Graduation Plan

Master of Science Architecture, Urbanism & Building Sciences

Graduation Plan: All tracks

Submit your Graduation Plan to the Board of Examiners (Examencommissie-BK@tudelft.nl), Mentors and Delegate of the Board of Examiners one week before P2 at the latest.

The graduation plan consists of at least the following data/segments:

Personal information	
Name	Lars Louis Cazemier
Student number	5057124

Studio		
Name / Theme	Real Estate Management	
Main mentor	Prof.dr.ir. A. Den Heijer, TU Delft	Public Real Estate, TU Delft
Second mentor	Dr.ir. A. (Alexander) Koutamanis	MBE | DCM, TU Delft
Third mentor	Ir. B. Valks, TU Delft	Smart (campus) tools, TU Delft
Argumentation of choice of the studio	Based on the supervisors' research, this studio fits best with my research, and this has also been a personal reason. Since 2017 when I first came into contact with blockchain, I have become interested in IoT and tools like this. I also contributed to a blockchain event in the Amsterdam Rai and went to meetings to see what technology already has to offer, and it's potential. As a result, my interest in data-driven developments grew, which hardly came to the fore in the master's program. This has been a reason to follow these interests, and now I can further expand this during my master thesis. I also experienced the lockdown and the pros and cons of studying at home and would have liked to see a better balance in a hybrid form. Because of COVID-19, this could not be done. However, for universities, it is necessary whether smart tools can be used even better to use spaces on campus more efficiently during this fluctuating demand. In this way, I would like to contribute to universities' decision-making so that the use of the campus can be better managed.	

Graduation project	
Title of the graduation project	Smart Campus Tools 2021: Gaining insights from universities and other organizations to support the back to campus movement following COVID-19
Goal	

Location:	TU Delft, Cases are interviewed in an online environment.
The posed problem,	On January 30, 2020, the World Health Organization Emergency Committee declared a global health emergency based on increasing reports of cases in Chinese and international locations (World Health Organization). The emergence of COVID-19 and the ensuing pandemic disrupted the world as we know it. As the pandemic spread across the world, governments instated lockdowns, closing office buildings, education institutions, sport facilities and various public facilities. Ever since, the world has moved in and out of lockdowns with different intensities. On April 4, 2020, over 3.9 billion of people in over more than 90 countries were in a lockdown, and in December the AFP confirmed over 60 million confirmed COVID-19 cases and almost 1,5 million fatalities (World Health Organization). In this transitional phase, organizations have to continuously adapt to the most recent regulations (e.g., 1,5-meter distance between people, ventilation regulations) to facilitate students to come study, employees to work at the office, people to practice sports, hobbies and meet each other. University campuses have been similarly affected. It is estimated that more than 1.6 billion students, representing 91% of all students worldwide are affected by the COVID-19 pandemic (Sharma, 2020a). In a very short time, universities have been forcibly adapting their teaching methods and facilities to switch to online learning (Rijksoverheid, 2020). Depending on government regulations, education now takes place in a hybrid model with classes both on campus and online (NOS, 2020). Similarly, research activities have also been affected: several types of research are now conducted virtually, or face capacity constraints in laboratories (Radecki & Schonfeld, 2020). Public events on campus such as graduations, PhD defenses, inaugural speeches, conferences and study-related activities are all organized online or in a very limited on campus setting. Thus, it can be concluded that the space use on the university campus is radically different than it was just 12 months ago. Previous studies have identified the importance and added values of space and campus management. In particular, De jonge et al. (2009), with the DAS framework to anticipate the demanded changes, determine the match between supply and demand of campus real estate. In supplementary, Den Heijer has demonstrated the importance of the multi-stakeholder approach what supports the DAS frame to retrieve the match (2008). In a further instance, in recent years, there has been more research into smart tools or IoT in real estate, and this has shown that Smart campus tools can support campus decisions (Valks et al., 2018; Valks et al., 2017; Valks et al., 2016; Valks et al., 2020). SCT and SCT 2.0 show that several universities have already implemented Smart tools, showing that Smart campus tools contribute to more effective space use and support campus decisions. This contribution is formulated as: "a smart campus tool is a product or service that collects real-time data to improve space use on the current

