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Campus development as catalyst for innovation

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Abstract

Purpose – This paper aims to model the relationship between innovation and real estate, providing campus managers with a tool that illustrates how campus development stimulates innovation and that guides them to add value to their organisations.

Design/methodology/approach – The authors review previous research and build theory from the study of two cases. They shape a hypothesis by linking various theoretical concepts and by verifying it with empirical data to finally model how campus development stimulates innovation.

Findings – Findings suggest that campus development facilitates five conditions required to stimulate innovation through decisions and interventions over long-term periods. These findings acknowledge that location is key to explain campus development as a catalyst for innovation. In addition, this paper identifies potential issues in decision-making processes that can inhibit the facilitating role of real estate in innovation.

Practical implications – A framework clarifying the path to stimulate innovation through real estate will allow campus managers to steer their real estate strategies in line with this specific organisational goal and to better communicate how their decisions add value to their organisations.

Social implications – Findings advocate a more effective and efficient resource allocation for campus development in and around cities.

Originality/value – Until now, studies on stimulating innovation through real estate have focussed on workplace level. A core theoretical contribution of this paper is enlarging the application scope of CREM theories to the urban level involving multiple organisations.

Keywords Innovation, Added value, Alignment, Real estate management, Campus development, Location

Paper type Research paper

Introduction

In July 2012, the Economic Development Board of New York City announced the investment of US\$2bn in redeveloping Roosevelt Island in collaboration with Cornell University to accommodate research activities branded as “NYCTechCampus”. This area development is one of several encouraged by NYC to diversify their economy towards a knowledge-based one. The rebranded “CornellNYCTech” is under construction and plans to open in summer 2017. Yet, it remains to be seen if this development will be completed as planned or will generate the expected number of new jobs and companies, which is one of the presumed innovation goals.



Similar stories can be told for many locations around the world. The development of campuses, science parks and other areas with the “innovation label” can be found in nearly every city of developed countries. Governments, universities and companies have been joining their resources to develop these areas with the explicit goal to stimulate innovation and remain competitive in the knowledge economy. In Europe, the attention is growing on the policy agenda, as billions of euros have been allocated to research and innovation, including research infrastructure. Investing public capital in developing physical infrastructure is controversial because the added value of this strategy to innovation goals is uncertain. It takes time and many resources to develop these areas while priorities in cities and organisations change faster than expected. The managers of newly developed and existing campuses have both the opportunity and pressure to support “stimulating innovation” as the ultimate organisational goal. Unfortunately, the research on campus development and its relationship with innovation is scarce in the CREM domain, leaving campus managers with limited evidence to explain how they can do this.

This paper seeks to develop knowledge about the role of campus development in stimulating innovation and to provide decision-support information to CRE managers of campuses. This paper is the result of a doctoral research titled “Technology campuses and cities” carried-out at Delft University of Technology. Its results and discussion are organised around the following research questions:

RQ1. How does campus development stimulate innovation?

RQ2. How can campus managers use this knowledge to add value through real estate?

Stimulating innovation and campuses in the CREM literature

“The role of campus development in stimulating innovation” is a relatively unfamiliar topic in the CREM literature. Campuses in relation to innovation have been predominantly studied in the fields of spatial planning, regional studies and businesses (Link and Scott, 2003, 2006; Castells and Hall, 1994), but much less from the real estate perspective. In the CREM field, Den Heijer (2011) studied the management of university campuses, offering a theoretical basis for campus development. However, her results focus on the accommodation of universities, excluding the accommodation of R&D firms and research institutes, which are relevant organisations for innovation in campuses and cities. Hence, there is a need for a comprehensive framework that explicitly addresses the relationship between innovation and real estate at the broad organisational and physical scales involved in campus development. Existing CREM research provides some theoretical foundations to address such relationship. Particularly, approaches that position real estate decisions as input add value to processes in organisations.

In CREM research, *innovation* is one of the many aspects of organisational performance supported by real estate next to image, users’ satisfaction, productivity, culture, flexibility and real estate value. Accordingly, *stimulating innovation* is both an explicit organisational goal and a real estate strategy or added value proposed in previous CREM research (De Jonge, 1996; Lindholm and Leväinen, 2006; De Vries, 2007; Den Heijer, 2011). The literature in this field suggests that real estate strategies or added values have the attributes of being versatile, interdependent and intermediate. This paper discusses how these attributes may contribute to develop an appropriate framework to study the role of campus development in stimulating innovation.

First, stimulating innovation is considered a “versatile” real estate strategy. Depending on the study and the application area, innovation contributes to organisational performance

by means of different performance outputs, i.e. competitive advantage in firms driven by technology capabilities (Nourse and Roulac, 1993) and in universities (Den Heijer, 2011), revenue growth in firms across different industries (Lindholm and Leväinen, 2006) and productivity in higher education institutions (De Vries, 2007).

In the knowledge economy, stimulating innovation is a goal whose contribution to organisational performance has an effect on the competitive advantage of universities of technology, research institutes, R&D companies and municipalities. These organisations are driven by technology as competitive force. However, according to each organisation's core business, competitive advantage may relate to productivity, profitability or distinctiveness. As these organisations are involved in campus development, this paper brings together the existing research addressing the versatility of this added value regardless of each study's distinct application area.

