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Information to support strategic campus management in universities

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Abstract

Purpose – This paper aims to underpin the importance of the availability (or absence) of campus management information (CMI) in supporting universities' goals.

Design/methodology/approach – Four perspectives of campus management were used to develop a structured survey enquiring campus managers about universities' goals, finances, users and spaces. Its descriptive analysis distinguishes two domains: campus strategy and CMI.

Findings – A total of 14 participant universities in nine countries provided substantial data, increasing the available CMI in each of the four perspectives compared with previous research. Three goal-related patterns driving the strategies of universities and their campuses were identified across competitive, social, economic and environmental performance aspects. Accordingly, particular CMI is discussed.

Research limitations/implications – The paper's overarching approach in four perspectives challenged the collection of data, which needed to be retrieved from different departments in the organisation, with different domains (human resources, finance, facilities and organisational strategy), lingo and accountability cultures.

Originality/value – These findings improve the current understanding of university campuses as strategic resources enabling a variety of university goals and missions in today's knowledge-based economy, society and cities. Moreover, the authors discuss that a more structural approach to collecting CMI may benefit universities to identify critical aspects of campus management supporting their strategies from which performance indicators can be derived and shared among campus managers with similar strategies to make better future decisions.

Keywords Alignment, Campus management, Campus management information, Universities of technology, Campus strategies, Universities strategies

Paper type Research paper

1. Introduction

Campuses provide physical and functional infrastructure supporting the activities of universities, as well as other public and private parties engaged in boosting socio-economic development. However, it is a challenge to understand how campuses can best be managed as resources to meet this ambition and to use this understanding to inform future campus decisions. Thus, enough information is required to manage campuses in "strategic" ways, which entails facilitating the expected contribution of the campus to university performance considering the dynamic context of the knowledge-based economy (KBE), in which they operate.

Sustaining competitive advantage can be regarded as the most important performance aspect in this context. In science and education, competition is understood in terms of

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prestige, recognition or distinction embodied in the unique expertise and intellectual achievements of students and staff (Schulze-Cleven *et al.*, 2017). Nonetheless, universities' new competitive profiles are reflecting the rise of the KBE discourse (Jessop, 2017). The term "entrepreneurial university" has established them as actors leading education, advancing research, controlling their resources, organising their own capacity to transfer technologies and fostering entrepreneurship as a culture among their faculty and students (Etzkowitz, 2004, 2008). Similar functions outlined by Drucker and Goldstein (2007) and Simha (2005) are evident in universities developing science parks and districts to collaborate with industry in research projects that require a dedicated and expensive infrastructure (Curvelo Magdaniel, 2016, 2019).

As universities are being considered key agents of economic change, their campuses are becoming magnets for regional innovation, which in turn are becoming physically and functionally more integrated with the city (Den Heijer and Curvelo Magdaniel, 2018; Hoeger and Christiaanse, 2007). Broadly, universities need to attract the best talent and simultaneously collaborate with private, public and third parties to sustain their competitiveness. Universities use vibrant campus locations, as wells as iconic and modern buildings, in their marketing strategies to succeed in the global battle for brains and partners. Thus, the strategic approach to campus management emphasises a comprehensive view of the university campus supporting the goals of multiple stakeholders who are involved in and affected by campus decision-making.

This approach is increasingly outlined in research and the practice of renowned European universities (Den Heijer, 2011; Haugen, 2015; Rymarzak, 2014; Rytkönen and Nenonen, 2014). For instance, Den Heijer (2011) outlined four main perspectives in campus decisions –organisational, financial, functional and physical – represented by different stakeholders within and outside universities. These four perspectives are often conflicting and need to be considered and weighed in decision-making. However, campus decision makers need management information to create (more) policy-supportive, meaningful, functional, affordable and sustainable places to learn, work, innovate, live and visit. This information is referred to here as campus management information (CMI) and such views as to the stakeholders' approach. Overall, collecting, using and sharing CMI is becoming increasingly relevant and simultaneously complex.

First, obtaining and sustaining financial resources enabling universities' operations are increasingly difficult. Financial competitiveness 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 and Olson, 2017). Kauppinen (2012) defines academic capitalism as a wide variety of market activities used by faculty and institutions to secure external funding because of reduced public funding (e.g. patenting, spin-off companies, grants, university–industry partnerships and tuition fees). Such "marketisation" of today's higher education is evident in the USA and the UK (Schulze-Cleven and Olson, 2017). Indeed, changing funding structures is acknowledged as a crucial aspect of challenging the process of campus management (Rytkönen *et al.*, 2017). Simultaneously, this shift has enabled many universities to have more autonomy in the management of their real estate previously in the hands of the state (Den Heijer, 2011). Nonetheless, while the public funding necessary for such management has decreased, the public demand for transparency and accountability is growing. Such developments are putting pressure on many universities that have had little or no real estate management and accountability history and now have to deal with increasing students and staff while bearing the high cost of investing in dedicated research infrastructure and maintaining their heritage buildings and/or ageing facilities.

Second, universities are pressed to set an example as socially responsible institutions committed to solve societal challenges and foster sustainable development. Wright (2002) argues that the way universities frame and perceive their own commitment to sustainability is influenced by major international declarations and institutional policies. Their increasing role in environmental impact is demonstrated by a focus on the efficient utilisation of their physical and natural resources such as reducing ecological footprint, greening the campus and slowly integrating sustainability in teaching and learning (Ralph and Stubbs, 2014). Similarly, Alghamdi *et al.* (2017) confirm that universities are increasingly focusing on sustainability through five main aspects: environment, management, academia, engagement and innovation. Indeed, recent research assessing the application of circular economy and sustainability principles in Dutch campus development shows that campus managers are working on the subject of circularity (Hopff *et al.*, 2019).

Largely, campus managers need to adequately support contemporary universities' missions and functions. Previous research supporting campus decisions in Europe (Den Heijer and Tzovlas, 2014) used the stakeholders' approach to collect various indicators across 866 European universities. However, their comprehensive description and comparison of the campus were limited by data shortage and differences in data sources. Thus, this article addresses the challenges to collect and share comparable CMI with the aim and to underpin their importance in supporting universities' contemporary goals. Particularly, this paper emphasises the importance of universities of technology (UTs) in stimulating innovation to increase the attention of policymakers towards campuses as strategic resources by asking: *What campus management information is currently available in European UTs to support their goals?* Section 2 provides a conceptual framework to understand the concept of strategic campus management and the need to collect CMI. Section 3 describes the methods used to answer the research question. Section 4 describes and discusses the results based on 14 participant UTs in nine European countries. Finally, Section 5 answers the main question and draws lessons for practitioners and researchers.

