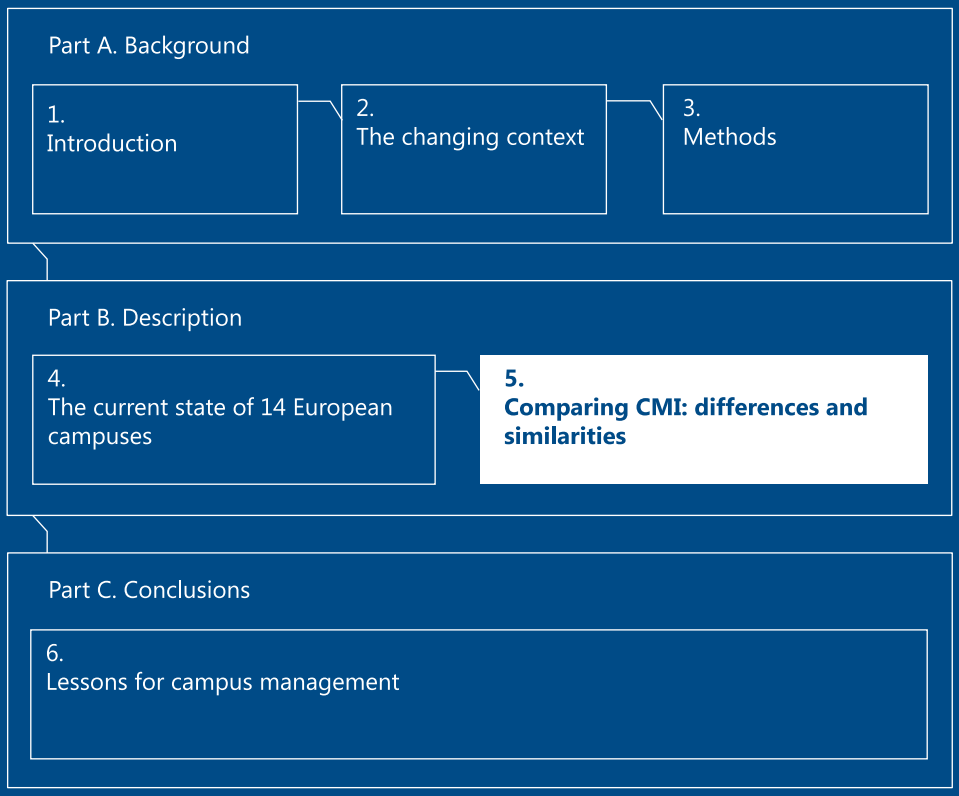
Table 4.16. WUR Campus management information.
Information collected: 29 data variables on four perspectives (D.1-29); Information derived: 12 campus-related KPIs.
Period data collection 2015-2016. Period data access: June 2017 - March 2018.

WUR Campus Management structure: Internal centralised
- Facilities & Services
  - Real Estate
- Value Creation & Cooperation
  - Shared Research Facilities

- Support Office RE&H
- Real Estate Policy
- Real Estate Construction & Maintenance
- Safety & Environment
- Technical Installation Services & Construction Services Wageningen

Stimulating innovation and supporting users activities are the ultimate UTs' campus strategies and Europe should invest in CMI to track successful implementation.

Comparing CMI: differences and similarities



5. Comparing CMI: differences and similarities

This chapter compares the available CMI among the fourteen participant UTs. The comparison mainly exhibits the fourteen UTs in an anonymous way in search for patterns emerging from the data. The comparison is structured in three parts. The first part distinguishes the existing campus management structures embedded in the current university governance structures as patterns in campus governance. The second part distinguishes the current campus goals in line with the existing university goals as patterns in campus strategy. The third part focuses on particular indicators from the available CMI that can help campus managers to support those current campus strategies.

5.1. Campus governance

Data about university governance illustrate the three type of governance structures that exist in European universities (EUA, 2017). Most UTs in this study have a dual structure, which broadly speaking and considering the different terminologies used, comprises a board or council and a senate. UTs in Austria, Germany, and Slovakia have a 'traditional dual structure' (n=3), in which the board or council is often responsible for long-term decision-making while the senate is entrusted with academic issues and consists of staff and students representatives. Depending on the country the senate can be separate bodies distinguishing scientific, academic as well as administrative members. UTs in The Netherlands, Finland and Switzerland have an 'asymmetric dual structure' (n=7), in which one of the bodies can be identified as the main decision-making organ (executive board), while the second one has more restricted competencies (supervisory board). Furthermore, the remaining universities in Sweden, Norway and Denmark have a 'unitary structure' (n=4), in which there is only one main decision-making body. In the four UTs these bodies are known as the board and composed by both external and internal members. In some cases, they report directly to the countries' ministries.

Data about the campus management structures shows that most universities have an internal campus management organisation (n=12). That is, these UTs manage their campuses with their own staff and decisions are made including university governing bodies. Only universities in Finland (n=2) have an external management organisation such as the University Properties of Finland Ltd, which is an organ that owns and develops university campus properties outside the Helsinki metropolitan area. This company is owned by ten universities operating in this area and the Finnish State, which are involved in campus decisions.

Moreover, internal campus management organisations are found centralised in one office or division (n=10) or decentralised in two of them (n=4). Often, these two divisions distinguish strategic from operational focus in campus management. In these UTs, the former are known as Real Estate Management or Property Management and the latter as Facility Management or Campus Services. Simultaneously, each of these offices or divisions is organised by a number of sub-divisions, which range from three up to eight departments with different tasks. These often include strategic planning, building construction, space management, budget and controlling, maintenance, workplace development, asset management, business development and support, among other terminologies encompassing campus management tasks. Figure 5.1 illustrates the observed patterns in campus governance (i.e. campus management structures embedded in university governance).

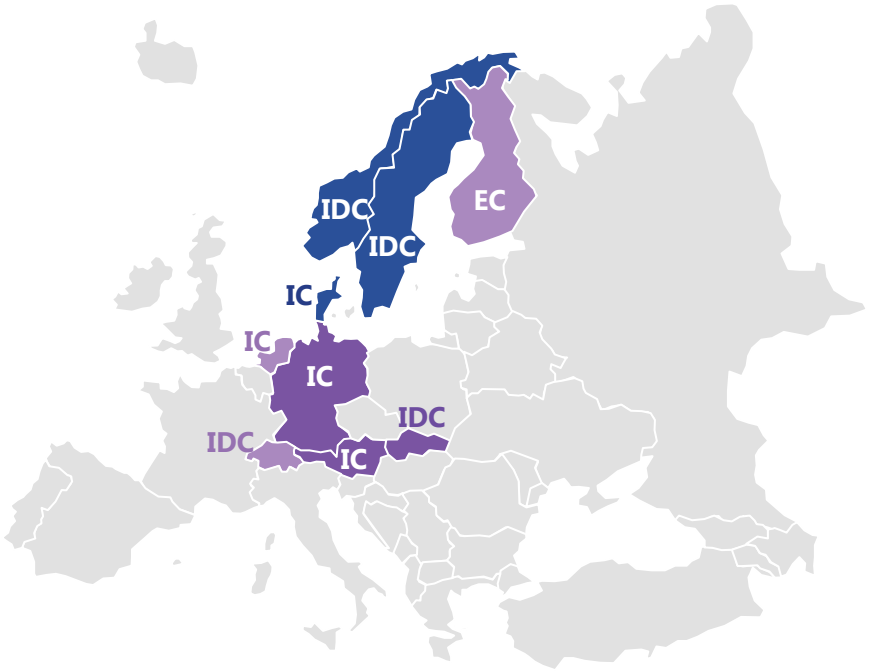


Figure 5.1 Overview of university governance and campus management structures in 14 European UTs (C=Centralised; DC= Decentralised).

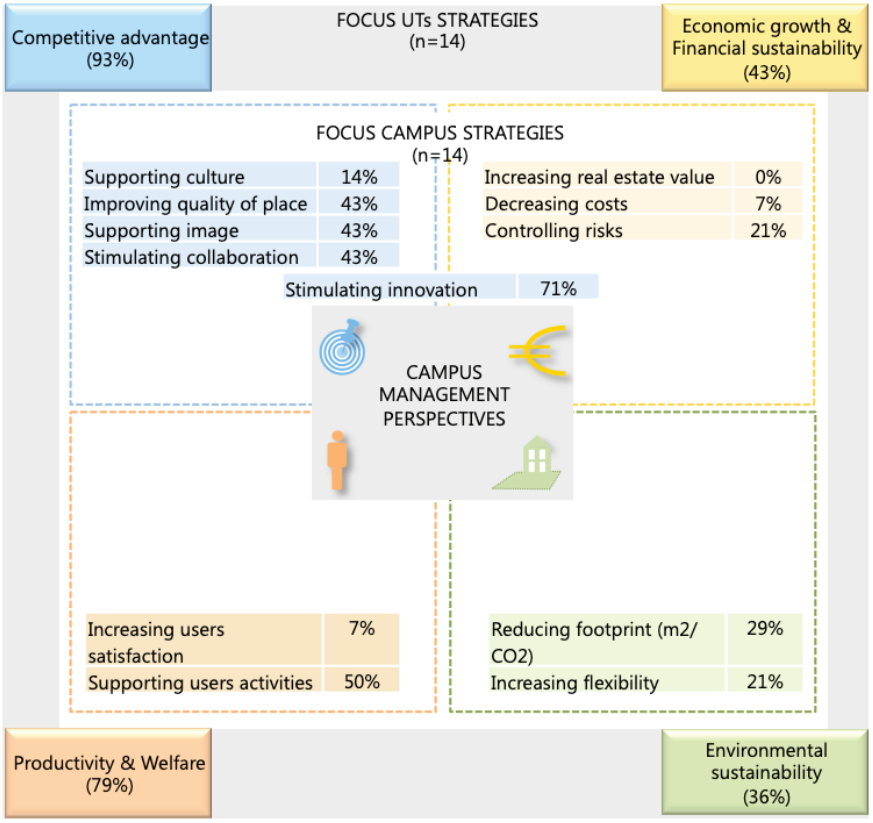
Campus management		*Internal (I)*		*External (E)*		
		C	*DC*	*C*	*DC*	
University Governance						Total
Unitary structure		2	2	0	0	4
Dual structure	**Traditional**	2	1	0	0	3
	Asymmetric	4	1	2	0	7
	Total	8	4	2	0	14

5.2. Campus strategies

In Chapter 2, this study illustrates how the dynamic context in which UTs operate is influenced by multiple and interdependent trends linking the four perspectives on campus management (i.e. organisational, financial, functional and physical). Data on UTs ambitions and campus goals confirms that their plans at organisational and real estate levels are also considering multiple focuses related to each of these perspectives (See Figure 5.2).

Certainly, these multi-perspective focuses illustrate the universities' contemporary adoption of social and economic roles next to their traditional mission of advancing education and research. For instance, UTs are engaged in fostering innovation and entrepreneurship at local and regional levels as well as providing solutions to global and local societal and environmental issues. Accordingly, 93% of UTs focus on competitive advantage in their universities strategies. This is concluded from explicit statements in their ambitions such as sustaining their a) excellence in education, b) leading role in research, c) attractive international profile to catch and retain the best students and staff. Moreover, 79% of UTs address productivity and welfare in as a broad component in their organisational strategies. This is inferred from their stated ambition to prepare

Figure 5.2 Overview of UTs' and campus' strategies in relation to campus management perspectives



the talented human capital and the highly qualified engineers who will solve the current and future societal challenges. These main organisational ambitions are supported by two main campus goals addressed by most UTs: a) stimulating innovation (71%) and b) supporting users' activities (50%). Next to these, this study identifies c) supporting image (43%), d) improving quality of place (43%) and e) stimulating collaboration (43%) as common campus goals addressed by many UTs to strengthening their international profile as world-class environments.