Second, stimulating innovation is considered "interdependent" with other real estate strategies or added values (De Vries, 2007; Den Heijer, 2011; Lindholm *et al.*, 2006; Nourse and Roulac, 1993; Appel-Meulenbroek, 2014). According to most of the studies reviewed, *innovation*, *user's satisfaction* and *image* are mutually dependant aspects of organisational performance. Herein, attracting and retaining high-skilled people seems central to maximise competitive advantage in particular organisations such as firms driven by technology (Nourse and Roulac, 1993), higher education institutions (De Vries, 2007), knowledge-based businesses (Lindholm *et al.*, 2006) and universities (Den Heijer, 2011).

In these views, innovation may be perceived as a social process driven by the exchange of tacit knowledge (i.e. knowledge embedded in people). Although there are other theoretical approaches to innovation pointing out its multiple meanings (i.e. input, process and output), this paper follows the approach of existing CREM research, i.e. innovation as *a learning process*, in which the human dimension connects the creation, diffusion and application of knowledge. Largely, these three interrelated processes take place across multiple organisations and the places in which they concentrate such as campuses and cities. This assumption scales up the study of "stimulating innovation" as a real estate strategy, which has been studied in CREM research within the boundary of one (type of) organisation. It also suggests the need to incorporate theoretical concepts from urban studies.

Third, stimulating innovation is considered to be an "intermediate" real estate strategy in guiding decisions and interventions. The latter two are seen as potential measures to assess the impact of real estate strategies on organisational performance. Because innovation has been related to users' processes (i.e. learning and knowledge sharing), this real estate strategy is hard to measure with financial or quantitative indicators – also regarded as soft CRE strategy (Appel-Meulenbroek, 2014). Existing research considering quantitative measurements for innovation shows that such measurements are scarce compared with other strategies (Lindholm and Leväinen, 2006). Correspondingly, *innovation* and *users' satisfaction* are less frequently perceived as explicit added values in public and private firms (Lindholm *et al.*, 2006) or in higher education institutions (De Vries, 2007; Beckers *et al.*, 2015). Largely, real estate decisions and interventions linked to innovation focus mostly on perceived spatial quality, judged by the users (Table I). Moreover, it has predominantly focussed on "workplace design". Empirically, the concept of "workplace" has been mainly explored in office environments of organisations driven by technology and creativity. This focus is limited to particular activities and may exclude those that require different working settings. Although workplace solutions have a deserved place as a real estate decision linked to innovation, it does not seem adequate to explain how campus development may stimulate innovation as seen in this paper (i.e. a learning process across organisations and the places they concentrate).

	Key sources linking real estate decisions to innovation-related strategies						
Focus of real estate decision	Nourse and Roulac (1993)	O'Mara (1999a, 1999b)	Roulac (2001)	Den Heijer (2011)	Lindholm <i>et al.</i> (2006)	Appel-Meulenbroek (2014)	Waber <i>et al.</i> (2014)
Workplace (design/use)	Theory		Theory	Theory and empiric	Theory and empiric	Theory and empiric	Theory and empiric
Location (accessibility)	Theory	Theory and empiric	Theory	Theory and empiric	Theory and empiric	Theory and empiric	Theory and empiric
Amenities (functional diversity)	Theory	Theory and empiric	Theory	Theory and empiric	Theory and empiric	Theory and empiric	Theory and empiric
Facilities (design/use)	Theory	Theory and empiric	Theory		Theory and empiric	Theory and empiric	Theory and empiric
Space control	Theory						
Participatory design (organic use)					Theory and empiric	Theory and empiric	Theory and empiric

Table I.
Real estate decision linked to innovation in the CREM literature

Early CREM theories (Nourse and Roulac, 1993; O'Mara, 1999a, 1999b) emphasise the relevance of location and the provision of amenities for innovation. These real estate decisions have received less attention in CREM empirical research investigating innovation. Conversely, their importance for innovation is gaining relevance in the urban context (Florida, 2010; Porter, 2008b; Van den Berg *et al.*, 2005). They are considered place-based aspects creating an attractive social environment for highly educated individuals, who perform innovation processes in cities (Fernández-Maldonado and Romein, 2008; Drucker and Goldstein, 2007; Van Winden *et al.*, 2008; Den Heijer and Curvelo Magdaniel, 2012). The contemporary context and urban scale of campus development have the potential to explore real estate decisions associated to innovation other than the workplace. Identifying more interventions in campus development may help to better illustrate how stimulating innovation as a real estate strategy has an effect in the competitive advantage of various organisations.

Generally, the study of campus development stimulating innovation is rather complex as it integrates the contemporary dynamics behind this practice in the knowledge economy and at urban level. Although CREM studies offer a solid theoretical basis to explore this paper's main assumption, it is necessary to establish connections between particular concepts in related fields, including CREM and urban and regional studies. Understanding how innovation occurs across organisations in campuses is relevant for two reasons. First, it will help to clarify the role of real estate in innovation at a scale that has not been explicitly studied in CREM research but widely discussed in other fields. Second, it may help campus managers to make decisions that effectively support their ambitions to stimulate innovation. In absence of an adequate theoretical framework to address the relationship between innovation and campus development, this paper sketches a preliminary arrangement of concepts from different fields.