2. Conceptual framework

2.1 The management of the campus as a strategic resource

This paper considers campuses as strategic resources influencing the performance of universities and other organisations that use them to accommodate their various activities. This resource-based view is influenced by the conceptualisation of corporate real estate (CRE) as "the fifth resource" (Joroff, 1993). Accordingly, real estate is outlined as a facilitator of the primary processes of an organisation next to their capital, human resources, information and technology. This approach established CRE as a management field, whose changing role was described in five evolutionary stages that moves from a technical towards a strategic focus. In this approach, the "alignment" between corporate and real estate strategies is central as well as the "dynamic environment" in which organisations operate.

Different alignment models have been explored in the fields of corporate real estate management (CREM). In their holistic analysis of alignment models, Heywood and Arkesteijn (2017) conclude that alignment is more complex and pluralistic than the individual models assumed in terms of alignment forms, objects to be aligned in different directions. Accordingly, the organisation and real estate have a multivalent relationship between CRE and the business with many words used to capture different values. A value hierarchy was evident, suggesting that higher value words are more important in theorising and describing alignment. Further analysis of 14 CRE models' graphical representations by Heywood and Arkesteijn (2018) showed that 12 components have been used to model CRE

alignment. These are categorised into four building blocks: understanding corporate strategy, understanding real estate performance, making real estate strategy and implementing real estate strategy. For instance, the so-called "added value of real estate" is conceptualised by many CREM researchers as a form of alignment (Appel-Meulenbroek, 2014; De Vries, 2007; De Vries *et al.*, 2008; Den Heijer, 2011; Jensen *et al.*, 2012; Krumm, 1999; Lindholm *et al.*, 2006; Lindholm and Leväinen, 2006; Scheffer *et al.*, 2006; Van der Zwart, 2014). A key theoretical argument shared by them is that the presumed influence of real estate on organisational performance resides in the combination of *real estate strategies*, which requires comprehensive decision-making, balancing individuals' perspectives and understanding of organisational driving forces.

However, these forces are not static. The link between alignment and its dynamic context is gaining attention in research. Cooke *et al.* (2019) hypothesise that a more flexible CRE portfolio capable of "dynamic alignment" is required to meet the future needs of the business in organisations bounded to complex adaptive systems. Herein, CRE managers should be learning from past decisions. Similarly, Too *et al.* (2010) identified flexibility, network organisation and managerial learning as CRE capabilities that are important in a hypercompetitive business climate driven by globalisation. Recently, the concept of "dynamic capabilities" in organisations has been linked with CREM theories to study campus development as a long-term process enabling universities to adapt to the changing environments in which they operate (Curvelo Magdaniel, 2019). Herein, the author illustrates with a single case the transition of the Massachusetts Institute of Technology from a traditional to an entrepreneurial university and how CRE managers have used the university's real estate as a resource to attain sustainable competitive advantage.

Undoubtedly, the adoption of the KBE is influencing the performance of universities in general and UTs in particularly. The current attention placed on knowledge creation to address societal challenges gives to this type of universities a particular role in societies and economies. Indeed, stimulating innovation has become an explicit ambition of UTs, high-tech firms, municipalities and other public agencies (Curvelo Magdaniel, 2016). Campus management in UTs is shaped by increased investments in research infrastructure, shared facilities, urban connectivity and other interventions aimed to foster the development of innovation ecosystems (Curvelo Magdaniel *et al.*, 2018). Such attention surpasses universities' goals because research laboratories are important targets for investment and management in the European innovation agenda (Van Drooge and Deuten, 2017). Developing science parks and innovation districts is also a joint venture between municipalities, universities, private and third parties to attract the most talented knowledge workers and students (Curvelo Magdaniel, 2019; Ng *et al.*, 2019). However, measuring the contribution of campuses to attain these goals in UTs and other organisations driven by similar forces remains a challenge, considering their different views on innovation.

This challenge can be tackled by using Den Heijer's (2011) conceptualisation of "campus management", which is seen as a process defined in four "tasks"– assessing the current campus, exploring the changing demand, generating future models for the campus and defining projects to transform the campus. At a strategic level, this process can span over decades, making campus decisions crucial to enable universities' long-term visions. For their various tasks, decision makers need *supporting information* considering all stakeholders involved and their performance-related campus goals. These are:

- improving quality of place;
- supporting image;
- supporting culture;

- stimulating innovation;
- stimulating collaboration as universities' primary goals contributing to competitive advantage;
- decreasing costs;
- increasing real estate value;
- controlling risks as financial goals contributing to profitability;
- reducing footprint as a physical goal contributing to sustainable development;
- supporting users' activities;
- increasing users satisfaction; and
- increasing flexibility as functional goals contributing to productivity.

These campus goals are referred to as real estate strategies in the CREM literature (Nourse and Roulac, 1993; Van der Zwart, 2014). Thus, they can also be called *campus strategies* or the courses of actions supporting overall universities' strategies. The supporting information required in decision-making is defined here as *CMI* or the body of information campus managers require to design and implement those campus strategies (Figure 1). Ultimately, CMI forms the bridge between campuses' current situations and decisions about the campus of the future.

2.2 Campus management information

As seen in this research, CMI can be metrics, descriptions, images, maps and/or testimonies used to support campus decisions. However, metrics are the most common type of information used to evaluate performance in management practice and research, including CREM and facility management (FM).