Next to the main strategic focus described above, UTs also consider financial and environmental aspects to shape their strategies. 43% of UTs focus on economic growth and financial sustainability by stating their ambition to collaborate with local, regional, and global parties to generate value and support entrepreneurship. Conversely, 71% of UTs address 'stimulating innovation' as a campus strategy to support these economic ambitions by investing in research infrastructure, for instance. Last, 36% of UTs focus on environmental sustainability by expressing their ambition to contribute with technologies and solutions to tackle environmental challenges such as climate change. Likewise, 29% of UTs uses 'reducing footprint' as a campus strategy supporting environmental ambitions. This campus strategy is identified by the UTs goals to decrease CO2 emissions and/or using their space in ways that are more efficient.

Generally, UTs focus on eleven of the twelve campus goals and/or strategies identified in campus management research (Den Heijer, 2011). These results confirm that some European UTs also use a multi-stakeholder approach in their campus management. This

study also compared the campus goals with the current campus management structures in participant UTs (Table 5.1). Accordingly, it can be said that managers in all three types of campus management structures address five main strategies. These are a) supporting image, b) stimulating collaboration, c) stimulating innovation, d) reducing footprint and e) supporting users' activities. Altogether, they cover the four stakeholders' perspectives on campus management.

Focus Campus strategy	UTs (n=14)	Campus management structure			Perspective
		IC	IDC	EC	
Supporting culture	14%	50%	50%	0%	Organisational
Improving quality of place	43%	50%	50%	0%	
Supporting image	43%	50%	33%	17%	
Stimulating collaboration	43%	50%	17%	33%	
Stimulating innovation	71%	40%	40%	20%	
Increasing real estate value	0%	0%	0%	0%	Financial
Decreasing costs	7%	100%	0%	0%	
Controlling risks	21%	67%	33%	0%	
Reducing footprint (m2/CO2)	29%	50%	25%	25%	Physical
Increasing flexibility	21%	67%	33%	0%	
Increasing users satisfaction	7%	100%	0%	0%	Functional
Supporting users activities	50%	71%	14%	14%	

Table 5.1 Overview of campus strategies in relation to current campus management structures in UTs.

Strategy types		Performance driver	UT's strategies (n=14)	Campus strategies (n=14)
Unilateral		Competitive	-	21%
Bilateral		Competitive-Economic	14%	-
		Competitive-Social	29%	36%
		Competitive-Environmental	-	21%
		Economic-Environmental	7%	-
Multilateral		Competitive-Economic-Social	21%	-
		Competitive-Environmental-Social	21%	-
		Competitive-Economic-Environmental	-	7%
		Economic-Environmental-Social	-	7%
		Competitive-Economic-Environmental-Social	7%	7%

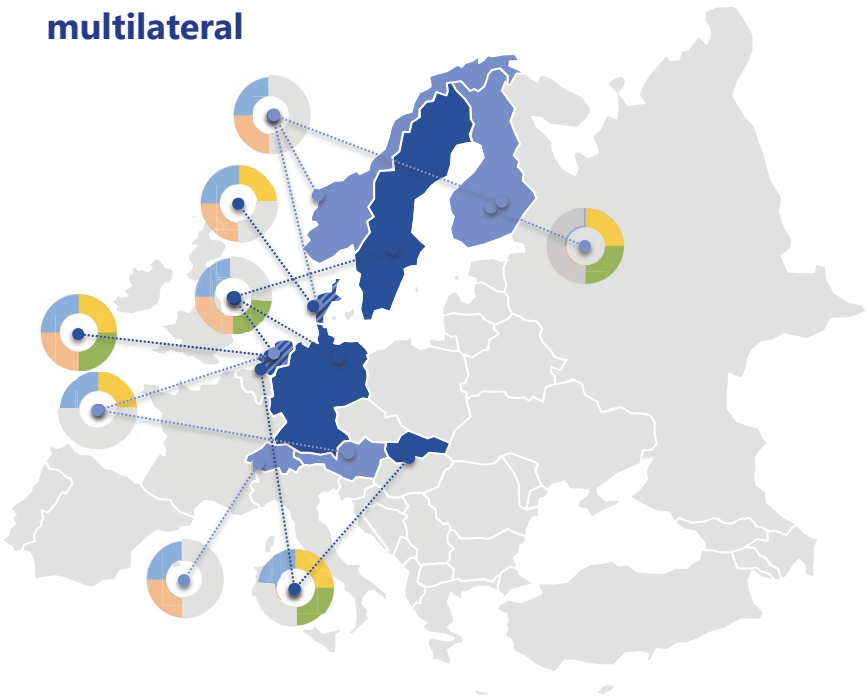
Table 5.2 Types of university- and campus strategies according to their performance drivers

Similarly, two observations can be made by looking at the differences in the focus of campus strategies among the existing campus management structures. On the one hand, external campus managers (n=2) do not address financial campus goals, except from 'stimulating innovation', which is considered an organisational goal with impact on the competitive advantage as well as the financial sustainability of UTs. On the other hand, internal campus managers with a centralised organisation (n=8) address all 11 campus goals addressed by all UTs. Besides, they are the only ones that support 'decreasing costs' and 'increasing users' satisfaction'. Likewise, they also predominantly address physical goals.

Based on the heterogeneous focuses of university- and campus strategies, this study distinguishes three types of strategies: unilateral, bilateral, and multilateral. These three types span across four performance drivers linked to the perspectives on campus management, from which ten combinations can be identified (See Table 5.2).

As shown in Table 5.2, unilateral strategies exist only on campus level and with a focus on competitiveness. In contrast, bilateral and multilateral strategies are found at both university and campus level. Bilateral strategies entail four combinations with a focus on two of the four performance drivers. Multilateral strategies entail five combinations with a focus on three or four performance drivers. In both types, competitiveness is also the predominant driver present in seven of the nine strategic combinations. Largely, the bilateral 'Competitive-Social' strategy is the most predominant type at both university and campus levels. The heterogeneity of the strategic focus in European UTs and their campuses is illustrated in Figures 5.3 and 5.4. These typologies are referred in the analysis of the CMI in the following section.

Figure 5.3 Overview of UTs strategies and their multiple focuses



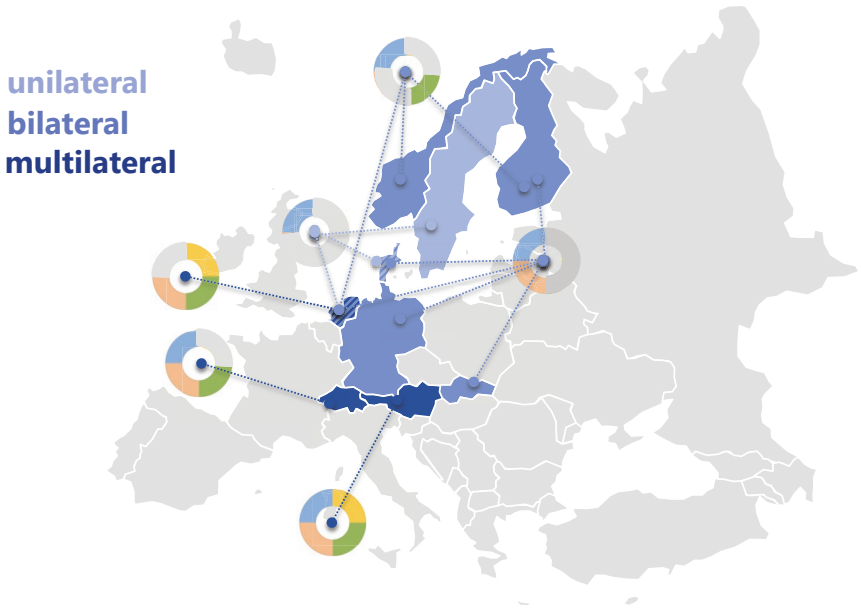


Figure 5.4 Overview of campus strategies in UTs and their multiple focuses

5.3. CMI

The previous sections acknowledges bilateral competitive-social as the predominant strategy in UTs at both university and campus level. Correspondingly, 'supporting users activities' and 'stimulating innovation' are distinguished as the most common campus goals addressed by the UTs. The following paragraphs describe and compare indicators derived from available data in the financial, physical and functional perspectives on campus in relation to these two campus goals or strategies.

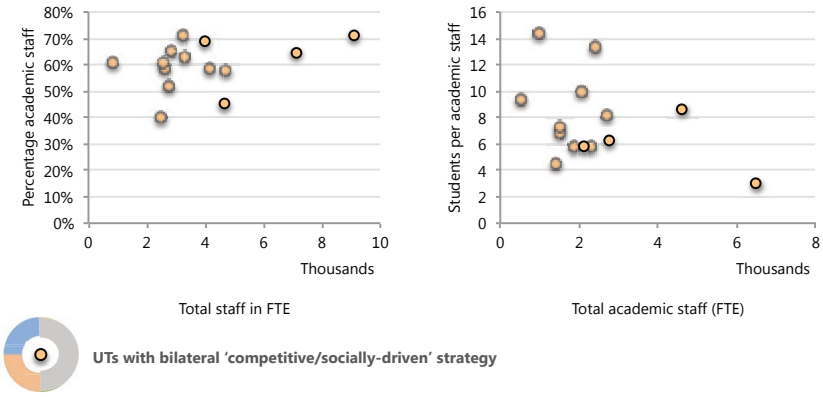
5.3.1. Supporting users' activities

Half of the UTs in this study explicitly focus their campus management to support the activities of their students and staff. It can be said that supporting users' activities is the '*raison d'être*' of campuses and perhaps it is the reason it might be implicit in the campus strategy of any university rather than explicitly mentioned.

Next to valorisation and other administrative undertakings, education and research are the main activities performed by UTs. Therefore, the relation of academic and administrative staff indicates the capacity of UTs to perform these primary processes. Roughly, 60% of the FTE employed at UTs accounts for academic staff. Although the share of academic staff in most UTs is around this average, the values range from 40 to 71% (See Figure 5.6 left). Tracking the share of academic staff is important for UTs competitive profile in education and research since their productivity influence the number of publications, research projects, grants and courses offered in the education portfolio. Not surprisingly, three of the four UTs with a bilateral 'competitive-social' strategy have a higher share of academic staff than the average.