	campus and decision-making about the future campus" (Valks et al., 2019). This research assumes using the hypothesis: with the changed situation due to COVID-19 with an increased demand for a hybrid form of education, measurement of space use will become more important after COVID-19 than before. In terms of efficient and inefficient space use and finding these spaces for the users. More information from smart campus tools will contribute to decision-making for the period after the COVID-19 crisis. It will, given the increase in fluctuating number of users on campus, become even more important. With real-time information, campus managers can better monitor the crowds, better manage space use and provide insight into how space is being used. With this information, campus managers can increase short- and long-term decision-making to benefit of users and campus real estate. Despite the accumulation of literature, there is an absence of research that examines the contextual effects of the recent COVID-19 at universities and other organizations. The content of this research builds upon the results presented in SCT 2.0 (Valks et al., 2018). Based on the problem and the lack of shared knowledge in practice and science, this research addresses the following research question: "What has changed in terms of type, demand, and use of smart campus tools at Dutch universities and other organizations due to COVID-19 compared to the 'Smart Campus Tools 2.0' research?".
research questions and	Main RQ: What has changed in terms of type, demand and use of smart campus tools at universities and other organizations due to COVID-19 compared to the 'Smart Campus Tools 2.0' research? Sub RQ's: 1. What are smart (campus) tools? 2. What is campus management, and what is the added value of smart campus tools in a changing demand? 3. What effect does COVID-19 have on the campus? 4. What progression have universities made compared to previous research? 5. To what extent do smart campus tools meet the needs and use of universities after COVID-19? 6. What progression have other organizations in the Netherlands made compared to previous research? 7. To what extent do these smart tools meet other organizations' needs and use in the Netherlands? Hypothesis: Due to the changed context resulting from COVID-19, increased demand for a hybrid form of education has been generated, the measurement of space use will become more critical after COVID-19 than before.

design assignment in which these results.	This is not involved.

Process

Method description

In the SCT2.0 study, a qualitative research method was used since quantitative research was not appropriate (Valks et al., 2018). This research's strategy is the re-examination of SCT 2.0, and the same research method will be applied. The approach to gathering information for the qualitative research consists of a brainstorming session, literature study, and case study interviews, which are eventually combined in the synthesis.

The approach to the various elements will be clarified. The brainstorming session created insights into the impact of the COVID-19 period at universities. In parallel, it contributed to formulating the problem statement and objective.

The literature review's primary goal is to understand campus management focused on space utilization, understand what smart (campus) tools are, and how they can contribute to changing demand. The data will be collected by studying existing literature.

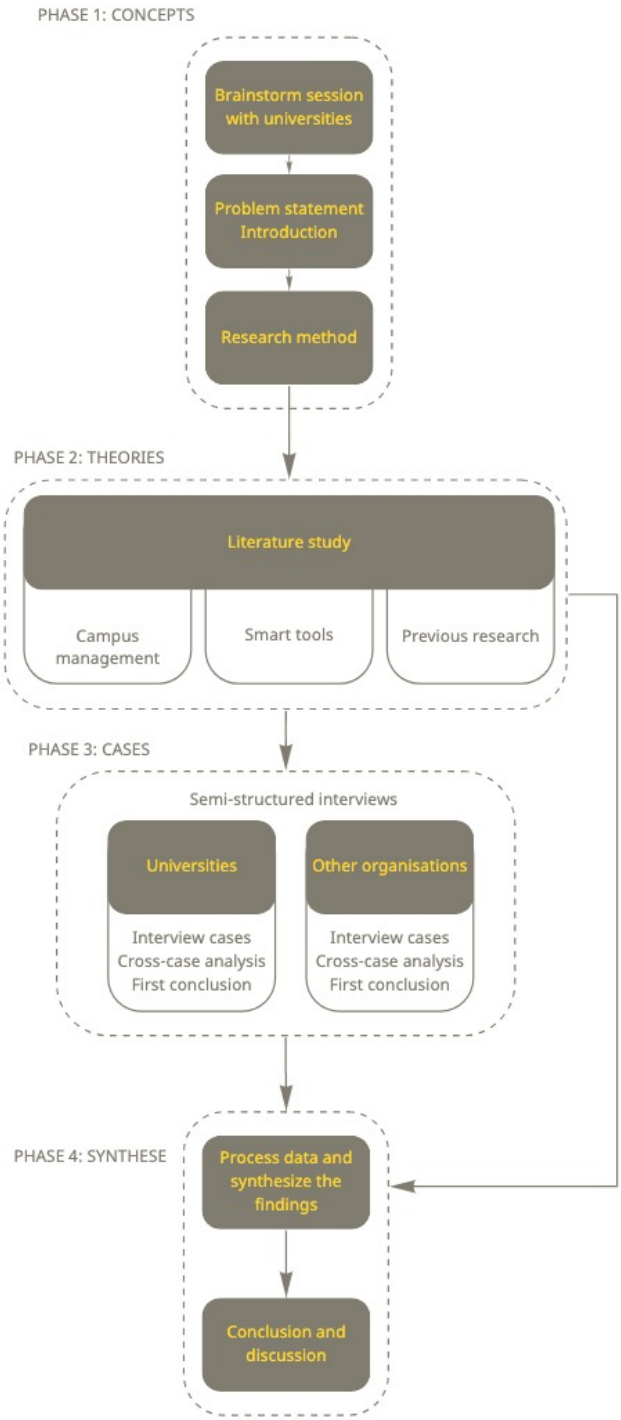
The basis of the research is to conduct repeating research. Hence, the main focus is on conducting the interviews at the same Dutch and foreign universities and other conducted organizations during SCT2.0. Through these case studies, insight is gained into current practices in the field of smart campus tools. Using the same strategy regarding the interview protocol and processing information allows identification if progress has been made. The reason for no or little progress will be mapped out. This will contribute to more informed decisions for integrating or expanding smart campus tools at universities or other organizations. Furthermore, the same interview protocol will be expanded to include questions to determine whether, as a result of COVID-19, there have been changes in the type, demand, or use of smart campus tools.