In the FM literature, a range of performance measurement approaches have been proposed such as benchmarking, balanced scorecard, post-occupancy evaluation, critical success factors and key performance indicators (KPIs) (Lavy *et al.*, 2010). The preference for the latter is being emphasised, as well as criticised, in the literature. Organisational advantages of KPIs can be summarised as facilitating guidance to management, accountability, external legitimacy, efficiency in the operation and design of facilities;

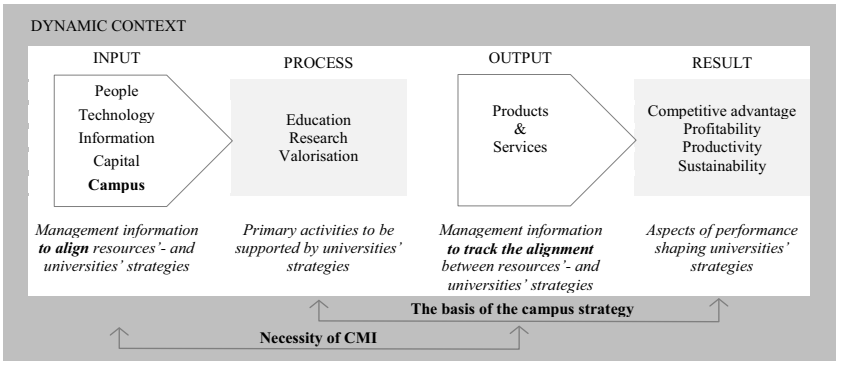


Figure 1.
Analytical framework positioning the campus as one of five strategic resources in universities

Note: CMI: campus management information

comparison in positioning; ability to react in changing contexts; and alignment between organisational strategy and real estate strategy. Similarly, there are limitations associated with their use. FM studies agreed that the existing lists of KPIs are extensive, including indicators that are not quantifiable, are not measurable or provide redundant measurements (Lavy *et al.*, 2010; Neely *et al.*, 1997; Shohet, 2006). CREM studies have also outlined the lack of proper measurements or KPIs, making it difficult to compare alternative CREM strategies quantitatively (Lindholm *et al.*, 2006) and qualitatively (De Vries *et al.*, 2008).

The issue of proper categorisation of KPIs is relevant because it determines their broader applicability and potential use (Douglas, 1996), as well as the reliable establishment of facility performance metrics (Lavy *et al.*, 2010). This is important for managers interested in both holistic performance evaluations and assessments of a specific aspect of a facility. Proper categorisations of KPIs must provide different CRE managers with the opportunity to select the performance indicators that interest them most (Douglas, 1996; Gumbus, 2005; Ho *et al.*, 2000). Four main categories are distinguished to group the many distinct but related categories in these studies based on the holistic categorisations for facility management (Lavy *et al.*, 2010) and campus management (Den Heijer, 2011): organisational, financial, physical and functional.

These four categories can help to filter extensive lists of KPIs, which may be relevant to multiple CRE managers. Certainly, these four categories express multiple *aspects of performance* assessment related to the various challenges contemporary universities face. Organisationally, universities need to attract talent and deal with organisational changes such as merging to sustain their *competitive advantage* in the KBE. Financially, they need to allocate their resources more efficiently to endure their *financial sustainability* in times of decreased public funding. Functionally, they have to offer healthy, connected, flexible and sufficient space to support the activities of students, researchers and staff, who determine universities' *productivity*. And physically, universities need to care for the heritage and natural resources they own and the quality of place their campuses create to foster *environmental sustainability*.

Generally, these four categories can be used to collect CMI in a comprehensive way with a twofold purpose. On the one hand, it can be used to assess the current university campuses (i.e. the first campus management task) and the availability of CMI in universities. On the other hand, it can serve to illustrate the attitude towards KPIs, their collection, use and wider applicability to focus decisions in the second, third and four tasks of campus management. In general, this attitude may differ per organisation (Agostino and Arnaboldi, 2017). In universities, it can be influenced by the university governance and the management structures binding campus decisions (Rymarzak *et al.*, 2019).

3. Methods

3.1 Scope

This study uses stratified sampling to collect multi-perspective CMI for particular universities (i.e. UTs located in Europe's most innovative regions). This sample enables analysing similar universities operating in comparable socio-economic contexts to minimise limitations experienced in similar research (Den Heijer and Tzovlas, 2014).

UTs entail a variety of universities that specialise in engineering, technology and sciences. Institutes of technology, polytechnic universities and technical universities are the most common terms used in different countries. Nonetheless, these universities offer all three levels of higher education (i.e. BSc, MSc and PhD).

Europe's most innovative regions are identified using the "Leader" and "Strong" classes of innovative performance in European regions according to the Regional Innovation Scoreboard 2017 (European Commission, 2017). The scoreboard and the CESAER (Conference of European Schools for Advanced Engineering Education and Research) member list were used to identify 62 European UTs across 12 countries (Figure 2).

3.2 Data collection and analysis

The four categories of KPIs identified in the literature were used to develop a structured survey containing 29 data fields labelled accordingly: organisational, financial, functional and physical (Table I). These data fields pertain to selected variables relevant to assess the current campus in relation to universities performance in the knowledge economy (Curvelo Magdaniel, 2016; Den Heijer, 2011). Organisationally, it sought for the goals addressed by university officials and campus managers to sustain their competitive profile. Financially, it looked at the capital resources available to spend on campus and research infrastructure, as well as those ensuring universities' fiscal sustainability. Functionally, it considered the users accommodated on campus and the particular functions supporting research, education and valorisation as their productive activities. For instance, variables in this category are extensive because UTs are increasingly engaged in diverse activities that involve the accommodation of multiple users beyond students and researchers (e.g. firms that collaborate with research groups on campus, start-ups that are facilitated with space on campus and visitors that use campus facilities and infrastructure). Physically, it explored how these activities are accommodated in particular places and available spaces enabling environmental sustainability.

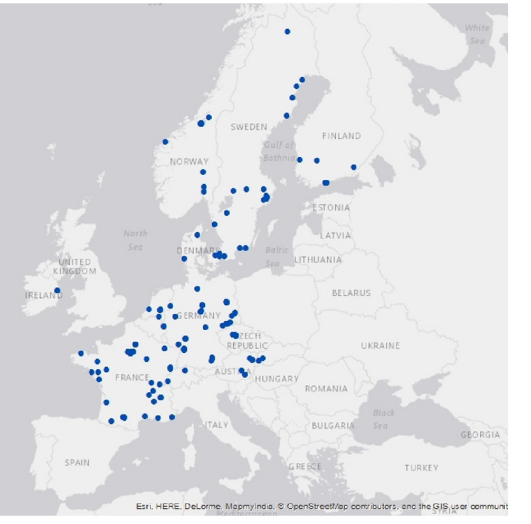


Figure 2.
Sample of 62 UTs across 186 locations in Europe's most innovative regions