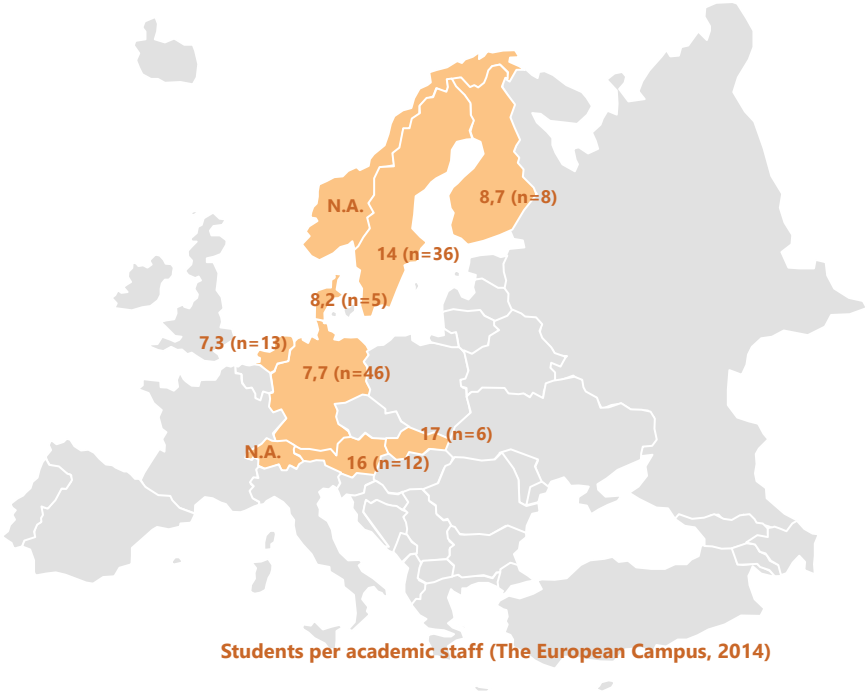
Moreover, this study looked at the relation of students per academic staff to have an indication of the capacity of UTs to meet their ambition of educating and training the engineers who will solve societal challenges (See Figure 5.6 right). The fourteen UTs have an average ratio of 7,7 students per one academic staff FTE. This study used the median

Figure 5.5 Left: share of academic staff per total staff. Right: number of students per academic staff.



for this ratio because large differences were encountered among the participant UTs, which range from 3,1 to 14.4 students per one academic staff FTE. These differences indicate the UTs dissimilar human resource capacities to fulfil education as their primary activity. The two UTs with the lowest and highest proportion of students per academic staff have addressed supporting users as a campus goal but only the UT with the lowest value has a bilateral 'competitive/socially-driven' strategy at university level. Comparing data from previous research and the data retrieved in this study, some differences can be outlined between European UTs and European universities in general. In 2014, 539 European universities had on average 16,8 students per one academic staff with a larger range from 0,7 to 81. However, the average students per academic staff among universities in the nine countries participating in this study ranged from 7,3 to 17 (See Figure 5.6). This range is similar to the one obtained in this study.

Figure 5.6 Average students per academic staff in the countries participating in this study based on available information from previous campus management research (N.A. stands for not available since these countries were not part of the 2014 research, which focuses only on EU member states).



On average, UTs accommodate about 21.000 people among students and staff. However, the main users' population in UTs range from 5.600 to 47.000 people. Certainly, ensuring efficient availability of space to effectively facilitate users' activities is a relevant task for campus managers. As shown in Chapter 2, the dynamic and uncertain change in the number of students and staff makes this task particularly relevant. Data available from twelve UTs illustrate that they have very different sizes in their built portfolios. For instance, this size ranges from 70 thousands up to 1 million m2 of gross floor area (GFA). Nonetheless, the share of usable floor area (UFA) per GFA is similar with a mean of 64% (See Figure 5.7 left).

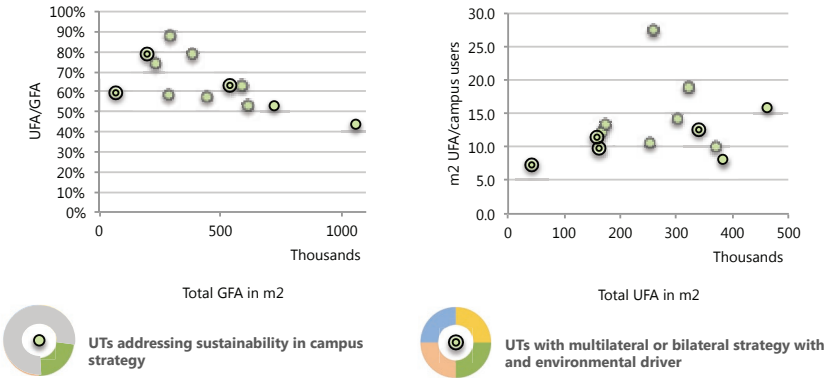


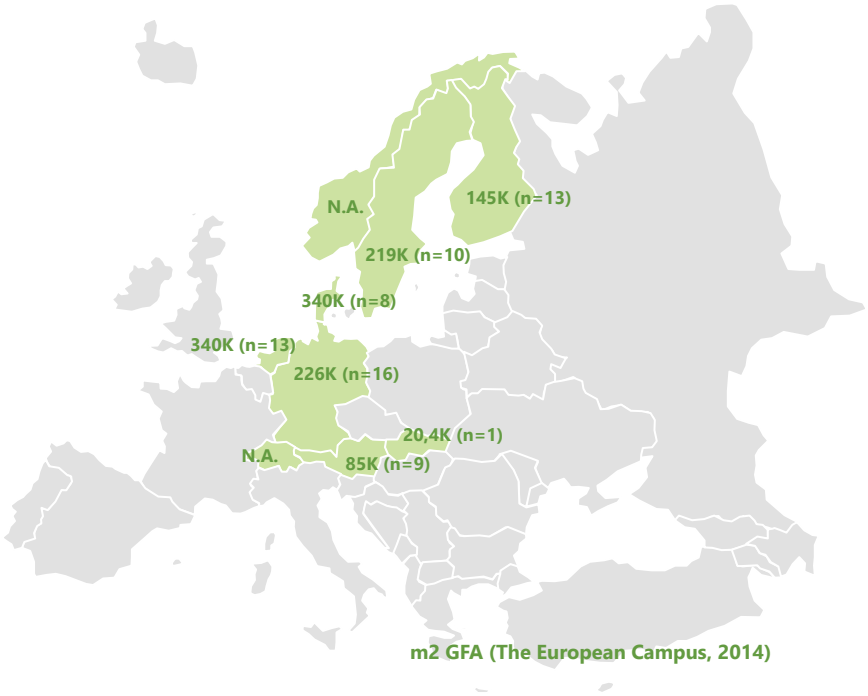
Figure 5.7 Left: share of floor- and built area (n=11). Right: amount of m2 floor area per campus users (students and all staff).

Similarly, large differences were observed among UTs in the number of users per m2 of floor area (n=13). The median is 11,9 m2 UFA per user while the range varies from 7,4 up to 27,6. Two observations can be made from this wide range. UTs may have a contrasting ways to use their space in more or less efficient ways or they could be measuring the UFA in different manners. Indeed, some UTs provided explanations on how they calculate this while others did not. Existing campus benchmarks indicates that the share of UFA/GFA in university campuses ranges between 55 to 65%. Values outside this range may indicate the UFA is being calculated differently among UTs. Moreover, it is interesting to note that the UT with the smaller built area and with least users per m2 is committed to sustainability and environmental responsibility in its campus strategy. These two indicators can be used also to devise and track campus strategies such as reducing footprint and increasing flexibility, which are ways to support the increasing environmental ambitions of universities in general.

Comparing available data from previous research and the data retrieved in this study, some similarities can be outlined between European UTs and European universities in general. In 2014, 319 European universities had as well a very dissimilar portfolio size ranging between four and 830 thousands m2 GFA. Likewise, the average portfolio size among universities in the nine countries participating in this study ranged widely from 20,4 to 340 thousands (See Figure 5.8). Accordingly, the existing difference between the largest and the smallest portfolio in UTs (i.e. 70 thousands up to 1 million m2 GFA) is much larger than the average country figures in 2014.

The accessibility to urban amenities and residential areas seems to be a decisive factor for young students and knowledge workers when deciding where to study and work (Van Den Berg et al., 2005). The convenience of campuses facilitating not only core activities but also the access to supporting functions can increase UTs' attractiveness

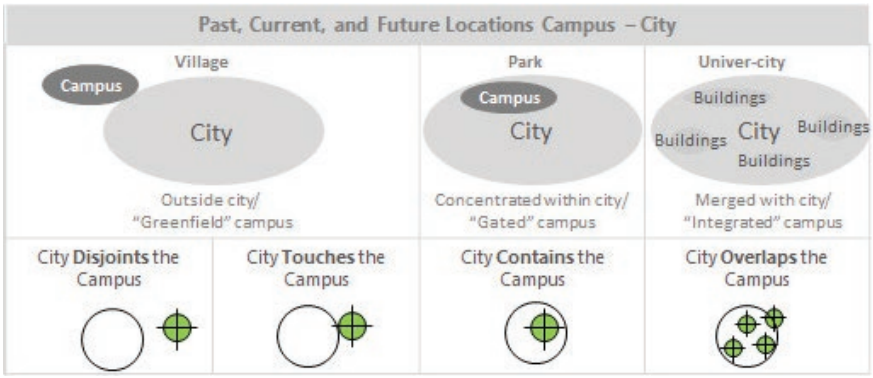
Figure 5.8 Average m² of campus built area in the countries participating in this research based on available information from previous campus management research (N.A. stands for not available since these countries were not part of the 2014 research).



in their competitive race for talent. UTs in this study have different campuses in term of location. For instance, there are UTs that concentrate in one site but there some UTs which campuses comprise several locations. Indeed, UTs with multiple campus locations varied from 2 to 32 different sites but most UTs have less than five sites.

Nonetheless, these locations have different characteristics in relation to the city and so, to urban amenities. Recently, Den Heijer and Curvelo Magdaniel (2018) grouped three different types of locations based on their own existing categorisations (See Figure 5.9): greenfield (the city disjoints or touches the campus), gated in the city (city contains the campus), and integrated into the city (city overlaps the campus).

Figure 5.9 Categories of physical relations between campuses and cities (Den Heijer and Curvelo Magdaniel, 2018)



Accordingly, 50% of the participant UTs has campuses located in both the inner city and in its periphery while 36% of them have sites only in the inner city. The remaining 14% of UTs have campuses only in the periphery of cities (See Figure 5.10).

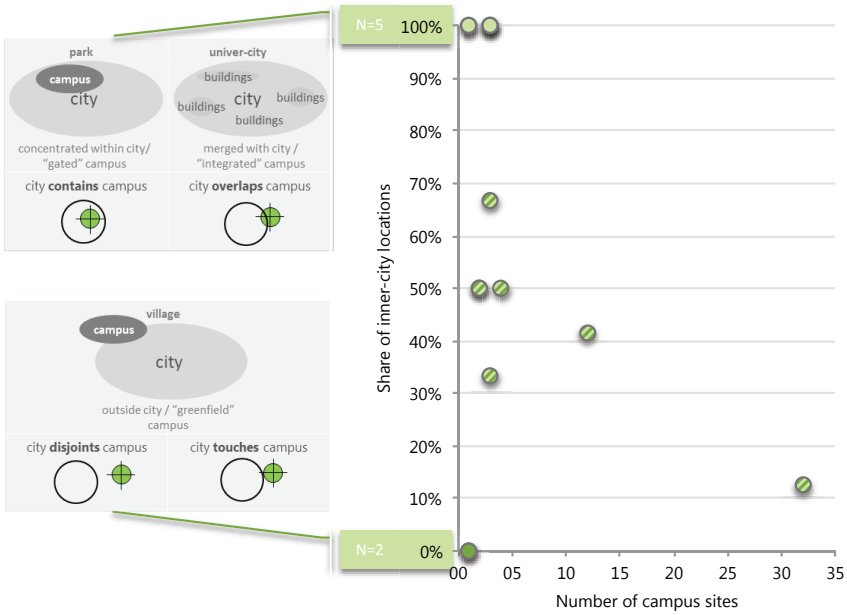


Figure 5.10 Share of campus locations in relation to campus-city relations by Den Heijer and Curvelo Magdaniel (2018) (n=14).

Accordingly, most UTs have an urban presence, which can benefit them in their ambition to attract and retain students and staff. However, two UTs in this sample are considered 'greenfield' campuses outside the city, which may challenge their campus strategies to increase the diversity of functions supplied on campus as well as to improve their transport accessibility and connectivity. Not surprisingly, these UTs and those that have a large part of their portfolio in the periphery, offer more parking spaces per staff (i.e. above the average of 0,7 parking unit per staff).