Conceptual framework: stimulating innovation at urban level

This framework positions campus development as catalyst for innovation. The big picture of this framework is explained in terms of "input – process – output" within the context of the knowledge economy. Accordingly, innovation as a learning process is a major source of competitiveness for the different organisations involved in campus development. There are five input-conditions necessary to perform the processes of knowledge creation, diffusion and its application, leading to different innovation outputs (i.e. diverse measurable targets such as patents, citations and sales from new products). While outputs are independent measures that are valued differently by each type of organisation, the five input conditions are interdependent, and each of them has a particular function enabling innovation as a process. This framework focusses on the input side of the system as it sketches innovation as a process in which real estate is a special type of input-resource – i.e. campus development is a catalyst facilitating these five conditions. Thus, the following conditions are the key to understand and explain how campus development can possibly stimulate innovation:

- *Concentration of innovative organisations:* These are universities of technology, R&D firms, research institutions and other organisations, which primary process a deal with technology-based research. Their presence in an area is the basic condition for innovation in cities and regions (Porter, 2008a; Van den Berg *et al.*, 2005). The function of this condition is to make the innovation processes happen. The way innovative organisations concentrate defines the innovation area.

- *Innovation area*: It is the area defined by the spread of the concentration of innovative organisations in particular places (e.g. an urban area, the city or the region). These areas enable geographical proximity, which is believed to facilitate other types of proximities (i.e. cognitive, social, organisational and institutional), which are critical for innovation (Boschma, 2005; Legendijk and Lorentzen, 2007; Torre and Rallet, 2005). The innovation area functions as the geographical setting allowing face-to-face contacts among diverse people working in innovative organisations.
- *Diversity of functions*: Having diverse functions in the innovation area allows bringing together diverse people with complementary intellectual backgrounds. Social dynamics are considered central for innovation as a learning process, which is driven by the exchange of ideas (Jacobs, 1961; Florida, 2008; Van den Berg *et al.*, 2005). This condition functions as the invisible force increasing the frequency of encounters and thus the chances for interaction among people.
- *Innovation climate*: This results from the dynamic institutional, technological and social developments happening at particular times and places influencing innovation (Boschma and Frenken, 2006). This condition functions as the initial state that makes innovation a prerequisite for growth. An innovation climate preserves a continuous flow of incentives.
- *Flow of incentives*: This refers to continuous actions required to start and carry-on the innovation processes (e.g. investments on research, policies, entrepreneurial activities, networking, etc.). It usually involves the engagement of and collaboration between the multiple parties interested on stimulating innovation (Van den Berg *et al.*, 2005; Etzkowitz, 2008). The function of this condition is triggering interactions between innovative organisations.

Campus development as catalyst for innovation. The campus is a resource capable of facilitating conditions required for innovation. The word “catalyst” is used as a synonym of enabler of activities performed by individuals and organisations (De Jonge and Den Heijer, 2008; Den Heijer, 2011). Steering the campus as a resource increases its capacity to stimulate innovation and attaining the desired organisational performance (De Jonge, 1996; De Vries, 2007; Den Heijer, 2011; Joroff, 1993; Lindholm *et al.*, 2006; Nourse and Roulac, 1993). The catalyst role of the campus is dependent on the existence of all five conditions described in the framework (Figure 1). Herein, the relationship between real estate and innovation is not a direct one.

Methods

This paper uses case studies for theory building based on the development of context-dependent empirical evidence (Eisenhardt, 1989; Eisenhardt and Graebner, 2007; Flyvbjerg, 2006). This paper applies, verifies and revises the preliminary conceptual framework by using a comparative case design. This framework allowed replication logic of two campuses accommodating different organisations in different cities. These are the High Tech Campus Eindhoven (HTCE) in Brainport Eindhoven region in The Netherlands and the Massachusetts Institute of Technology campus (MITC) in the Cambridge-Boston area in the USA (Table II). These two cases are chosen from a sample of 39 international campuses analysed in a pilot research because of their likelihood of offering theoretical insights (Curvelo Magdaniel, 2016). In both cases, stimulating innovation is an explicit goal addressed by the organisations involved in campus development, and they have relatively

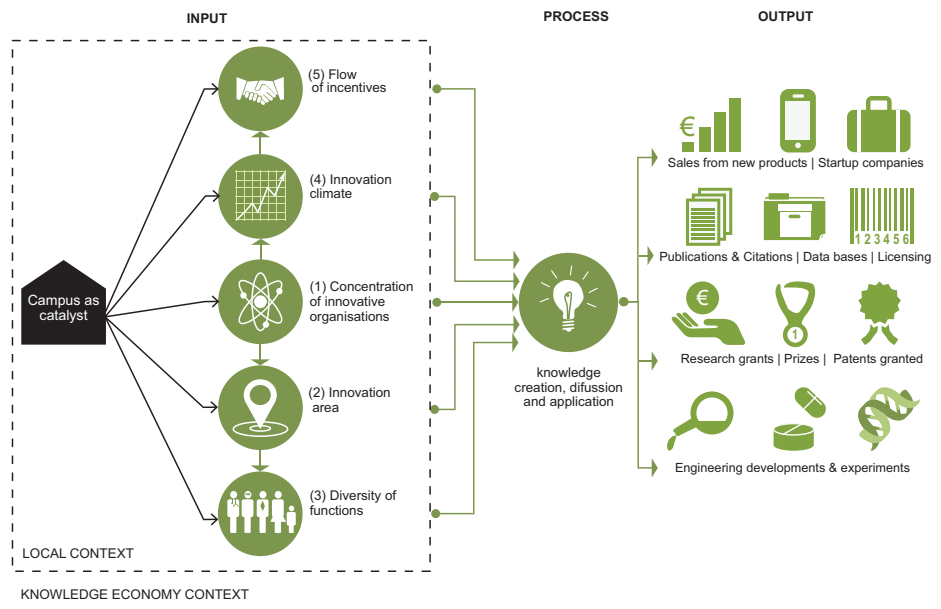


Figure 1.