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

Category	Variable	*Data*	Related university performance output
Organisational	University strategy	*University goals*	Competitive advantage
	University campus strategy	*Real estate goals*	
Financial	Annual operating revenues	*Country currency*	Financial sustainability
	Sources	*Percentage public funding*	
		Percentage private funding	
	Annual operating expenses	*Country currency*	
	Investments in research facilities	*Country currency*	
Functional	Students population	*Headcount enrolled*	Productivity
	Types	*Percentage bachelor*	
		Percentage masters	
		Percentage other	
		Percentage doctoral	
	Staff population	*FTE (full-time equivalent) employed*	
	Types	*Percentage academic teaching/research)*	
		Percentage supporting (administrative/ technical)	
	Residential function	*Housing units*	
	Related business function	*Firms*	
		Incubators/accelerators	
	Research function	*External research institutes*	
	Education and research function	*Specialised laboratories*	
		Shared learning facilities	
	Infrastructure function	*Parking spaces*	
Physical	Campus portfolio	*Sites*	Environmental sustainability
	Campus location	*Inner-city locations*	
		Suburban locations	
	Campus built area	*GFA (gross floor area) in m^2*	
		Percentage owned	
		Percentage leased	
	Campus floor area	*UFA in m^2*	

Table I. Requested data fields categorised by campus perspectives sent to campus managers

All data fields are metrics except the variables in the organisational category. The review of public documents and statistical data sets generated by country organisations were used as preliminary data sources. However, available data from these sources focused on one or two types of indicators and were used as preliminary input for verification in the survey sent via email to both university country organisations and university real estate management departments.

From 62 universities contacted in 12 countries, 14 universities in 9 countries agreed to participate (22.5 per cent response rate). Between June 2017 and March 2018, the respondents provided and verified most of the indicators or sent links to relevant documents for retrieval. 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.

3.3 Available campus management information

Substantial and homogeneous data in the four perspectives were available to describe the current state of the campus at 14 European UTs (Figure 3). This showed an increase in available CMI per perspective using a survey as a main data collection technique compared with previous research that used Web search. When not provided in the survey, the organisational data about universities' and campus' goals were retrieved from primary sources publicly available in the UTs' websites.

4. Description and discussion of results

4.1 Campus strategies

Data about the ambitions addressed by universities in both their institutional and their campus strategies show that UTs' plans are shaped by heterogeneous focuses across the four stakeholders' perspectives used in this research. At the level of university strategy, this heterogeneity indicates the duality between traditional and contemporary roles adopted by universities in the KBE (Table II). Accordingly, UTs combine their missions of supporting education and research, stimulating innovation and entrepreneurship, as well as offering solutions to societal and environmental challenges.

Their predominant focus on increasing their competitive profile is inferred from their explicit ambitions to sustain their leading role in education and excellence in research, as well as from their focus on internationalisation becoming more attractive for overseas' students and staff. Likewise, a substantial amount of UTs focus on productivity and welfare in a broad sense, identified by their explicit ambition to prepare talented human capital and train highly qualified engineers.

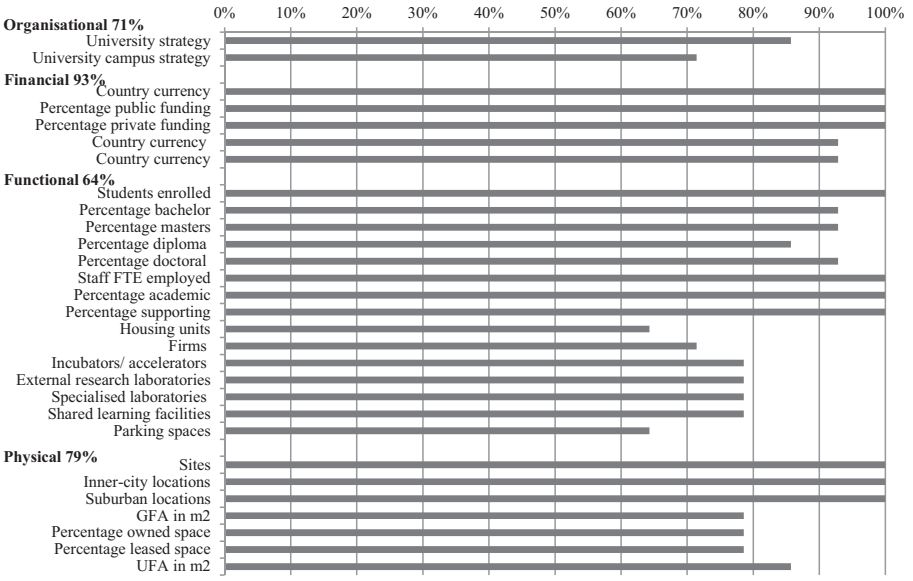


Figure 3.
Overview of information collected per categories and variables

Notes: FTE: fulltime equivalent, UFA: usable floor area, GFA: gross floor area

Table II. Overview of university and campus strategies (CM: campus management)

Focus university strategy	UTs ($n = 14$)	Focus campus strategy	UTs ($n = 14$)	CM perspectives			
Competitive advantage	*93%*	Supporting culture	14%	Organisational			
		Improving quality of place	43%				
		Supporting image	43%				
		Stimulating collaboration	43%				
Economic growth	*43%*	Stimulating innovation	71%		Financial		
Financial sustainability		Increasing real estate value	0%				
		Decreasing costs	7%				
		Controlling risks	21%			Physical	
Environmental sustainability	*36%*	Reducing footprint (m^2/CO_2)	29%				
		Increasing flexibility	21%				Functional
Productivity and welfare	*79%*	Increasing users satisfaction	7%				
		Supporting users' activities	50%				

At the level of campus strategy, most UTs address "stimulating innovation" and "supporting users' activities" as main campus goals supporting competitiveness and productivity and welfare as main organisational strategies. This finding suggests that there is an alignment between the main focus of organisational and real estate strategies in UTs. Similarly, "supporting image", "improving quality of place" and "stimulating collaboration" are identified as common campus goals addressed by UTs, which can also align with UTs' organisational ambitions to strengthen their international profile as world-class environments.

Moreover, a good number of UTs focus on economic growth and sustainable development. The former is expressed by their ambitions to collaborate with local, regional and global parties to generate value and support entrepreneurship. The latter is stated in their determinations to provide solutions to environmental challenges. At the campus level, two strategies align with these ambitions: "stimulating innovation" by investing in research infrastructure and "reducing footprint" by decreasing CO_2 emissions or using their space in more efficient ways.