Although UTs with 'greenfield' campuses outside the city do not address 'improving quality of place' in their campus strategies, they already provide student housing on their premises and/or nearby. Possibly, they also provide functions supporting student life on campus (i.e. retail and sport). Indeed, supplying variety of functions on campus can help UTs to 'support their image'; an ambition that was addressed by nearly half of the participant UTS in their campus strategies, including the one UTs with a single location outside the city.

5.3.2. Stimulating innovation

71% of UTs in this study explicitly focus their campus management to stimulate innovation. That is by far, the most important campus goal identified in this study. It can be said that fostering the creation of knowledge that leads to new and improved technologies is the contemporary DNA of UTs and perhaps it is the reason why it is explicitly mentioned in most campus strategies.

A common way to stimulate innovation in campuses is to invest in world-class research facilities and/or state-of-the-art laboratories and related infrastructure. Nonetheless, the financial capacity of UTs to invest in research and education in general and research infrastructure in particular, is quite dissimilar. The median annual expense per one student in the fourteen UTs is €25,6K but ranges from €7 thousands up to €77 thousands. These vast differences hold when looking at the annual expenses per all users including students and staff (See Figure 5.11 left). Correspondingly, the operating revenues of UTs differ widely (See Figure 5.11 right). Herein, the share of public funding seems to be more homogeneous since more than 60% of the annual operating revenues in most UTs come from public sources. Correspondingly, the two UTs with the highest public funding have a unitary governance structure, in which there is one main decision-making body that reports directly to the countries' ministries.

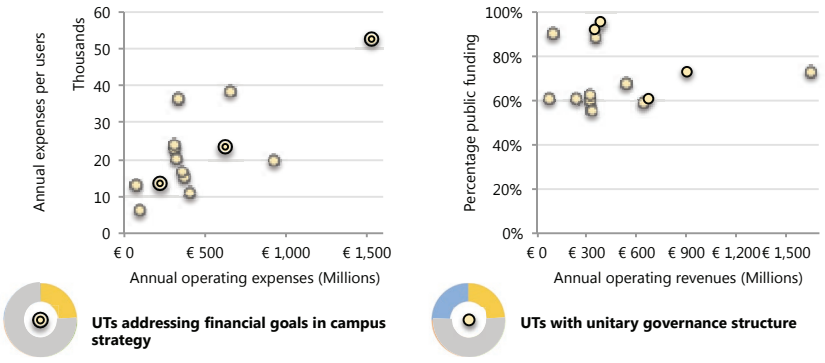


Figure 5.11 Left: UTs financial capacity to support their users' activities (n=14). Right: revenues of UTs and their sources.

These numbers indicate that although the participant UTs are located in regions where their governments are keen to invest in education and research, their available budgets as well as their expenses differ widely. All the same, it is worth noting that half of the UTs obtain between 39% and 45% of their funding from non-public sources. As shown in Chapter 2, the uncertainties in the future financial models for higher education is an aspect that might be shaping universities' ambition to become financial independent to ensure their long-term sustainability.

Comparing available financial data from previous research and the one retrieved in this study, some similarities can be outlined between European UTs and European universities in general. In 2014, 404 European universities had as well a very dissimilar budget ranging between €14 thousands and €1,5 billion. Likewise, the average budget among universities in the countries participating in this study ranged widely from €63 to €450 million (See Figure 5.12). Accordingly, the existing difference between the largest and the smallest revenues in UTs (i.e. €75 million up to €1,5 billion) is much larger than the average country figures in 2014.

Similarly, 395 European universities had, in 2014, very disparate expenses per one student ranging between €4,5 and €206 thousands. Likewise, the average expenses per one student among universities in the countries participating in this study ranged widely from €4,1 to €25 thousands (See Figure 5.13). Accordingly, the existing difference between the highest and the lowest expenses per students in UTs (i.e. €7 thousands up to €77 thousands) is larger than the average country figures in 2014.

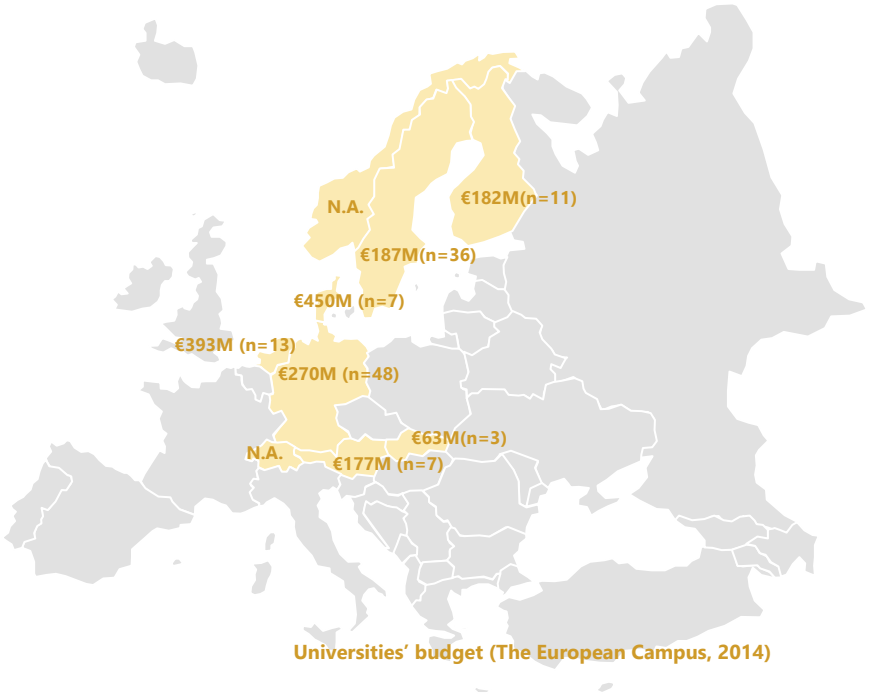


Figure 5.12 Average university budget in the countries participating in this research based on available information from previous campus management research (N.A. stands for not available since these countries were not part of the 2014 research).

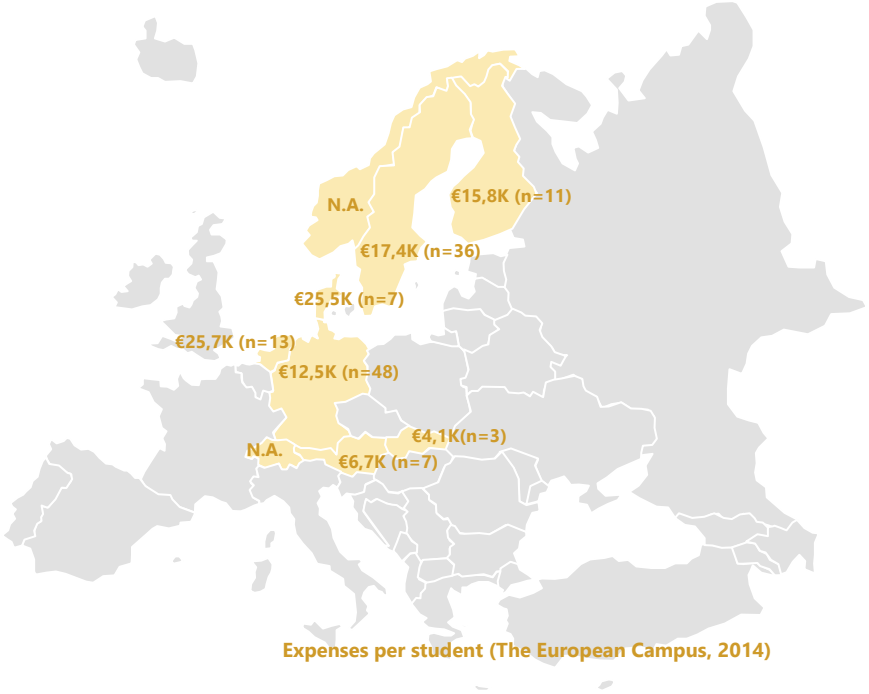
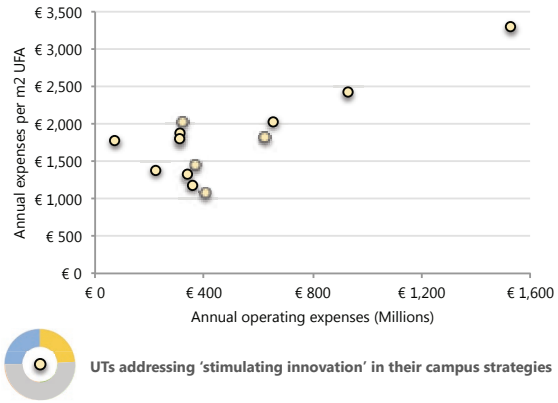


Figure 5.13 Average university expense for students in the countries participating in this research based on available information from previous campus management research (N.A. stands for not available since these countries were not part of the 2014 research).

Moreover, this study looked into UTs expenses in relation to their existing space. Accordingly, UTs have similar expenses in relation to the amount of space used in their campuses. On average, thirteen UTs spend €1,8 thousands per m2 UFA in one year. The values range from €1 thousand to €3,3 thousands per m2 UFA (See Figure 5.14). Nine of the thirteen UTs with available data on this indicator address stimulating innovation in their campus strategies. Nonetheless, their annual operating expenses are more heterogeneous ranging from €74 million to €1,5 billion. Thus, they have relatively different financial resources to spend in research infrastructure to support this goal.

Figure 5.14 UTs' expenses in relation to amount of space used in their campuses (n=13).



Eight UTs provided financial data on their investments in research facilities. When looking at this value as the percentage of their annual operating expenses, some differences can be observed (See Figure 5.15 left). Accordingly, 4% of their annual operating expenses is, on average, what these UTs invest in research infrastructure. However, this value ranges from 1% to 9% among these eight UTs. Similarly, there are wide differences between UTs when looking at combined functional and financial data such as the annual investments in research facilities per one student. The range is €175 to €1,4 thousands per one student (See Figure 5.15 right). However, by looking at the two UTs defining this wide range, it can be observed that their annual expenses per one student are not so different (i.e. €18 thousands and €29 thousands).

Thus, the differences in investments in research facilities per one student can be attributed to variances in the definition of 'investments in research facilities' given by the data providers. For instance, the UT with the highest investment in research facilities per student indicated that these investments were calculated based on the total costs of ownership estimating the annual costs required for research infrastructure. Herein, this UT included both heavy and light labs in this estimation. While other definitions included the investments in laboratory buildings made in the previous year or the projected amount to invest in research facilities, some UTs did not provided explanations about how they calculate these investments. Those UTs providing links to financial reports to retrieve this data distinguished investment in facilities in general rather than specialised research infrastructure.

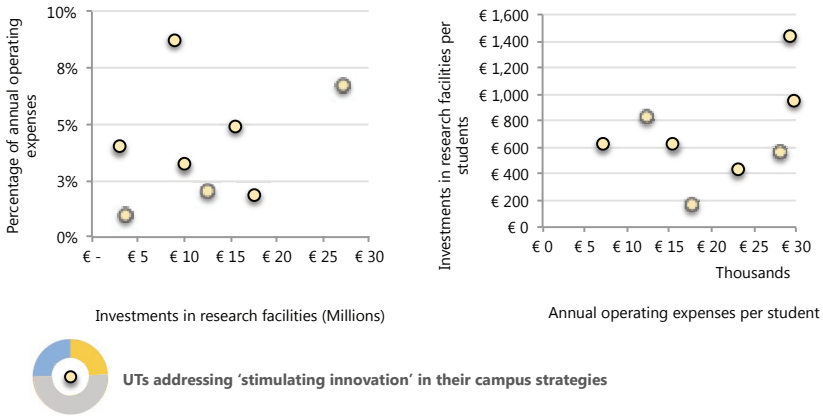


Figure 5.15 UTs' investments on research facilities in relation to annual operating expenses and students numbers (n=8).