	HTCE	MITC
Development periods	1963 (initiation) 1999 (first redevelopment) 2012 (second redevelopment)	1916 (initiation) 1960s (first redevelopment) 1990s (second redevelopment)
Campus research activities	R&D	Scientific research + R&D
End-users	125+ R&D companies (Philips Research is the larger organisation) Five research institutes	1 research university (Massachusetts Institute of Technology) 200+ R&D companies and institutes
Hosting city/region	Eindhoven, North Brabant, The Netherlands	Cambridge, Massachusetts, USA
Location	Peripheral	Inner city
Surface	103 hectares (commercial land)	104 hectares (academic + commercial land)
City/Region's vision	Eindhoven, Leading in Technology. Brainport, Top Economy Smart Society	Cambridge, The heart of innovation!
Campus' vision	Open Innovation Ecosystem (HTCE Zoning Plan's concept) – Turning Technology into businesses (HTCE brand)	Innovation and Collaboration (MIT 2030 concept)

Table II.
Description cases studied

succeeded in realising this goal. This success is demonstrated by a number of output indicators in the framework (Figure 1), which are used to measure innovation in cities and organisations based on a review of the literature on innovation in the knowledge economy (Curvelo Magdaniel, 2016). Although the starting point for analysis is based on the cases'

observed similarities, the concepts arranged in the framework aim to explain the role of campus as catalyst for innovation in terms of the variations given by the contexts in which each campus has develop. In the end, the empirical insights from the cases are used to revise the conceptual framework to develop a conceptual model.

Data sources

This research used a variety of data sources for triangulation with the aim to document campus development as a long-term decision-making process (See [Table III](#)). The period of data collection differs per case study considering the variety and accessibility of data sources. Data on HTCE were collected during the period of June 2013-July 2014. Data on MITC were collected during the period of September 2014-December 2015:

- *Open and semi structured interviews* with experts and key informants provided lead to facts and relevant readings on the cases in their respective contexts. Experts on the subject possess in-depth knowledge on particular domains of campus development as they have been involved in this practice over long periods (e.g. designers, planners and managers with over five years of experience working in the cases). For the HTCE, five experts were contacted via e-mail, and four of them responded (i.e. the managing director of the campus since 2009, the urban planner and designer of the campus since 1996, the operations and facility manager of the campus since 2007 and a designer and building contractor of campus buildings since 1996). For the MITC, three experts were contacted via e-mail, and two of them responded (i.e. the campus planner during the period 1960-2000 and the campus real estate manager since 2000). These interviews include about 10-15 open questions aimed to gain knowledge on the campus development process from each expert's experience. The interviews were often divided in two parts. The first part sought for the visions and decisions that have influenced the development of each campus to identify the strategies aimed to stimulate innovation. The second part asked about the implementation of such strategies and to what extent they considered the built environment helped attaining their goals. Experts on the object of study had particular knowledge about innovation dynamics in the region where the campuses locate. For both cases, two experts were contacted and responded via e-mail (i.e. a campus developer and innovation strategy official for HTCE and two senior researchers on technology-driven real estate for MITC). These interviews include about ten open questions aimed to gain insight into the contexts influencing each campus development. The interviews were often divided in two parts concerning innovation in the city/region. The first part focusses on the perceived relationship between innovation and physical infrastructure. The second part focussed on external developments influencing the development of the campus studied. Key informants played a role leading to facts on campus development and extra insights on context-related information. They were contacted incrementally as suggested by experts and/or as indicated in reports while documenting the cases. For the HTCE, 11 key informants were contacted via e-mail, and 8 of them responded. For the MITC, 14 key informants were contacted via-email, and 10 of them responded. This group of interviewees involved professionals in diverse fields, including urban planners, real estate managers, facility managers, innovation policy officers and lecturers on innovation and entrepreneurship. These interviews were tailored enquiries on particular campus development phases, strategies or decisions.

Table III.
Overview of data
collected

Case studies	<i>In-person interviews</i>			Data sources			Apps	Examples	
	Experts	Key informants	Total	Types	Examples	Types			
HTCE	6	8	14	6	Seminars; site visits; guided visit to special facilities; attendance to events; informal meetings and talks	4	Maps' collections; official reports; existing empirical research; news	3	Google Earth; Esri Maps;
MITC	4	8	12	9		4		4	Google maps; and Mappnificent
Total	10	16	26	15	n.a	4	n.a	4	n.a

- *Documentation* allowed collecting exact information containing references, names and details of campus development covering a long time. This included maps and photos from archives, official briefing and administrative reports, existing empirical research or formal studies on the cases and articles in the media.
- *Site observations* allowed insights into cultural features of the concepts, opinions and leads to facts. These were possible during site visits, including field trips, seminar attendances, guided walks and informal meetings with end-users.
- *Mapping* using open access applications allowed corroborating exact and particular information containing physical details on the subjects of study over time.

Data analysis

The analysis and interpretation of data followed as much as possible the explicit process of “theory building from case study research” (Eisenhardt, 1989; Eisenhardt and Graebner, 2007). Given a preliminary arrangement of concepts in the framework, this research combined both deductive and inductive approaches. The use of rich and extensive descriptions, tables, maps and figures was central to the generation of insights. Besides, it helped to cope with the large amount of qualitative data collected. The systematic use of notes, drawings and diagrams was organised through manual coding and categorisations in personal diaries and Excel sheets.