Overall, these UTs address 11 of the 12 campus goals in campus management research (Den Heijer, 2011). This illustrates the inclusion of multi-stakeholder, i.e. perspectives, approach in strategic campus management and decision-making in European UTs. Generally, the multiple focuses present in university and campus strategies enabled to identify three types of strategies: unilateral, bilateral and multilateral. Different combinations of focuses exist and span across the four performance drivers representing the perspectives on campus management: competitive, economic, social and environmental drivers (Table III).

Unilateral strategies are present only at the campus level and with a focus on competitiveness. Bilateral strategies exist at both university and campus levels and focus on at least two of the four campus management perspectives with a predominance of competition as the main driver. Multilateral strategies also exist at university and campus levels and focus on more than two campus management perspectives. Overall, the bilateral "Competitive-Social" is the most predominant type of strategy at both university and campus levels. Indeed, the predominant campus goals of "stimulating innovation" and "supporting users' activities" illustrate the alignment between "competitive-social" organisational and real estate strategies in UTs. Accordingly, the following paragraphs use these two campus goals to illustrate how UTs can use CMI to assess the current state of their campuses in supporting their strategies. Thus, this research selects particular CMI from the

Table III.
Three types of university and campus strategies according to their performance drivers

Strategy types	Performance driver	UT's strategies ($n = 14$)	UT's 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%

comprehensive data set available, which is limited to the explorative approach used in its survey.

4.2 Campus management information

The following paragraphs describe and compare indicators derived from available metrics collected in the financial, physical and functional perspectives on campus in relation to the main campus goals addressed by UTs. In "supporting users' activities", this study uses the available CMI that characterise UTs main users and that illustrate the quantity and quality of the space used to support their activities. In stimulating innovation, this study uses the available CMI that provides an insight into the UTs financial capacities to undertake investments in research infrastructure in relation to their populations and campus sizes. Similarly, it uses available CMI that illustrate the current diversity of their campuses as innovation ecosystems and their potential to facilitate collaboration among the actors in such ecosystems.

4.2.1. Supporting users' activities. *Supporting users' activities* is explicitly addressed by half of the campus managers in the participant UTs. This goal is undoubtedly the reason why campuses exist and possibly why it is implicit rather than mentioned in campus strategies. It can be said that university students and staff are the main campus users (next to visitors and citizens). On average, UTs accommodate on their campuses more than 21,000 users, which range from 5,600 to 47,000 people among UTs. These users perform different activities but learning and research can be considered their primary activities. Roughly, the relation of academic and administrative staff might indicate each UT's capacity to perform these activities. In UTs, the average share of academic staff from the total staff (FTE) is 60 per cent (i.e. mean). Although most universities are around this number, the values range from 40 to 71 per cent (Figure 4). This ratio can influence some of the performance outputs used by universities to track their excellence in research and education, such as the number of publications, research projects, grants and courses offered in the education portfolio. Half of the UTs performing above average in this indicator have a bilateral "competitive-social" strategy at the university level, which focuses on excellence in research and education as well as in productivity.

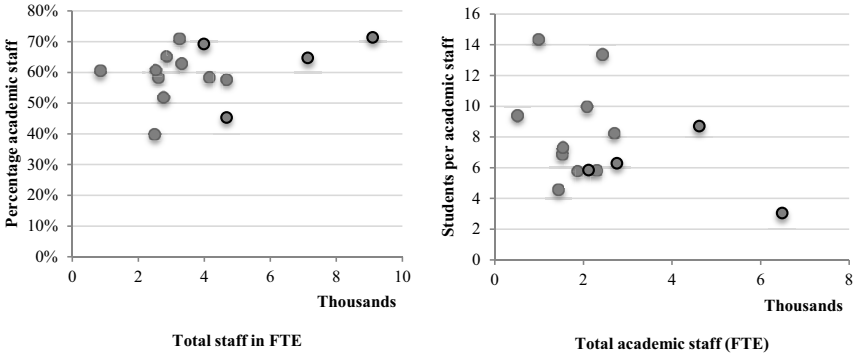


Figure 4.
Left: share of academic staff per total staff; right: number of students per academic staff

Notes: (FTE: Full Time Equivalent). Indicates UTs that address sustainability in their campus strategies. ● Indicates UTs that, besides addressing sustainability in their campus strategies, have a multiple or bilateral university strategy with an environmental driver

Similarly, an insight into the ratio of students per academic staff may indicate the capacity of UTs to train the future engineers that will solve the societal challenges. The average number is 7.7 (i.e. median), but large differences can be identified between UTs ranging from 3.1 to 14.4 students per academic staff. This difference indicates that UTs have a heterogeneous capability in terms of human resources to fulfil education as one of their main activities. Perhaps, these differences should call for different spatial resources to accommodate this activity. In spite of the wide differences, the two UTs at the extremes of this range address "supporting users' activities" as a campus goal, but only the UT with the least number of students per academic staff has a bilateral "competitive/socially driven" strategy at the university level.

Campus managers must ensure that universities have enough available space to effectively enable and facilitate the activities of its users on their campuses. This is particularly important to efficiently cope with the dynamic and uncertain growth of students and staff. UTs ($n = 12$) have very different sizes of building portfolios ranging from 70 K up to 1 million m^2 gross floor area (GFA). Nevertheless, they have more homogeneous available space for use compared to the built area. Accordingly, the average share of usable floor area (UFA)/GFA is 64 per cent (i.e. mean), and most UTs are within the range of 50-80 per cent (Figure 5). However, when looking into the number of users per m^2 UFA, large differences can be observed between UTs ($n = 13$). The average amount of m^2 UFA per campus users is 11.9 (i.e. median) but ranges from 7.4 to 27.6. This difference may indicate UTs are either using their available space in more or less efficient ways or measuring their floor area using different methods. According to existing benchmarks in practice, the share of UFA/GFA in university campuses ranges between 55 and 65 per cent. Values outside this range may indicate the UFA is being calculated differently among UTs, which limits its comparison. Apart from these differences, the comparative overview illustrates an interesting observation in terms of alignment. For instance, the UT with the smaller campus size in GFA and with least users per m^2 addresses sustainability and environmental responsibility in its campus strategy. These indicators can be used to track campus strategies that focus on reducing footprint and increasing flexibility in line with the environmental ambitions of some UTs.