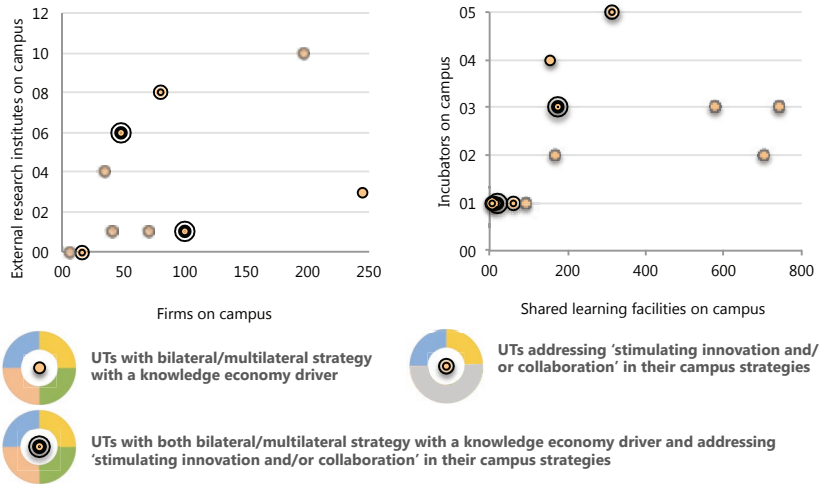
Overall, the diversity in the interpretation of this indicator limited its comparison and should be acknowledged when using this data for potential benchmarks. A similar observation is made for the amount of specialised laboratories facilities. The data provided by UTs refer to different types of spaces. Moreover, some UTs refer to a particular number of facilities while others refer to the built area. For example, the UT with the highest investment in research facilities per student has about 31 thousands m2 UFA of specialised labs in over 17 building while the UT with the lowest investment in research facilities per student estimate having 984 specialised labs.

Next to investing in research infrastructure, UTs may facilitate the stimulation of innovation as a campus strategy in two more ways. On the one hand, they can enable the accommodation of firms and research institutions on campus to enrich their innovation ecosystems and provide opportunities for collaboration with external parties. On the other hand, they can develop and/or promote the use of shared facilitates to facilitate interdisciplinary collaboration at internal level. Both interventions can also strengthen the UTs' research culture.

Functional data on the number of firms accommodated on campus (including star-ups) varies considerably among the eleven UTs with available data. Although some universities did not specify the size of the firms, this number ranges from 6 up to 245. For instance, the UT with the largest number of firms on campus have particularly promoted private real estate development on their own land to attract external firms besides their own spin-offs and/or companies started by their students and staff. Similarly, the number of external research institutes ranges widely between 1 and 10 in nine UTs with available data (See Figure 5.16 left).

Moreover, the number of incubators and/or accelerators on campus ranges from 1 up to 5 in thirteen UTs with available data (Figure 5.16 right). Although this numbers give an indication that UTs are using their campuses to promote entrepreneurship and innovation, future research should consider the amount of space occupied by these incubators instead. Altogether, these indicators outline the potential of campuses to cluster different organisations and people that are relevant to stimulate innovation and also to increase their chances for collaboration. Herein, this study also looks into the number of learning facilities shared by interfaculty users as this can enhance interdisciplinary collaboration and innovations in education and research (Figure 5.16 right). Accordingly, large variations are observed among the twelve UTs with available

Figure 5.16 Potential of UTs' campuses to cluster knowledge workers and students to stimulate innovation and collaboration.



data on this indicator. For instance, some UTs specified hundreds of shared facilities including a variety of spaces (i.e. libraries, lecture halls, seminar rooms, and study rooms) while others only address a few without specifying the type of shared facilities. Similarly, one UT acknowledges that almost all their spaces on campus can be considered shared as they have adopted a flexible concept at wide portfolio level. In contrast, others UTs were more precise by outlining the amount of m2 besides the number of facilities and lists of spaces. Herein, the variances in the ways of defining 'shared facilities' challenge the reliability of this indicator for potential benchmarks.

5.4. Concluding remarks

The results described in this chapter provided a comparative overview of most of the empirical data collected in this research. According to its analytical framework, this study distinguishes the campus management structures embedded into university governance models as the domain of campus governance. Similarly, it distinguishes campus goals embedded into universities goals as campus strategy.

The results on campus governance show that three types of campus management structures exist across European UTs: internal centralised-, internal decentralised- and external centralised structure. The former two types of campus management structures exist across twelve of the participants UTs regardless their different governance models (i.e. unitary, dual traditional and dual asymmetric). This finding point out that campus management is predominantly considered an internal task, which can facilitate its embeddedness as a strategic task in the organisation of UTs.

External management structures exist only in UTs with a dual asymmetric structure. In this governance structure, one of the governance bodies can be identified as the main decision-making organ (executive board), while the second one has more restricted competences (supervisory board). Indeed, half of the UTs have this governance structure indicating that their decision-making processes highly involve the participation of diverse stakeholders who also have a saying in campus decisions.

According to this analytical framework, the universities' governing bodies make decisions about the plans for the future shaping universities' goals. Correspondingly, as campus managers respond to governing bodies, their campus goals are shaped by universities' goals. This study points out that there seems to be an alignment between UTs' goals and the campus goals addressed in their campus strategies. Indeed, the bilateral competitive –socially driven strategy is the most common strategy type found both at university and campus level. Moreover, this study acknowledges the multi-perspective focuses of both UTs' and campus' goals shaping campus strategies across all four stakeholders' perspectives. Figure 5.17 summarises the main findings on campus governance and campus strategies.

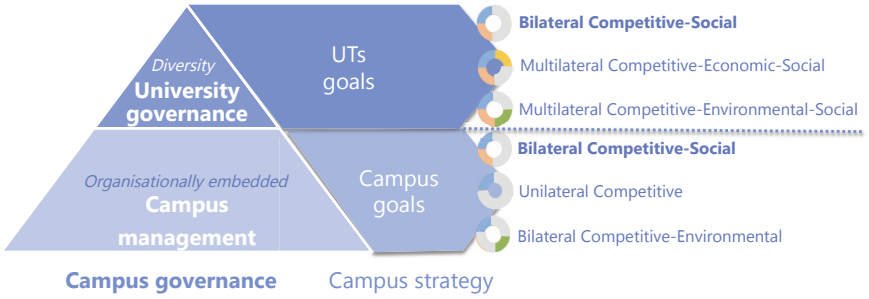


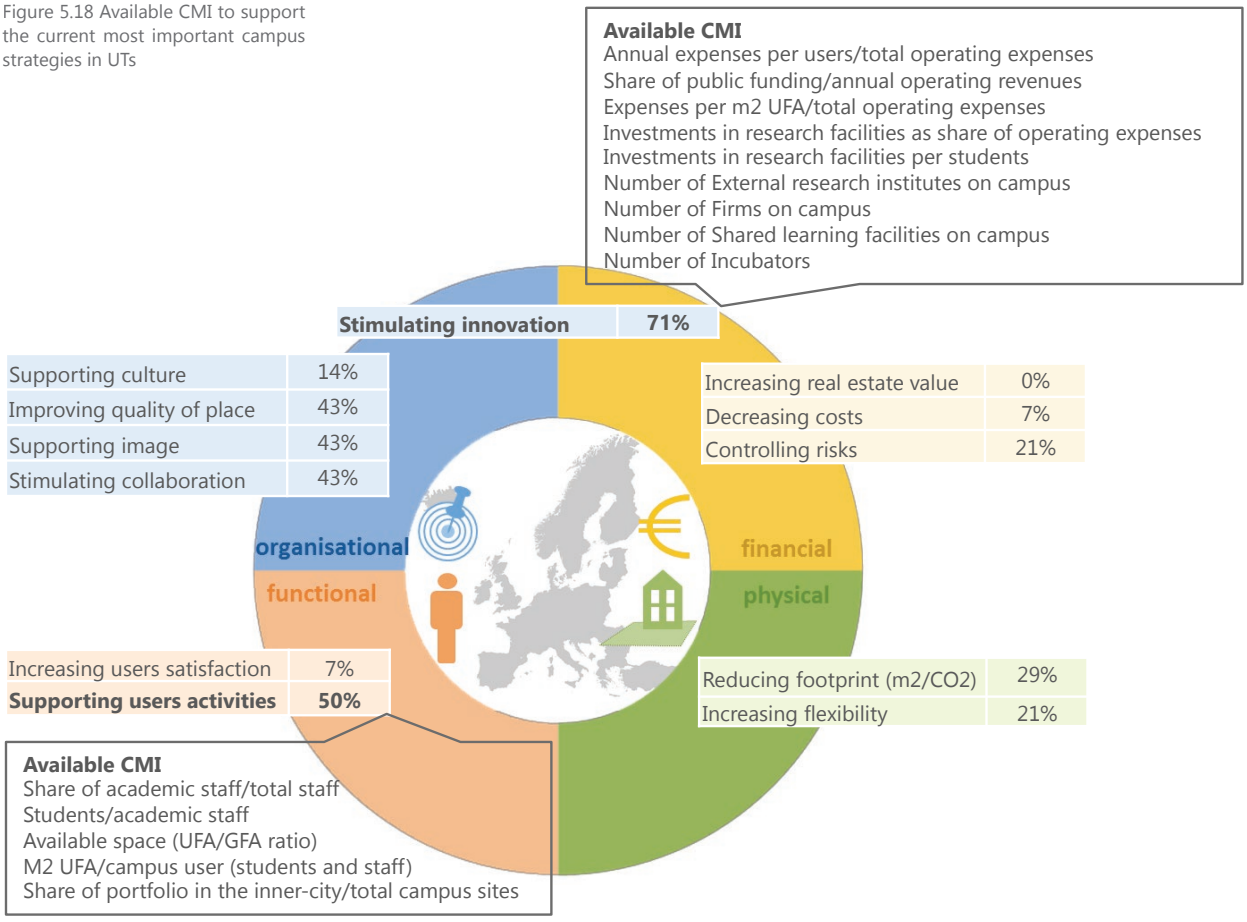
Figure 5.17 Positioning the results of this study on campus governance and campus strategies according to its analytical framework

Moreover, this study shows that campus managers in European UTs address eleven of the twelve campus goals identified in previous research in the Dutch context. These goals span across the four campus management perspectives (See Figure 5.18). Accordingly, stimulating innovation and supporting users' activities are the most common goals identified in European UTs. Therefore, this study used these two campus goals to illustrate the usefulness of collecting CMI to assess the current state of their campuses supporting these goals.

As illustrated in Figure 5.18, the comprehensive set of CMI collected in this study provided multiple indicators that campus managers can use to assess their campuses in relation to these goals. In supporting the activities of its main users, campus managers can use available CMI that characterise their main users' population (i.e. number of students and staff, share of academic staff per total staff and students per academic staff). Similarly, they can use available CMI that shows the quantity and quality of the space available to support the activities of these users in general (i.e. UFA/GFA ratio, m2 UFA per campus users, and share of the portfolio located in the inner city). For instance, CMI that focus on the quality and quantity of space can also be used to assess the campus in relation to 'improving quality of place' and 'supporting image', which are also relevant campus goals addressed by nearly half of the UTs.

In stimulating innovation, campus managers can use available CMI that provides an insight on their financial capacity to undertake investments in research infrastructure according to their population and campus size (i.e. annual expenses per users/total operating expenses, share of public funding/annual operating revenues, expenses per m2 UFA/total operating expenses, investments in research facilities as share of operating expenses, and investments in research facilities per students). Similarly,

Figure 5.18 Available CMI to support the current most important campus strategies in UTs



campus managers can use available CMI that asses the current diversity of campuses as innovation ecosystem and their capacity to facilitate collaboration among actors in such ecosystems (i.e. number of external research institutes on campus, number of firms on campus, number of shared learning facilities on campus, and number of incubators). The latter examples of CMI can also be used to assess the campus in relation to 'stimulating collaboration', which is also a relevant campus goal addressed by nearly half of the UTs.