The use of replication logic in case study research allowed to compare emergent relationships from the cases enhancing confidence in the validity of the relationships (Yin, 2013). The conceptual framework served as instrument for this analysis, facilitating the comparison in different contexts. An iterative analytical procedure is used to sharpen the constructs by displaying enough evidence for each of them with examples, anecdotal reports and descriptions. The neutrality of this process was supported by exposure of the theoretical constructs in different phases of the theory development process. Interim presentations, brainstorming sessions and in-person discussions provided relevant insights avoiding premature conclusions in the preliminary constructs that emerged throughout the research. Finally, tying the emergent theory in the model to the existing concepts from the literature arranged in the conceptual framework also enhanced the confirmability of the synthesis.

Results

How does campus development stimulate innovation?

Empirical data suggest that campus development is considered a catalyst for innovation. This relationship is modelled through decisions and interventions facilitating five interdependent conditions for innovation (Figure 2). Figure 2 illustrates a revised and detailed version of the conceptual framework, which zooms into the input side of the system. The empirical findings from the cases became critical in corroborating the main research proposition and clarifying some of the concepts and their relationships addressed in the framework. As a result, some of the conditions are more explicitly addressed. The model suggests that the catalyst function of real estate for innovation cannot be isolated from these conditions. This hypothesis is sustained by the following propositions explaining how campus development is considered a catalyst for innovation.

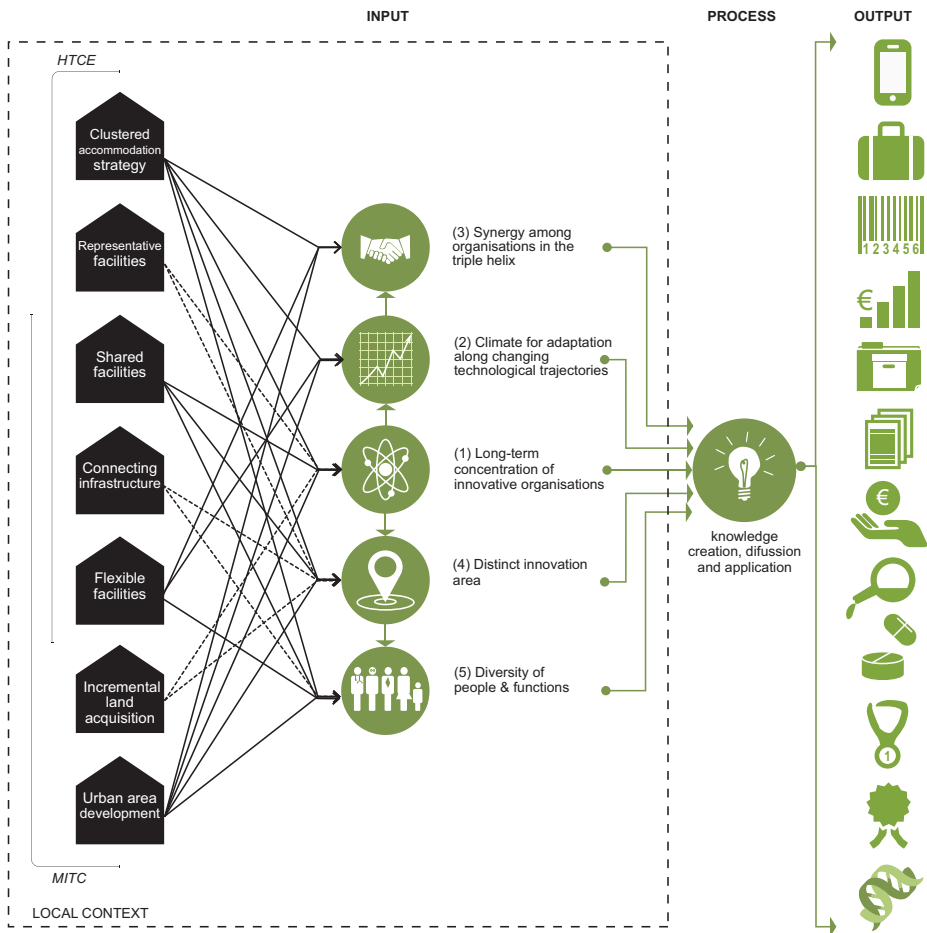


Figure 2.

Location decisions and area development facilitate the long-term concentration of innovative organisations. In the two cases, location decisions of anchor organisations (i.e. a prestigious university in Cambridge and a multinational firm in Eindhoven) to concentrate their research activities have played a significant role defining where innovation takes place in particular contexts. They have attracted and/or spun out more organisations to locate in these areas forming local knowledge networks. These empirical findings corroborate existing studies outlining the relevance of interconnected innovators in one location as sources of competitive advantage, especially in the knowledge economy (Porter, 2008b; Van den Berg *et al.*, 2005).

Data from this research indicate that campus development has facilitated this condition through location decisions and area development. Through the re-development of areas in collaboration with local governments, anchor organisations have attracted other innovative organisations to locate in their vicinities. The development of shared facilities (e.g. laboratories, mixed-use facilities and co-working office space) has strengthened the

attractiveness of these locations for specific organisations because of the potential access to knowledge networks.