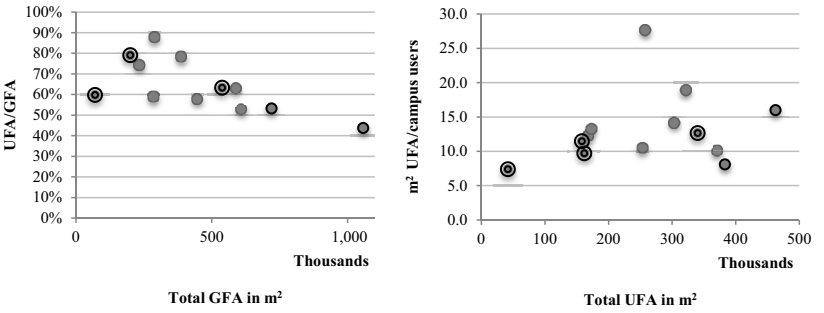


Figure 5.
Left: share of floor and built areas ($n = 11$); right: amount of m^2 floor area per campus users (students and all staff)

Notes: ● Indicates UTs that address sustainability in their campus strategies; ◉ Indicates UTs that, besides addressing sustainability in their campus strategies, have a multiple or bilateral university strategy with an environmental driver

This research used the location of the campuses, to roughly estimate their convenience to access urban amenities and supporting functions (e.g. housing, retail and sports), which can help UTs to attract and retain talent. UTs in this study have campuses that vary from concentrating their activities in a single location to spreading them in 2-32 different sites. At least 50 per cent of the sample ($n = 14$) has campuses with sites located both in the inner city and in its periphery. The remaining half is distributed between UTs with campuses only in the inner-city (i.e. 36 per cent) or only in its periphery (i.e.14 per cent) (Figure 6).

Accordingly, most UTs enjoy the benefits of having an urban setting that is diverse in functionality and can be attractive to young students and many knowledge workers. However, two UTs are in isolated locations that depend on transportation to access the diversity of environments offered by cities. Correspondingly, these two UTs and others with a large part of their portfolios in the periphery, offer more parking spaces per staff (i.e. above the average of 0.7 parking unit per staff). A common option for UTs outside the city is to adopt campus strategies to increase the diversity of functions supplied on campus. Surprisingly, UTs with peripheral campuses do not address "improving quality of place" in their campus strategies. Perhaps, they have done this already because most UTs with this location setting provide student dormitories on campus and/or in their vicinity. Although this study did not collect data on retail and sports facilities, these functions are usually supplied around housing units to enrich students' life on campus. Correspondingly, offering a variety of functions on campus can help campus managers to support image, a campus goal addressed by nearly half of the sample including one of the UTs that concentrates all its activities in one campus outside the city.

4.2.2 Stimulating innovation. *Stimulating innovation* is by far the most important campus goal addressed by UTs in this study. To do so, many universities invest in world-class research facilities and/or state-of-the-art infrastructure. This research uses data on annual expenses per students and per total campus population to illustrate the financial capacity of UTs to invest in research and education, according to the populations accommodated in their campuses. Accordingly, the average annual expense per student in UTs ($n = 14$) is €25.600 (i.e. median). However, this indicator widely differs among UTs ranging from €7,000 to €77,000. Similarly, these wide differences hold when comparing the expenses per all users, including students and staff (Figure 7). Equally, UTs report wide

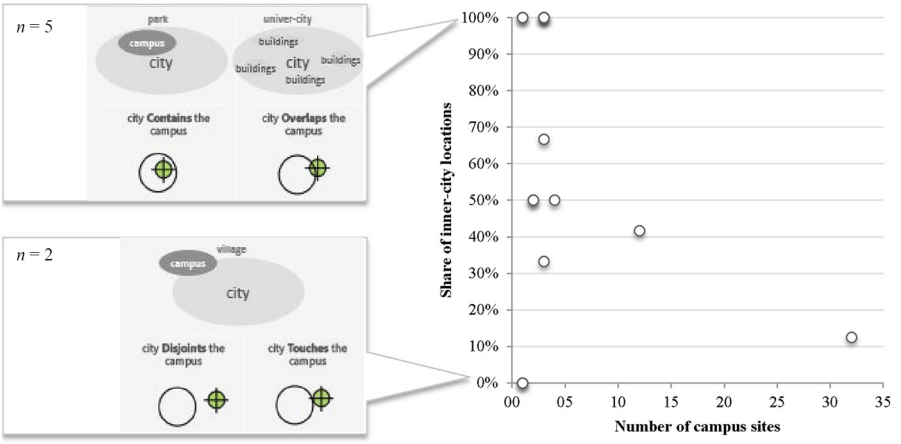


Figure 6.
Share of campus locations in relation to campus models by Den Heijer and Curvelo Magdaniel (2018) ($n = 14$)

differences in their annual operating revenues. Herein, the data show that these revenues come significantly from public funding (i.e. over 60 per cent of the total revenues in most UTs). Largely, these figures indicate that although the participant UTs are located in European regions where governments play a key role in investing in education and research, the available budgets and expenses among UTs differ widely.

Furthermore, it is worth noting that although public funding account for most of the UTs revenues, half of the UTs obtain a significant part of their budgets from non-public sources (i.e. from 39 per cent up to 45 per cent). These figures illustrate the tendency of higher education institutes to become financially independent to support their activities considering also the many uncertainties in the higher education system, including financial models.

Similarly, this study looked at the UTs expenses in relation to their portfolio size and research infrastructure (Figure 8). The annual operating expenses of UTs ($n = 13$) differ widely (i.e. between €74m and €1.5bn). Nonetheless, data on the annual expenses per m^2 UFA shows a less heterogeneous picture among UTs ($n = 13$) with an average of €1.8 K per m^2 UFA (i.e. mean) ranging from €1,000 to €3.3 K per m^2 UFA. This data can be used to outline potential differences in expenses that can be related to the sizes of the campus as these expenses consider rents, utilities and maintenance costs, among other real estate expenses.