Overall, the available CMI in this study are exploratory rather than representative of the main campus goals identified across the fourteen UTs. Therefore, future research that focuses on particular campus goals can be more explicit about the type of CMI collected and analysed. Similarly, clear definitions should be addressed to overcome potential limitations in the comparison.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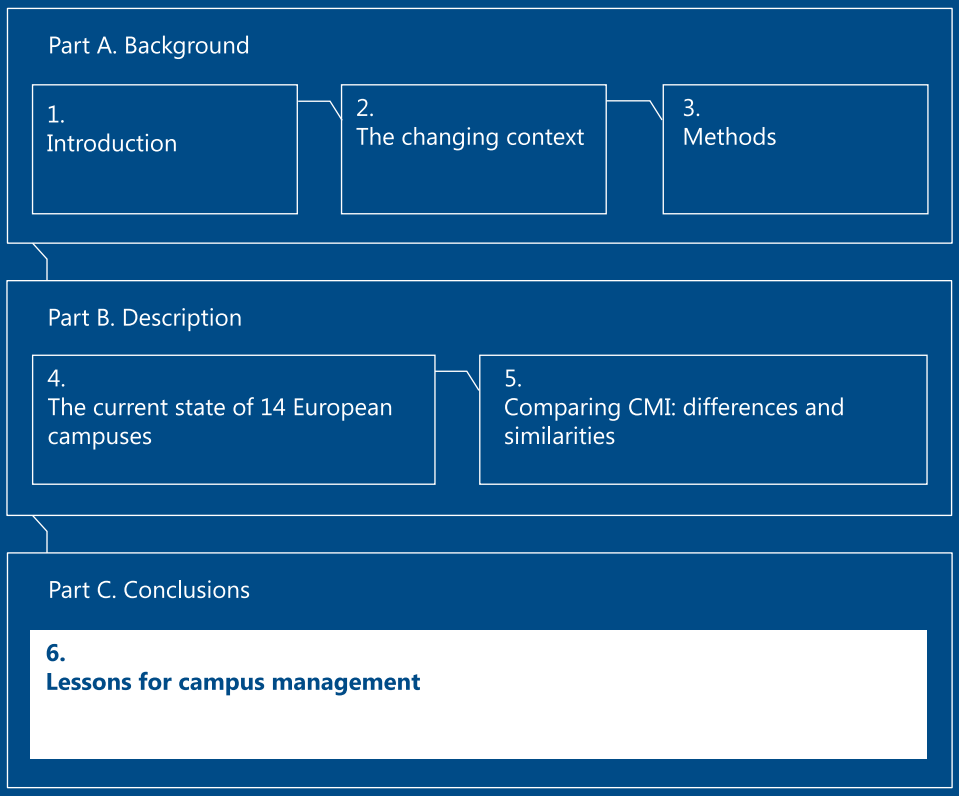
C. Conclusions

In an open data-driven society, sharing campus management information (CMI) encourages learning and professionalises campus management.

Lessons for campus management



6. Lessons for campus management

This chapter contains different campus management lessons for researchers and practitioners. These lessons can be read as summary of the main findings combined with recommendations for future research and campus management practices. The lessons are structured in four parts - the numbers also correspond with the subsections of this chapter:

1. The dynamic context of campus decision-making, based on the findings of exploring the changing demand, generating the future models and defining the projects transforming the current campus in European universities
2. Data overview as references in campus decision-making, based on the findings of assessing the current campus in fourteen UTs
3. Towards a sustainable campus management knowledge base, based on the reflections of the data collection process
4. Future research, based on the reflections of the quality of the research

Furthermore, the lessons in each of these parts are linked to eleven propositions, aimed to encourage discussion for better campus management.

6.1. The dynamic context of campus decision-making

The UTs' mission of advancing technologies for society has remained intact for more than two centuries and today's campus strategies are explicitly supporting this mission.

This study looked at the development path of UTs by providing an insight into their origins as well as the present and future trends affecting the context in which they operate (Chapter 2). It can be said that UTs have been characterised for being prestigious research institutions advancing the development of technologies with a societal purpose (Chapter 2, section 2.1). They have evolved to be important players in the knowledge-based economy and society, which are shaped by competition and collaboration. The predominant focus of current campus strategies in stimulating innovation explicitly supports this mission (Chapter 5, Section 5.2)

(Inter)national relations, competition, funding, politics and societal issues determine the increasingly dynamic context in which universities operate.

UTs have sought to organise themselves in order to collaboratively perform research and join forces to remain competitive in the global higher education landscape (Chapter 2, section 2.2). Indeed, this research pointed out the dynamic trends influencing such landscape in general. By providing a catalogue of alternative scenarios for universities (Chapter 2, section 2.3), this research identified main interrelated uncertainties used by scholars to shape the alternative futures for universities. It can be said that to shape their plans, universities must consider their 1) purposes and roles in society, 2) international and transnational relations; 3) sources of funding for education and research; 4) relationships with other universities, market and third-sector parties; 5) adoption, integration and adaption of digital technologies supporting their primary processes; and 6) segmentation of students and workforce.

These six uncertainties are the most critical based on the review of the literature, but they are certainly not the only ones that can be considered by universities in scenario planning (e.g. growth or shrinkage of students and staff, among others). Ultimately, acknowledging them will guide universities to make strategic choices to accommodate change.

To address the manifold challenges faced by universities now and in the future, managers (must) acknowledge the interrelation of the multiple perspectives in campus management.

This study establishes links between the uncertainties summarised above and institutional, economic, social and environmental developments that correspond to the four perspectives on campus management: organisational, financial, functional and physical (Chapter 2, section 2.3). University- and campus managers can select those uncertainties that are critical to them and determine ranges per uncertainty to develop their own scenarios, given their particular institutional, economic, social and environmental development. Indeed, they should see these uncertainties as interrelated aspects defining the future of higher education.

Altogether, the findings of this exploration emphasized the relevance of the multi-perspective approach in campus management. This is particularly important when anticipating the multiple trends that affect the organisation, community, finance and sustainability of universities. This was illustrated by campus managers in four UTs that provided feedback on this research, addressing the following as the most familiar challenges faced by UTs:

- University merging processes increasing the complexity of campus portfolio management.
- Digital transformations influencing campus use and the transformation of the built environment.
- Need for smart sustainable concepts to cope with the increased university buildings in need of renovation.
- Increased partnerships with local public and private parties in campus development.
- Sustainable preservation of campus heritage buildings
- Limited funding to cope with the costs of maintaining the campus
- Modernisation versus healthy and user-friendly environments

In this context, campus managers cannot disregard the interrelation of the multiple perspectives affecting strategic campuses management.

Identity, sustainability, location, collaboration, flexibility, digitalisation and health are shaping the physical campus in a combination of traditional, network and virtual arrangements.

By scanning the projects transforming the current campus in Europe (Chapter 2, section 2.5), this research grouped different interventions in eight campus labels that are linked to 12 strategic themes and three campus models identified in previous research. These labels are 1) Co-campuses; 2) Wow-campuses; 3) Eco-campuses; 4) Open-campuses; 5) Urban-campuses; 6) Home-campuses; 7) Smart-campuses and 8) Zen-campuses. Herein, it can be said that the current campus projects are rather heterogeneous in their themes (between 2 and 7 themes each). Accordingly, investing in state-of-the-art laboratories (Theme 4) and rethinking the academic workplace (Theme 1) are the

most popular strategic themes present in at least four categories of campus projects. The comprehensive review of projects that are transforming the current campus also confirmed the proposition that the campus of the future will be a combination of traditional, network and virtual spatial arrangements as suggested by Den Heijer et al. (2017).

Campus managers can use the overview of campus projects as a catalogue of references.

The collection of campus projects is demonstrating organisational, financial, physical and functional drivers shaping the future demand in universities. The physical driver "quality of place" is the most common supported by projects in five of the eight groups, followed by "distinctiveness" also as physical driver, "identity" as organisational driver and "productivity" as functional driver. Campus managers can use the catalogue of reference projects to determine to which extent their current and planned interventions align with the changing demand in the higher education landscape; and/or match their ideal campus models.

6.2. Data overview as references in campus decision-making

Multi-perspective data overviews offer comprehensive pictures to various campus decision makers.

This study provided a comprehensive assessment of the current campus in fourteen European UTs (Chapter 4). The information displayed in section 4.2 allows campus managers to have a transparent and thorough picture of the campus management information collected per each university from four different perspectives – organisational, financial, functional and physical. This information has already been used for campus managers to assess their own practices based on comparable situation and to identify patterns in the alignment between the strategies of UTs and their campuses.
This study suggests continuing mapping the readiness of Europe's higher education infrastructure to engage global competition and sustainable development through references that can inform campus decision makers.

Campus decision-making remains a multi-stakeholder process regardless the governance structure of the university

This study has assessed the current state of the campus in UTs located in Europe's most innovative regions. To do so, it uses a strategic approach to campus management based on literature from Corporate Real Estate Management. Herein, campus management is a complex process embedded in a variety of multi-stakeholder decision-making arrangements and courses of actions that distinguishes campus governance, campus strategies and campus management information or CMI.

This research illustrates the heterogeneous overview of campus governance in European UTs (Chapter 5, Section 5.1). The predominance of dual structures in UT's governing bodies exemplifies how campus decisions are shaped by the manifold goals of multiple stakeholders strengthening this study's approach to strategic campus management. Correspondingly, there is a challenge for campus managers to consider and balance the multiple perspectives of these stakeholders, which can be contrasting and require trade-offs.

Although the campus management structures varied per context, there is a preference in UTs to internally manage their real estate in a centralised way. This stresses the prevalence of user-oriented approach in campus management; in which UTs tend to embed the campus' strategies within their overall university strategies to exert more control in campus decisions. Similarly, the dominance of user-oriented approach in UTs is illustrated in those internal but decentralised campus management structures, which clearly distinguish their focus on individuals and organisation.

Stimulating innovation and supporting users activities are the ultimate UTs' campus strategies and Europe should invest in CMI to track successful implementation.

Moreover, this study has shown that UTs have multiple and heterogeneous organisational- and campus strategies (Chapter 5, Section 5.2). This finding corresponds with the campus management task to support multiple stakeholders' perspectives. At organisational level, most UTs have the ambition to consolidate their competitive advantage and productivity while simultaneously supporting socio-economic ambitions in their local contexts such as regional growth in their knowledge-based societies. At campus level, there is a correspondence to such ambitions and demonstrated by the UTs current focus on 'stimulating innovation' and 'supporting users' activities' as the main campus goals shaping their campus strategies.

Such findings on campus strategy are limited to identifying the multi-perspective focus used by campus manager to design their strategies rather than to implement them. In order to know how campus managers are attaining such goals, information that is more specific is needed.

Indeed, this research attempted to explore the importance of collecting CMI in 'assessing the current campus' as the first campus management task (Chapter 5, Section 5.3). Accordingly, collecting CMI in this first task will enable campus managers to focus on their remaining tasks (i.e. exploring the changing demand, generating future models for the campus, and defining projects to transform the campus). This study used its comprehensive set of available data variables and indicators to present complete pictures of the current campus per each UTs (Chapter 4, Section 4.2) and to compare selected CMI in relation to the main goals addressed by most of the participant UTs in their campus strategies (Chapter 5, Section 5.3). This rich information can be used not only to advance the existing understanding of the current campus in European UTs but also as reference to inform benchmarks in campus management research.