Interventions enabling the transformation of the built environment at area and building levels facilitate the climate for adaptation along changing technological trajectories over time. In both cases, regions hosting campuses experienced severe decline of their economies, which enforced their governments to take different reindustrialisation measures in different periods. Regional leaders in government, industry and academia had a proactive role in sorting the economic crisis while pulling together the advantage of hosting innovative organisations, which helped these regions to re-orientate their economies in specific sectors aligned with the technological trajectories they continued. These empirical findings support a core concept defining evolutionary economic geography that “views institutions as primarily influencing innovation in a generic sense and as co-evolving with technologies over time and differently so in different regions” (Boschma and Frenken, 2006). Similarly, it strengthens the theoretical approaches explaining the different dimensions of proximity from a dynamic perspective (Balland *et al.*, 2015).

Campus development has facilitated this condition through interventions, enabling the transformation of the built environment at two scales. At an area level, urban renewal and area redevelopment facilitated the regions’ resolutions for change in attracting innovative activities in targeted sectors that reinvigorated their economies. At a building level, the development of flexible facilities in campuses has accommodated the dynamic demands of organisations that adapted their activities along with changes in the technological trajectories they continued over time. In both cases, the adaptive re-use of existing buildings with particular design and building qualities (e.g. modularity, standardisation and openness) facilitated this climate for adaptation because of the changing activities within the same organisation and/or the changing end-users over time.

Large-scale real interventions facilitate the synergy among organisational spheres of university, industry and government. Findings demonstrate how a concerted agenda created synergy among different organisations that were able to play non-traditional roles to accomplishing their goal of stimulating innovation. These empirical findings validate existing theoretical concepts outlining this required synergy and role-taking ability, such as the organising capacity of cities in the knowledge economy (Van den Berg *et al.*, 2005) and the triple helix relationships in regions – i.e. university, industry and governments (Etzkowitz, 2008).

Campus development has facilitated this condition through the implementation of large-scale interventions collectively conceived by these organisations over long periods. Urban renewal and area development were set up as *ad hoc* collaborations among multiple organisations to encourage socio-economic development. They involved long-term processes that demanded strategic alignment, agreements and commitments between the different organisations involved in such interventions. This strengthened the relationships and trust among stakeholders in these organisational spheres, who worked together for decades pursuing mutual benefits. Developing areas helped channelling public and private investments that work in retaining and attracting economic activities in each particular context and during critical periods. The development of flexible facilities played a secondary role facilitating this synergy. In both cases, the adaptive re-use of functional buildings over time may help to direct collective R&D investments to other targets rather than building new infrastructure. Examples in both cases suggested that organisations may save costs because some facilities needed no further renovations when adapting functional changes over time.

Location decisions and interventions supporting image and accessibility facilitate shaping a distinct innovation area with particular identity, scale and connectivity features. Findings suggest that organisations concentrated their research activities in particular ways determined by the distinct geographic features of the places they decided to locate. Such features have defined the scale and connectivity of these areas, shaping the way organisations access their networks and related activities. The singularities of those activities and places have shaped a mutual identity for the organisations located in these areas. These empirical observations build upon existing studies outlining that geographical proximity facilitates other four dimensions of proximity relevant for innovation because it eases the flows of tacit knowledge by means of face-to-face interactions and collaborations among knowledge networks (Boschma, 2005; Lagendijk and Lorentzen, 2007; Torre and Rallet, 2005; McCann, 2007).

Campus development has facilitated this condition through location decisions and interventions supporting the image and the accessibility of these areas. In both cases, the redevelopment and renewal of areas had the explicit intention to change the image of these areas, highlighting the character of specific innovative activities at different times (i.e. from industrial districts to high-tech and R&D sites). This supporting role is replicated on a smaller scale with the development of particular shared facilities that have become landmarks and/or brands identifying its users. The development of physical infrastructure favouring walk-ability (e.g. public space, bike-paths and landscape design) and the use of public transportation show a turn towards transit-oriented development rather than the use of cars to improve the accessibility to and connectivity of these areas. The effectiveness of developing physical infrastructure improving the campus connectivity depends on the unique features of the location, enabling accessibility of knowledge networks within and beyond these areas.

Real estate interventions enabling access to amenities increase the diversity of people and functions, regardless of the particular geographical settings in which innovation activities takes place. Empirical evidence suggests that particular locations determined differences in population, density of amenities and thus, the diversity of people and functions per case. Cities are recognised as natural sources of innovation and creativity because the abundance of these aspects (Florida, 2008; Van Winden *et al.*, 2008; Jacobs, 1961; Pentland, 2014). Findings support these theoretical viewpoints as more amenities and diversity of people are found in the inner city compared to the peripheral location studied. However, both environments have provided enough diversity favouring contacts among knowledge networks.

Campus development has facilitated this condition through real estate interventions, enabling the access to amenities and knowledge networks in different ways. In the peripheral campus, the relative lack of amenities and diversity of people is compensated by concentrating mixed functions in central facilities. The distribution of the amenities and diversity of people becomes limited to these central areas, strengthening the isolated identity of these locations. These facilities became exclusive for campus end-users because of limited campus neighbours. Only in case of temporary events (i.e. conference, congress and symposia), these facilities enable more diversity by having external users. These locations deal with improving their integration with nearby cities by using efficient connectivity. In the inner-city campus, amenities, diversity of functions and people were abundant and distributed in shared facilities within and beyond the campus. Citizens use these facilities besides its end-users because there are no formal boundaries between the campus and the city. However, these locations deal with affordability and congestion because of the limited space in urban areas.

Issues in both cases can be detrimental to innovation because they can drive away key actors of the knowledge network and decrease the attractiveness of these areas in the long term. These findings reinforce the important role of the social dimension for knowledge networks and the need for controlling its advantages and associated problems for learning addressed in economic geography (Boschma, 2005; Boschma and Frenken, 2010). Findings also pose questions about the rise of the so-called “innovation districts” and a stream of research underestimating the potential of peripheral locations for innovation (Katz and Wagner, 2014).