Moreover, this study outlines that UTs ($n = 8$) spend on average 4 per cent of their expenses in research infrastructure (i.e. mean) ranging from 1 to 9 per cent among UTs. When comparing UTs annual investments in research facilities per one student ($n = 7$) wide differences can be observed among them because these values range from €175 to €1.4 K. However, the two UTs defining this range do not have such disparity in their annual operating expenses per one student (i.e. €18,000 and €29,000, respectively). Thus, such difference can be attributed to the different ways in which UTs define "investments in research facilities" and "specialised laboratories facilities". For instance, the university with the highest investment in research facilities per student indicated that this data were calculated based on the total costs of ownership estimating the annual costs required for research infrastructure, including heavy and light labs. Similarly, this UT indicated having circa 31,000 m^2 UFA of specialised labs in over 17 buildings. The UTs with the lowest investment in research facilities per student estimate having 984 specialised labs and did not indicate how these investments are calculated. Nonetheless, some UTs provided

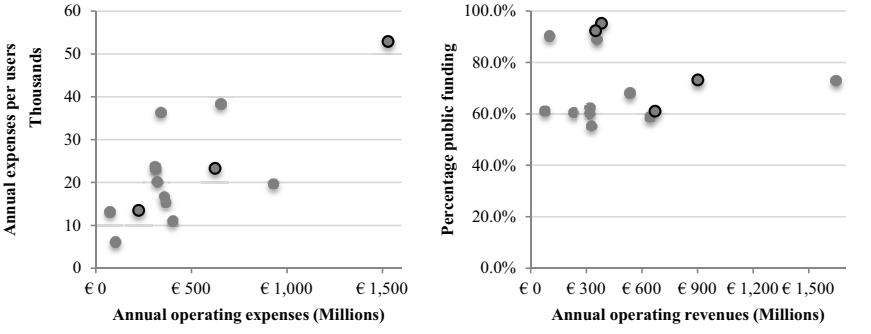
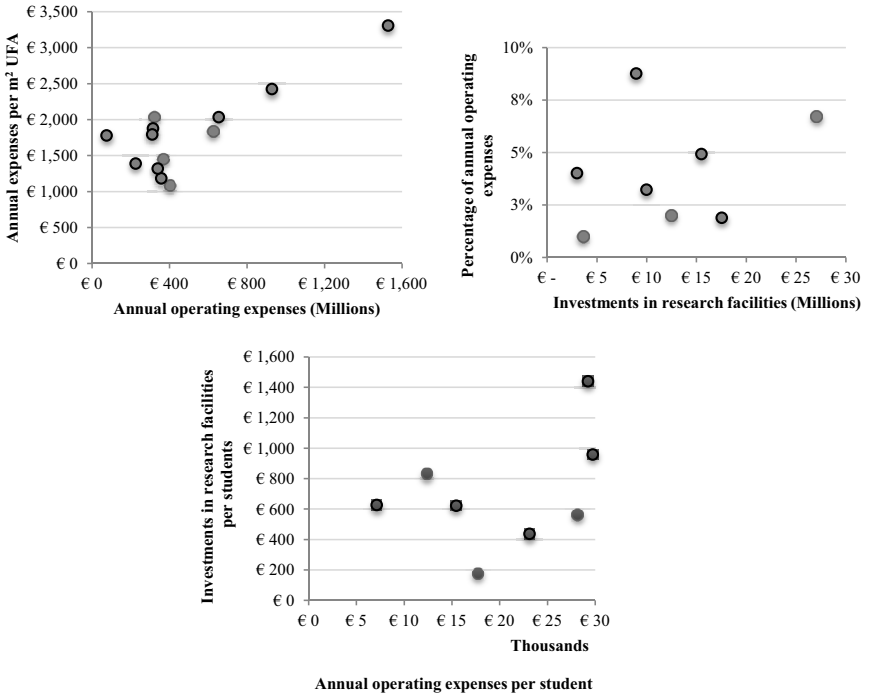


Figure 7.
Left: UTs' financial capacity to support their users' activities ($n = 14$); right: revenues of UTs and their sources

Note: ⚬ Indicates UTs that address 'stimulating innovation' in their campus strategies



Note: ○ Indicates UTs that address 'stimulating innovation' in their campus strategies

Figure 8.
UTs' expenses in relation to campuses' sizes and investments

explanations about how they calculate these investments. For instance, other universities used the investments in laboratory buildings made in the most recent year, which can vary widely from year to year. One university used their projected amount to invest in research facilities while some others did not provide explanations at all. Those UTs providing links to financial reports to retrieve this data distinguish in their books only investment in facilities in general. This diversity in data for one indicator limits its comparison but also points out the necessity to improve accountability in campus management for some CMI.

Besides investing in research facilities, universities may attempt to stimulate innovation in two ways; by promoting the accommodation of firms and external research institutes on campus, and by developing shared facilities to enable interdisciplinary collaboration. While the possibility to establish collaboration with external entities that settle on campus is expected to increase the competitive profile of UTs in the KBE, internal collaboration among UTs' institutes and faculties is expected to strengthen their research culture. In terms of external collaboration, the number of firms accommodated on campus (including start-ups) varies significantly among UTs ($n = 11$) ranging from 6 to 245. Because of the comprehensive scope of this study, the size of the firms was not asked in the survey and therefore, it was not specified by UTs. Generally, the UT with most firms on campus have, deliberately and in collaboration with public and private parties, developed areas of its campus to accommodate external firms besides their own spin-offs and/or start-ups. Moreover, the number of incubators on campus ranges from one to five in UTs ($n = 13$). This figure illustrates how UTs are using their campuses as resources to promote

entrepreneurship, also relevant for innovation and their competitive profile. Last, the number of external research institutes range from one to ten between UTs ($n = 9$), which altogether outline the potential of UTs campuses to cluster innovators and simultaneously increasing their chances for collaboration (Figure 9).

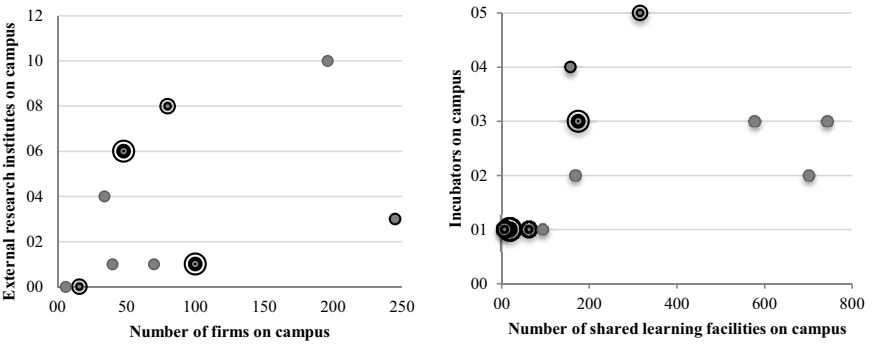
In terms of internal collaboration, this study attempted to outline the potential of UTs' campuses to enable opportunities for interdisciplinary cooperation in their primary processes. To do so, it looked at the number of facilities shared by interfaculty users for learning purposes based on the general assumption that having users of different disciplines under one roof might increase the chances for interactions that can lead to potential collaborations. Accordingly, this data varied greatly among UTs making the comparison challenging. While some universities specified hundreds of shared facilities, including a variety of spaces (i.e. libraries, lecture halls, seminar rooms and study rooms), some of them addressed a few without specifying the type of shared facilities. For instance, one university did not provide a number but instead acknowledged that almost all spaces on campus had adopted a flexible concept and were more or less open to shared use. Similarly, others were more precise and provided the amount of m^2 besides the number of facilities. Overall, this ambiguity in definitions limited these results (Figure 9).