Largely, this research acknowledges the importance of collecting multi-perspective CMI, given the fact that UTs addressed multiple goals in their campus strategies. Similarly, it suggests that, by knowing the current focus of campus strategies, future research should focus on particular indicators and the relationships among the four campus management perspectives. That is because for particular goals such as 'stimulating innovation', campus managers need to look both at the quality and quantity of space as well as the ways they are used and financed. This study's explorative exercise to provide campus managers with complete pictures was limited by the broad character of the data collected and its availability. However, more research can enable UTs to identify a set of particular CMI that can be easily measurable and widely applicable. Herein, attention should be paid also to output indicators as measures of performance that focus more on the effectiveness of campus strategies rather than their efficiency.

6.3. Towards a sustainable campus management knowledge base

Campus managers of UTs are collecting CMI but their willingness to share it is limited.

A response rate of 22% in this study's survey shows that UTs are enthusiastic to participate in campus management research. Indeed, the reasons for not participating are left unknown except from two UTs. One of them showed interesting but claimed that 'as a matter of principle does not participate in any kind of surveys'. The other explicitly mentioned its lack of interested in the research. From the participant UTs, two of them did not fill the survey because their campus managers lacked the time but were willing to participate by providing links to the information instead. In fact, one of them reviewed the data collected during the verification process.

Overall, it can be said that UTs are willing to spend time in collecting the requested information in exchange for information and learning from comparable situations. Simultaneously, the latter could be one of the reasons why some UTs did not participate in this research fearing potential judgements from unwanted comparisons. Other plausible reasons could be the lack of structural databases and the availability of incomplete data in UTs' real estate departments. All in all, the positive participation of fourteen European UTs is helping to advance the current understanding on campus management and to expand the existing knowledge base on CMI.

In an open data-driven society, sharing campus management information (CMI) encourages learning and professionalises campus management.

Four participant UTs provided feedback to this study on different aspects of the data collection process. Accordingly, the survey sent to managers was mostly filled by two to three people in most campus management departments and/or divisions. Only one UT reported that the data was collected by one person. Similarly, campus managers reported that the collection was reasonably easy, as most of the information was available on the UTs website and/or in their own department databases. Herein, campus managers in these UTs acknowledged the use of performance indicators in their practice for three main purposes: 1) to support a range of goals in UTs, 2) to make decisions in practice and 3) for comparison in official documentation.

This insight confirms the practical importance of multi-perspective CMI. Besides the data gathered in this study, one UT provided examples of KPIs in all the four campus management perspectives including footprint ratios, financial ratios, quality of real estate, occupation and actual use of the space, performance contracts and sustainability. Overall, this research provided campus managers with data they wish to see in benchmarks such as space per user and space per students. However, campus managers pointed out other information they would like to see in future research such as space frequency and occupancy data, office space per person, space management efficiency, education timetabling, quality of learning spaces and energy usage.

Moreover, when asking managers how they are sharing CMI among the different decision-makers in their practice, most of them outlined two main channels for data sharing: existing Excel databases and annual reports. Two of them mentioned other channels such as institutional repositories, national databases on higher education statistics open to the public in general, and digital databases open to campus decision-makers in particular. Notwithstanding, some campus managers pointed out other ways in which they wish to share CMI such as online dashboards that can be frequently

updated and research. The latter seems to be important as the collection of CMI requires attention to definitions and interpretation of data. This insight confirms the practical relevance of this study.

Overall, this feedback suggests that understanding the reasons, methods and processes used my campus managers to obtain and share CMI in their own practice is an interesting avenue for future research on campus management. On the practical side, this research recommends to invest resources in developing shared CMI databases as a task of the existing European and transnational collaboration agencies among universities (Section 2.2.2).

6.4. Future research

Managers' participation in research is essential to advance the current understanding of campus management and its improvement.

This research advanced the existing understanding of strategic campus management in the CREM field. First, its analytical framework helped to collect data that illustrates the existing alignment between organisational and campus goals and the multi-perspective focus of universities' and campus' strategies.

Second, this research strengthened the existing knowledge base on CMI. Compared to previous research, this study made progress in the collection of available KPIs on all four perspectives on campus management. The use of survey rather than desk research helped to obtain more specific and reliable information from first sources. Nonetheless, its explorative approach seeking for comprehensive datasets helped to identify limitations and areas for improvement in future research. For instance, the persistent differences in the definitions of particular variables indicate universities may be measuring aspects in different ways. This suggests further improvements in the methodological design of surveys, which should provide more clear definitions in advance rather than on demand. This study opted for providing definitions on demand to alleviate pressure on campus managers. As a learning point, it can be said that the benefits of collecting CMI may not seem to exceed the costs of investing time on it regardless potential challenges and constraints.

Third, next to more clarity on the definitions, this study suggests to explore more open channels for dialogue with campus managers to obtain richer and more consistent CMI. For instance, interviews with campus managers can complement surveys as methods for data collection. Their narratives can make a significant contribution towards building multi-perspective CMI to support campus decisions.

Fourth, the assumption that studying a more homogenous sample would ease the comparison of data is not confirmed in this research. Although the strategy to focus on UTs located in Europe's most innovative regions provided a more homogeneous context to identify current campus patterns compared to previous research, wide differences are observed among them. These differences were particularly obvious in the financial indicators. Nonetheless, the focus on Europe's most innovative regions may have acted as a trigger to for some universities to participate in this research as their selection positions them as important nodes in the European innovation system.

Last, this study acknowledges that the dynamic context in which UTs operate poses limitations for campus management research. For instance, several campus managers outlined changes in CMI during the verification period of the data collected. That is

about one year after the data was retrieved. However, the researchers opted for not updating the information to maintain the homogeneity of the data provided by the participant UTs. This particular observation suggests the use of more dynamic ways of collecting and using CMI in research. This is even more reason to professionalise data collection to generate management information for European universities.

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Appendices

I. Universities' country organisations

The following table lists the country organisations that were contacted in this research and/or which databases were consulted to fill in preliminary data on the 62 UTs. Three types of organisations were contacted and/or consulted:

1. Universities' associations or networks that provide information about higher education trends to policy makers and campus managers.
2. Real estate companies that focus on university properties, and
3. Institutions that provides statistical information on higher education

Country	Name	Overview (as described in the their websites)
Austria	Universities Austria (UNIKO - Österreichische Universitätenkonferenz)	Universities Austria is a non-profit association under private law. Its purpose is to assist the Austrian universities in the fulfilment of their tasks and responsibilities and thus to foster scholarship and research.
	Bundesimmobiliengesellschaft (BIG)	BIG is a real estate company in Austria, which largest tenants include the Federal Ministry of Education, Science and Research, the Austrian universities, and the Federal Ministries of Justice, Finance and Home Affairs.
	UNIDATA Federal Ministry for Science, Research and the Economy	UNIDATA is the university statistical information system in Austria. Its main task is the provision of up-to-date facts and figures about the Austrian higher education sector. Depending on the authorization, UNIDATA provides permanent access to statistical information in the areas of budget, students, graduates, staff and room as well as teaching and research indicators of universities and technical colleges
Denmark	Universities Denmark (DKUNI)	Universities Denmark is the organization of the eight Danish universities to enhance their cooperation, visibility and impact. Universities Denmark works to ensure that its members have the best possible conditions for shouldering their responsibility towards research, research-based education and dissemination of knowledge. University management and staff convene at Universities Denmark to discuss issues of common interest, to take joint initiatives, and to communicate with politicians, ministries and partners.
	Bygningsstyrelsens (Danish Building and Property Agency)	The Danish Building and Property Agency is the state's property enterprise and developer. Their responsibility is creating modern, functional and cost-effective frameworks for some of the country's most important government institutions, for example the universities, the police, the courts and the government departments.

Finland	Universities Finland UNIFI	UNIFI is the Rector's Council of Finnish Universities that promotes university cooperation and brings forward common positions on key research and education policy issues. UNIFI also aims to strengthen the role of universities as an important part of social dialogue.
	Vipunen - Education Statistics Finland	Vipunen is the education administration's reporting portal. The Ministry of Education and Culture and the Finnish National Agency for Education are jointly responsible for its content.
France	Conference of University Presidents (CPU)	CPU, as defined in Article L233-1 of the French Code of Education, is composed of the directors of universities, national polytechnic institutes, écoles normales supérieures, grandes écoles, and research and higher education clusters (PRES). The CPU participates actively in the public debate on education issues, and plays a proactive consulting and negotiating role with the public authorities, the various higher education and research networks, social and economic partners and national and international institutions.
	High Council for Evaluation of Research and Higher Education (HCÉRES)	Hcéres is defined by the Law of 22 July 2013. Its method is based on a commitment to the evaluated institutions, a commitment to accompany them and to be a partner in their progress.
Germany	German Rectors' Conference (HRK)	HRK is the association of public and government-recognised universities in Germany. The member institutions are represented in the HRK by their executive boards and rectorates. The HRK currently has 268 member institutions, in which around 94 per cent of all students in Germany are enrolled.
	Federal Statistical Office (DESTATIS)	The Federal Statistical Office is a federal authority of Germany. It reports to the Federal Ministry of the Interior. The Office is responsible for collecting, processing, presenting and analysing statistical information concerning the topics economy, society and environment including education and research.
Ireland	Irish Universities Association (IUA)	The IUA is the representative body for Ireland's seven universities. Through consultation and collaborative projects we develop strategy and policy to advance third and fourth level education and research. Our shared aim is to maximise the universities' contribution to Ireland's social, cultural and economic well-being.
	The Higher Education Authority (HEA)	The HEA has a statutory responsibility, at central government level, for the effective governance and regulation of higher education institutions and the higher education system in Ireland.

The Netherlands	VSNU (Association of universities in the Netherlands),	In VSNU, Dutch universities work together towards a strong university sector. The 14 Dutch universities within the VSNU show the outside world how they fulfil their social function, formulate shared ambitions relating to academic education and research and valorisation, and lobby for the preconditions needed to realise these ambitions.
Norway	Universities Norway (UHR)	Universities Norway (UHR) is a cooperative body for 33 accredited universities and university colleges. UHR's extensive networks enable the organisation to draw on specialised academic and administrative expertise from the entire sector.
	Statistics Norway	Statistics Norway is the national statistical institute of Norway and the main producer of official statistics. We are responsible for collecting, producing and communicating statistics related to the economy, population and society at national, regional and local levels.
Slovakia	Slovak Rectors' Conference (SRK)	SRK is one of the three bodies representing the universities in Slovakia. The aim of SRC is to coordinate and promote rectors' activities at Slovak universities in order to create a common higher education policy.
Sweden	Association of Swedish Higher Education (SUHF)	SUHF aims at promoting the sector interests to external actors and at strengthening internal cooperation. The Association was set up by the universities and university colleges themselves, the initiative being taken by the rectors concerned. It was as a merger between two existing rectors' conferences.
	Swedish Higher Education Authority (UKÄ)	UKÄ evaluates the quality of higher education and research, analyses the development, is responsible for official statistics about higher education and monitors compliance with laws and regulations among universities and university colleges.
Switzerland	Swissuniversities	Swissuniversities works to strengthen and enhance collaboration among Swiss institutions of higher education and promotes a common voice on educational and research issues in Switzerland. Furthermore, swissuniversities performs coordination tasks and acts on the international level as the national rectors' conference for all universities, universities of applied science and arts and universities of teacher education in Switzerland.
	The Swiss Federal Statistical Office (FSO)	The FSO is Switzerland's national competence centre for official statistics. It produces and publishes statistical information on the status and development of the population, economy, society, education, research, territory and the environment.

II. Survey protocol

Data collection procedure

This study used email as conduit to contact country organisations and campus managers in three steps. The first contact email introduced the European campus research project to draw their attention and interest to participate in this phase (See Box ii.1 below).