Moreover, the development of physical infrastructure connecting the different functions on campus allows opportunities to have more and diverse people in one building with chances for interaction. In the peripheral campus, landscape design and an internal system of outdoor pathways for pedestrians and bikes enabled chances for interactions among diverse people by connecting the shared central facility with the rest of the campus. In the inner-city campus, indoor and outdoor paths facilitated this condition by giving continuity to the transit-oriented system of the city through the campus (e.g. pedestrian paths, bike-lanes, bus and subway corridors). The indoor continuity of pedestrian paths through the campus’ facilities is a unique intervention in this case because it keeps a continuous flow of people moving, and information is displayed in different facilities that accommodate mixed uses. In this case, physical connectors become not only channels that increase the opportunities to meet diverse people but also indirectly share knowledge.

Discussion and conclusions

The contribution of this research is discussed in two parts. First, the main theoretical insights for the CREM field are discussed. Second, the practical implications of the results are outlined.

Theoretical discussion

This paper provides CREM research with a framework that models the relationship between innovation and real estate at the urban and portfolio level. Although its results are limited to two cases and use concepts from complementary fields, this paper builds upon the existing CREM research, studying stimulating innovation as a real estate strategy and campuses as real estate objects.

First, the study of campus development in two contexts confirms that *stimulating innovation is a versatile real estate strategy* contributing to organisational performance by means of competitive advantage in universities of technology, R&D companies and municipal/regional governments. Although these organisations have competitive advantage as a common performance criterion, this research also identified two predominant views of innovation by the stakeholders involved in campus development. On the one hand, stakeholders who focus on campus as an operational resource tend to perceive innovation as a process driven by the exchange of ideas. They seek to facilitate people’s activities and processes through the built environment. On the other hand, stakeholders who focus on campus as a strategic asset tend to perceive innovation as market-driven by the exchange of capital. They seek to maximise investments through the built environment and to increase real estate value. Although there is an evident difference and tension between their perspectives, both groups of stakeholders promote the first perception when developing campuses. Table IV shows conflicting situations that can reduce the function of the built environment as a catalyst for innovation because they may hinder the processes leading to innovation in the long term. This paper suggests to further study these conflicts to balance the different perspectives of these individual stakeholders in line with the organisational strategy.

Table IV.
Stakeholders’
conflicts inhibiting
the function of real
estate as catalyst for
innovation

Case	Conflicting situation	Stakeholders	Perspectives
MIT	Focusing on commercial developments over academic accommodation Attracting firms over retaining talent	Real estate managers/ municipal authorities vs users/campus planners Real estate managers and municipal authorities vs end-users and campus planners	Strategic/financial vs functional/physical
	Allowing form over functional needs	Designers/policymakers/real estate managers vs users/campus planners	Strategic/financial/ physical vs functional/ physical
HTCE	Competing over collaborating in urban strategies	City planners vs neighbouring city planners	Physical vs physical
	Investing resources to developing a campus as “a city”, while paradoxically improving its accessibility to urban areas	Real estate owners vs campus/ city planners	Financial vs physical
	Giving private parties autonomy for strategy implementation at the scale of area development	City planner vs real estate owners	Physical vs financial
	Arranging collaboration instead of giving room for spontaneous dynamics in collaboration patterns	Real estate managers vs users	Financial vs functional

Second, empirical data related to the conditions “distinct innovation area” and “diversity of people and functions” confirm that *stimulating innovation is an interdependent real estate strategy*, because its impact on organisational performance is linked to two other strategies, i.e. supporting image and increasing users’ satisfaction. This finding builds upon existing research outlining interdependencies among these three real estate strategies (Nourse and Roulac, 1993; De Vries, 2007; Appel-Meulenbroek, 2014; Den Heijer, 2011). Although this study tried to isolate “innovation”, future CREM research studying this aspect of organisational performance should explicitly consider such interdependence. While this finding strengthens the perception of innovation as a social process, this paper has outlined that in practice, this perception is used as a discourse to promote innovation even when other interests exist. Indeed, the increasing perception of innovation as market-driven by the exchange of capital could be considered in future research to interrelate innovation with other aspects of organisational performance such as real estate value and productivity.

Finally, this paper builds upon the idea that *stimulating innovation is an intermediate strategic level to guide real estate decisions and interventions*. As addressed in existing CREM research (Nourse and Roulac, 1993; O’Mara, 1999b), this paper acknowledges location decisions as key to stimulate innovation. By bringing concepts from complementary fields (e.g. urban studies and economic geography) and by scaling up the study of this added value from a multi-organisational perspective at an area level, this paper contributes with the following real estate interventions stimulating innovation:

- transforming areas through urban renewal and/redevelopment;
- building, adapting and re-using flexible facilities;
- implementing the shared use of facilities accommodating different functions and users;

- developing physical infrastructure that enable access to amenities and connection between functions by the users; and
- developing representative facilities and area concepts that support image.

Furthermore, the study of both campus development and stimulating innovation as long-term processes strengthens the “softness” of this strategy (Appel-Meulenbroek, 2014). Although the empirical findings of this paper link real estate with performance, this approach increased the complexity of measuring the impact of this real estate strategy in practice. That is because this research positions campus development as facilitating five conditions for innovation, whose attainment can only be measured in the long term. Overall, these theoretical insights suggest a relatively new way to look at the relationship between innovation and real estate that can be further researched and used in practice.