5. Conclusions

The previous results enrich our understanding of campuses as strategic resources and advance the publicly available knowledge based on information (CMI) relevant to campus managers. The following paragraphs draw the main conclusions on alignment and CMI in UTs and discuss the role of sharing CMI to improve campus management.

5.1 Alignment between universities and campus strategies

Strategic campus management in UTs is characterised by a variety of real estate strategies aligned to multiple organisational ambitions. This study has shown that UTs address multiple and diverse strategies, which also coincide with their task to support multiple stakeholders' perspectives. Most UTs aim to strengthen three different performance aspects simultaneously: competitive advantage, productivity and financial sustainability. The latter



Notes: ○ Indicates UTs that have a bilateral or multilateral strategy with a knowledge economy driver; ◉ Indicates UTs that address either 'stimulating innovation' or 'stimulating collaboration' in their campus strategies; ◉ Indicates UTs that address both 'stimulating innovation' and 'stimulating collaboration' in their campus strategies

Figure 9.
Potential of UTs' campuses to cluster knowledge workers and students to stimulate innovation and collaboration Left (n=10); Right (n=13)

is less explicit than the former two but is illustrated by the UTs' ambition to support regional growth in the KBE. Environmental sustainability is also addressed in combination with other performance aspects but is less common among UTs. Correspondingly, there is an alignment between campus goals supporting these universities' ambitions. This is demonstrated by the current focus on "stimulating innovation" and "supporting users' activities" as the main campus strategies. However, these findings are limited to illustrate alignment in the making of real estate strategies rather than in its implementation.

5.2 What campus management information is currently available in European universities of technology to support their goals?

European UTs are collecting CMI that consider organisational, financial, functional and physical perspectives. Most of the data variables collected were available in over 80 per cent of the participant UTs. Only few variables in the functional perspective (i.e. amount of housing units, firms, incubators/accelerators, external research laboratories, specialised laboratories, shared learning facilities and parking space) and in the physical perspective (i.e. GFA in m^2, percentage owned space and percentage leased space) were less available compared to the overall CMI collected. Undoubtedly, the survey used in this research progressed CMI's data collection compared to previous research. Approaching managers directly through surveys provides more consistent data than relying on publicly available data.

The diverse focus of the campus strategies in UTs identified in this research confirms the importance of collecting multi-perspective CMI. This comprehensive approach allowed to explore variables in different perspectives to illustrate the convenience of CMI to track particular campus strategies relevant to UTs (i.e. "stimulating innovation" and "supporting users' activities") and to illustrate the relation among perspectives. For instance, to have an indication of how universities are stimulating innovation, campus managers need to look at particular types of spaces, their use and their finance. In this way, comprehensive data sets allow campus managers to identify a set of particular indicators that can be more quantifiable and easily measurable and future researchers to demonstrate their wider applicability as emphasised in the FM and CREM literature.

The information collected and described in this research provides insights into which information is available to support decision-making. Data overviews are particularly relevant for "assessing the current campus" as the first campus management task to lay a foundation for the remaining tasks. However, the exploratory nature of this research – and its stakeholders' approach in the data collected – enabled the generation of mainly input indicators. Although input indicators are considered "limiting" as measures of performance (De Vries *et al.*, 2008), these are evidently the type of indicators available when attempting to measure how universities are stimulating innovation. Future research may explore other measures that focus more on the effectiveness rather than the efficiency of this particular campus strategy in UTs. Certainly, more research focusing on particular campus strategies can provide better insights about the importance of CMI, which enables campus managers not only to design but also to track the alignment path between campuses' and universities' strategies.

5.3 Discussion: next steps in sharing campus management information for improved campus management

Largely, this research illustrates that UTs are willing to participate in campus management research in exchange for information and learning from comparable situations while helping to expand the existing knowledge based on CMI. Although many UTs did not respond to the survey's invitation via email and their reasons are left unknown, only one UT explicitly

mentioned their lack of interest in this research. In turn, two UTs did not fill out the survey because their campus managers lacked the time but provided links to the information instead. It is plausible that because the indicators in our comprehensive framework integrate various stakeholders' perspectives, their collection process may be challenged by the availability of CMI in different departments or sub-divisions with different domains, lingo and accountability cultures. Besides the cost of investing time in finding the information, some universities may lack structural information databases and/or hesitate to share incomplete data fearing potential judgements from unwanted comparisons. Indeed, our analytical framework positioned campus as strategic resources to argue that in general, organisations track information about resources other than real estate more thoroughly. In campus management, the lack of available CMI can be a (relative) blind spot to support universities' strategies but also the reason to avoid the acknowledgement of lacking accountability culture. In this context, more research into knowledge management in universities and campus management practices is needed.

This research enabled UTs to share CMI to assess their current situation with comparable institutions. However, persistent differences in particular variables posed challenges in the data collection process, which should be consider to avoid generalisation. For instance, differences in the UTs' financial capacities to fulfil their missions and to implement their strategies outline the difficulties of making comparisons across Europe regardless the assumptions for homogeneity made in the sampling. Moreover, variances in definitions indicate that universities may be obtaining data in different ways. This limitation suggests areas for improvement in terms of methodology to assure that the benefits of collecting CMI exceed the costs of investing time in it regardless of the challenges. More clear definitions for some indicators are needed, and open channels for dialogue with campus managers may help future research to obtain more homogeneous variables. Additionally, the use of narratives can also be explored to complement the use of performance indicators. Understanding which methods or processes campus managers use to obtain the data requested in this study and their attitude towards the use of KPIs within their own practices can be an interesting avenue to explore in future research. Herein, interviews with managers can give insights into these questions and/or provide ideas on how to disseminate and share CMI for improved campus management.

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