Dear Mr/Mrs…,

As "Campus Research Team" of Delft University of Technology (TU Delft) we have been studying the future of (management of) the university campus since the mid-nineties, which resulted in many publications and a network of campus management experts in theory and practice. Since 2013 we are doing comparative studies of campus management practices in Europe: research project "The European Campus". This project aims to provide universities and universities' country organisations with information that supports decision making about (managing) the university and campus of the future. The first results about over 860 universities were published in 2014 in a book "The European campus – heritage and challenges". More recently a book was published – "Campuses, cities and innovation" (2017) - based on PhD research, describing 39 science parks that accommodate tech-based research.

At the current stage of this European campus project we are comparing campus management information of 56 universities of technology located in Europe's leading innovative regions. xxxx is part of this selection and we would welcome your help to collect this information. We are particularly interested in comparing these universities' goals, finances, users and spaces. To be more specific, we look for particular campus information regarding four perspectives:

- Strategic: for example the universities' goals stated in their (campus) vision
- Financial: for example the universities' annual operating revenues and expenses (of the campus)
- Functional: for example the number of students and staff employed at the universities, and
- Physical: for example the land property / use and floor area (in m2) on campus

We will use the results to produce a descriptive and comparative overview of campus management information of universities of technology in Europe's leading innovative regions. Institutions can use these results to benchmark their own performances in managing their resources based on homogeneous variables.

Reliable institutional data is crucial to produce consistent management information. Therefore, your help would be welcome to direct us to sources from which we can retrieve this information. This could be a link to an existing study, a publication and/or a person that can provide this information.

We are planning country visits in 2017/2018, both to explore how we can support your decision making with our research projects in the future and to show what we have already done in the past. We would like to know who would be the right person(s) to contact, for the data collection and for the interviews (on site or via e-mail, telephone call or Skype call).

Could you let us know if you are interested in participating in this research? Also, if you would like to receive the results of this research and/or have questions about this project, please contact the following researchers:

Dr. Ir. Flavia Curvelo Magdaniel, post-doctoral researcher, f.t.j.curvelomagdaniel@tudelft.nl, T. +31 6 39898693
Dr. Ir. Alexandra den Heijer, leading researcher, a.c.denheijer@tudelft.nl,
T. +31 6 81474384

We thank you in advance for your reply.

Box ii.1 Example of first contact email

The second contact email was sent as a reminder including the survey in a spread sheet format as an attachment (See Box ii.2 and Table ii.1).

Dear Mr/ Mrs…,

Recently, we sent you an invitation to participate in our comparative study of Campus Management practices. We asked to campus managers of 56 universities of technology in Europe's leading innovative regions to help us collecting data. We noticed that you have not yet responded on behalf of xxx campus. We also understand that campus managers are busy and have limited time to attend this type of requests. For that reason, we have extended the research period because your response is vital in helping us producing consistent campus management information. If you are interested in participating in this research, we kindly ask you to let us know by replying our email.
We have attached a spreadsheet in Excel with the overview of indicators we are looking for. For some universities, parts of the data have been collected and you will help us to corroborate this. There are different ways you can help us in our data collection process:
You can fill-in the data (or part of it) in the spreadsheet and return the file to us,
You can send us (a link to) a report or document where we can retrieve particular information (for example, the vision of the university where we can identify the main goals driving the campus strategy, or financial reports where we can retrieve the financial information).
We can also have an interview via Skype. We will send you a questionnaire to you via email beforehand.

Basically, we can do this the way that works best for you and adapt to your demands.
If you have any further question, please contact us by email (f.t.jcurvelomagdaniel@tudelft.nl) or by phone (+31 639898693).

We thank you in advance for your reply.

Box ii.2 Example of second contact email

Next to exchange emails that followed the second contact and reminders, the third step consisted of an update email. Herein, campus managers were asked to revise and verify the data collected in the format for publication. Simultaneously, this email was used to engage campus managers in future research and a collaborative network, which can encourage them to collect and share campus manager information to support their decisions (See Box ii.3).

Dear Mr/Mrs xxx,
It has been a long time since our last contact about this project in xxx.
I am writing to you (also on behalf of the campus research team at TU Delft) for two reasons, which have kept us busy for the last year and we believe they are also relevant for you.

EU Campus project progress and final data check
First, we are pleased to give you an update of our research progress. Thanks to your help, we have been able to gather comparative data of 14 European universities of technology including your university (see attachments). We are currently writing the report (to be published in a book that you will get from us) and in order to assure that the data is correct we would like you to check the data. In the Excel file, the information marked in yellow requires attention (if applicable to you), as it seems to be unclear or odd when comparing indicators among the 14 universities. Also, we kindly invite you to look closely at the other information and indicate if anything else needs to be corrected or added to the existing data.

We will phone you and/or arrange a Skype meeting with you to discuss this or any other particular matter if you mind. We hope to have your feedback by the end of September to proceed with the publication of the research.

Campus2Share network invitation to collaborate
Second, we have been busy building up an international network to share information among campus managers and researchers because the urgency to improve campus management is only increasing! In the attachments you can find a short description of the proposal that has been submitted by a team of 24 participants from 15 different countries. Because we have identified similar challenges in campus management, we ask you:

Would you like us to keep you informed about our campus management network activities, including CAMPUS2SHARE?
We look forward to hearing your reply many thanks in advance!

Box ii.3 Example of update email for data verification

The attached information accompany the update email consisted of two files. One of the files was a spreadsheet that contained one tab with the information they provided and one tab with an overview of the CMI of all 14 participants UTs. The other file was a PDF containing the two page overview of their descriptive data as presented in Chapter 4 of this report. Most UTs verified their data.

Overall, participant UTs maintained communication via email and telephone with the project researchers for data verification and further explanations. The people facilitating the information collected in this research and their affiliation to the participant UTs are listed in Table ii.1.

UT	Contact person	Affiliation
Aalborg University	Andreas Rasmussen	Department leader for Administration & Planning, Campus Service
Aalto University	Tuomo Uusitalo	Assistant Property Manager Aalto University Campus & Real Estate (ACRE)
Technical University Denmark	Henrik Liebach	Head of Administration and Economy, Campus Service (CAS) Administration
ETH Zurich*	Dominik Brem	Public Real Estate Management Sustainability and scientific concepts
Lappeenranta University of Technology	Petri Nuutinen	Property Manager, University Properties of Finland
Norwegian University of Science and Technology	Nils Jørgen Moltubakk	Senior Advisor, Finance and Property, Property management
	Tore Brandstveit Haugen	Professor, Faculty of Architecture and Design
Swedish University of Agricultural Sciences	Per-Olov Skatt	Director Division of Facilities Management
Slovak University of Technology in Bratislava	Maria Buciova	Strong
Delft University of Technology	Bart Valks	Policy Officer Real estate Development, Strategic Campus Management Department, Campus and Real Estate
Eindhoven University of Technology	Jeroen Carels	Program Manager Real Estate, Accommodation Service, Strategy and Programme Department
	Annemieke Pelt-Thissen	Portfolio Manager Real Estate, Accommodation Service, Strategy and Programme Department
Graz University of Technology*	Manuela Berner	Statistics and empirical Analyses
University of Twente	Marc Hulshof	Policy Advisor, Campus & Facility Management, Policy & Project Office
Wageningen University & Research	Ruud Duijghuisen	Manager Business Development, Wageningen Research
	Petra Caessens	Manager Campus & Facilities, Corporate Value Creation

Table ii.1 Contact people during the data collection and verification processes. Notes: *The contact people in these UTs did not fill in the survey but instead provided links to access the data. The contact person at ETH validated the information during the verification process.

Feedback questionnaire

After the data collection process ended, campus managers were asked to provide feedback to the researchers. A one-page questionnaire was sent via email to the contacts in the participant UTs (See Box ii.4).

The European Campus 2.0
Campus management information (CMI) of universities of technology in Europe's most innovative regions

The following questions are part of a research conducted at TU Delft and targeted to fourteen participant universities of technology in Europe. Answering these questions is voluntary. If you do so, you give us permission to collect and retain the information provided by you. Your institutional data and answers will be kept confidential and cannot be traced back to you. We will use the anonymous results to produce a report as outcome of the research project.

Part A. Campus Management organisation
1. Which organisation/division(s) is (are) in charge of campus management* at your university?
*By campus management, we mean managing the university's accommodation and balancing different views on universities' real estate, including strategic, asset, functional and technical views.

2. How many people or departments/divisions were involved in filling-in the form we provided you?

3. Was filling the form easy? If no, can you tell us why?

Part B. Campus Management Challenges
4. What do you consider the biggest (campus management) challenge your university is facing?

5. Does one or do some of the following challenges - addressed by other universities- sound familiar to you? Mark as many as applicable.

a. _____ University merging processes increasing the complexity of campus portfolio management.
b. _____ Digital transformations influencing campus use and the transformation of the built environment.
c. _____ Need for smart sustainable concepts to cope with the increased university buildings in need of renovation.
d. _____ Increased partnerships with local public and private parties in campus development.
e. _____ Sustainable preservation of campus heritage buildings
f. _____ Limited funding to cope with the costs of maintaining the campus
g. _____ Modernisation vs. healthy and user-friendly environments.
h. _____ Fostering the approach of accountability to students, faculty, partners and the public.

Part B. Collecting and sharing CMI
6. Do you use performance indicators in your practice?

7. If yes, which of the following reasons explain better the use of KPIs in your practice?
a. _____ To support a range of goals
b. _____ To make decisions in practice
c. _____ For comparison in official documentation
d. _____ All of the above

8. How are you sharing CMI among the different decision-makers in your practice? Mark as many as applicable
a. _____ With an institutional repository open to the public
b. _____ With a database that can be accessed by campus decision makers at any time
c. _____ With Excel databases shared at request by different campus decision makers
d. _____ With annual reports
e. _____ Other: _____
f. _____ We do not share data among campus managers

9. How would you like to share campus management information among the different decision-makers in your practice?

10. What information would you like to see in a campus management benchmark?

Box ii.4 Feedback questionnaire

III. Authors bio

Flavia Curvelo Magdaniel is a postdoctoral researcher of Real Estate Management at the Department of Management in the Built Environment, Faculty of Architecture, TU Delft. She was educated in Bogotá, Colombia, where she has worked as an architect. In 2008, she moved to the Netherlands to pursue a master's education in Real Estate & Housing. In 2010, she received the Master of Science degree at TU Delft and in 2011 joined the Department of Management in the Built Environment as a doctoral candidate. Her dissertation on the development of technology campuses combined insights from Corporate Real Estate Management and Urban Development Management.

Alexandra den Heijer is professor of Public Real Estate at the Faculty of Architecture and the Built Environment of Delft University of Technology (TU Delft). Her specialization is university campuses. She is the leading researcher of TU Delft's Campus Research Team and has published many books and other publications on this topic, including Managing the University Campus (2011) and The European Campus–Heritage and Challenges (2014). In the past 15 years, she assessed past campus decisions, opportunities, and threats of the current state of the campus and strategies for the campus of the future. For more information, see http://managingtheuniversitycampus.nl

Monique Arkesteijn is assistant professor of Real Estate Management at the Department of Management in the Built Environment, Faculty of Architecture, Delft University of Technology. Her research topics include CRE strategies, CRE alignment and measuring added value for corporate, public and semi-public organisations. Monique is in the last phase of her PhD study on preference-based accommodation strategy design. Monique is the (co-)author of Designing an Accommodation Strategy (2009), The power of pluralism for urban strategies (2012) and the award winning paper on Designing a preference-based accommodation strategy in the Journal of Corporate Real Estate (2015).

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