Practical insights

How can campus managers use this knowledge to add value through real estate? The previous insights are modelled into an information map for campus managers. This tool is targeted to guide their decisions when supporting stimulating innovation as an organisational goal and to better communicate how can they do so through real estate.

Towards a map for managing campus development as catalyst or innovation

This paper proposes a path linking organisational performance and real estate through four different and hierarchical levels, where innovation is a central aspect to explicitly focus on real estate strategy (Figure 3). This framework can be used by campus managers to guide the course of action from strategic to operational decisions in stimulating innovation. The

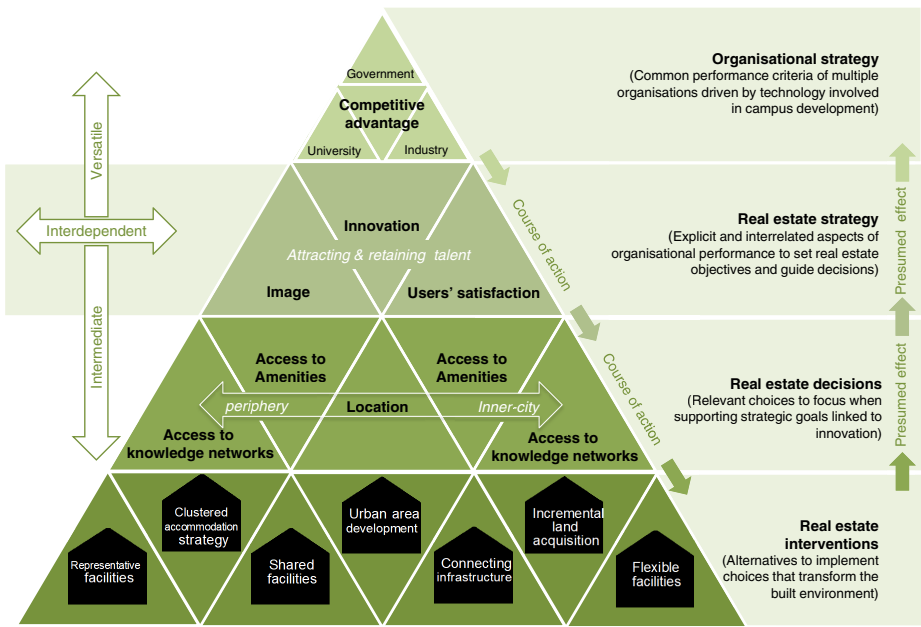


Figure 3. Information map for campus managers linking decisions and interventions to organisational performance through innovation

added values' attributes of being versatile, interdependent and intermediary are useful for managers to explain the alignment between real estate and organisational strategies.

Stimulating innovation is versatile. This tool positions "competitive advantage" as the main performance criterion of different organisations driven by technology. To remain competitive, each organisation focusses its strategy depending on its core business and mission, leading either distinctiveness, profitability or productivity. The hierarchical structure of this tool eases this dilemma by making precise the priority directing the path that might lead to stimulating innovation through real estate.

Stimulating innovation is interdependent. Innovation, image and users' satisfaction are interdependent aspects of organisational performance. Attracting and retaining high-skilled individuals and/or groups of individuals is essential for technology-driven organisations to perform their primary processes leading to innovation. Campus managers should be aware of the complementary relationship between these three real estate strategies when setting real estate objectives and guiding real estate decisions.

Stimulating innovation is intermediate. This tool outlines location and the provision of amenities per location as crucial real estate decisions stimulating innovation. Empirical findings exhibited that location is a crucial decision for tech-driven organisations because of the access to amenities, which are important for high-skilled workers in deciding where to live and work (e.g. housing, leisure and culture). Cities and densely populated areas have abundant amenities. Obviously, campuses located in and close to cities have a natural advantage over those who are in peripheral locations. However, location decisions not always involve making a choice from different alternatives. When organisations decide to relocate or expand their activities somewhere else, the site is often given because of availability of convenient land. In such cases, the provision of sufficient and diverse amenities in campus becomes an important real estate decision regardless of the location characteristics. Similarly, this tool lists a number of possible interventions at an area level transforming the built environment of campuses, which can be seen as choices to implement these real estate decisions. Building new, redeveloping areas, renovating facilities, adjusting the functionality of a space, etc. are examples of real estate interventions that can be targeted to attract and retain knowledge workers.

Generally, the inflation of the term campus in relation to innovation supposes a challenge for stakeholders involved in the practice of campus development. The commonly accepted assumption that concentrating people and their activities in one place is beneficial for innovation is encouraging the development of campuses worldwide. Although this paper attempts to clarify the relationship between real estate and innovation, the evidence is still scant. More research is needed on these subjects to support investment decisions on campuses. The in-depth study of two cases has shown that developing campuses take times and willingness and commitment of many stakeholders in different phases to attain a common goal: stimulating innovation. When it comes to campus development, sustaining this common goal becomes challenging given the different perceptions innovations has. These conflicting perceptions of innovation by stakeholders can hinder the facilitating role of the built environment in innovation. The main challenge for campus managers is balancing the stakeholders' perspectives while ensuring the continuity of real estate strategies and their implementation. This is critical considering innovation as a learning process takes place in the long term while managers have relatively short-term appointments. This paper acknowledges that stimulating innovation through real estate requires a user-oriented approach, as attracting and retaining talent is crucial for the survival of innovation-driven organisations.

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