Empirical observation can be added when the situation allows the interviews and the tools to be carried out in reality. In this way, the observations from practice can be linked to one's observations. By studying the situation at a university or organization, knowledge can be gained based on (sensory) observations or experience (Bryman, 2012, p. 23). Since smart campus tools are a privacy-sensitive component at universities and organizations, falsification is possible. This allows existing theories to be rejected and, where possible, replaced by better.

Literature and general practical preference

According to Bryman (2012, p. 384), a used sequence in qualitative research starts with a general research question, then selection of relevant site(s) and data, collection of relevant data, the interpretation of data. This is continued with a conceptual and theoretical work from which it can be concluded if further data is needed and finally a synthesis outlines the conclusion and findings. This process will also be maintained in this research and to answer the abovementioned research questions, a number of different research methods are used. These are:
1. Brainstorming session
2. Literature study
3. Semi-structured interviews with case studies
4. Potentially a follow-up brainstorming session

The conceptual model used in SCT 2.0 is used to retrieve the appropriate data and display these in a structured manner in the report. More focused literature research can be carried out by being aware of this model and the interview protocol. This concerns the 'why, how and what' as the extension of the definition of smart campus tools, which is explained on p.18-20.



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Phase 1: Concepts
Defining the reason, problem statement and objective is the primary focus of the first phase. To determine this, a brainstorming session is used to create insights into the challenges by COVID-19. This allowed the identification of the impact of COVID-19, thought for the longer term, and how universities have coped with COVID-19. This method also provided insight into the answer to the first sub-question: What effect does COVID-19 have on the campus? This session also indicated that the majority of the universities that attended were interested in doing follow-up research, this also contributed to the choice of research method.

Phase 2: Literature study
The next step of the research is the second phase. It will conduct a literature study to discover more in-depth information to understand the theory of smart tools, campus management, and the results of SCT 2.0. The information sources utilized to obtain existing literature are Google Scholar, Internet sources, Repository, the TU Delft library, and Scopus. *Table **Error! No text of specified style in document.**-1* displays a list of sources that provide information per theme that served as a basis in the literature study. Below will be described which the literature study can answer subquestions.

1. What are smart tools?
2. What is the added value of smart tools on campus in a changing demand?

*Table **Error! No text of specified style in document.**-1: Literature study (own table)*

Title	Search terms	Literature
Research method/strategy	"qualitative research", "social research methods", "architecture research methods"	Bryman (2016), Valks et al. (2016; 2018), Dorst & Cross (2001), Newman (2011), Design Council UK (2005 & 2011)
(Smart) Campus management	"Supply and demand real estate", "smart tools management", "campus management", "decision-making supply and demand" "Public Real Estate Management", "Corporate Real Estate Management", "Trends education", "Management education spaces", "Management user space", "space management"	Den Heijer (2008; 2011), De Jonge et al. (2009), Ibrahim, Yusoff, & Bilal (2012), Valks et al. (2014), van der Voordt (2017), Van Der Voordt et al., (2016), Temple (2014), Space management group (2006), Rondeau et al., (2012), Abdullah et al., (2012), Lindholm et al., (2006)
Smart campus tools / smart tools	"Sensor technology", "Campus internet of things", " smart real estate", "Smart tools" "smart technologies real estate", "Smart building", "Technology real estate", "Occupancy measurement"	Valks et al. (2016; 2018; 2019;2020), Labeodan et al. (2015), Brena et al. (2017), Mautz (2012), Salimi & Hammad (2019), Space management group (2006), Serraview (2015), Melfi et al., (2011), Erickson et al., (2014)

Phase 3: Semi-structured interviews from case studies
The method in the third phase is obtaining data on cases by in-depth interviews. These are the identical cases adopted in SCT 2.0. An overview of the results from SCT 2.0 of these universities has been created in appendix I. As a point of view for the cases of this research, the ten universities from the brainstorming session (04-11-2020) have indicated that they are prepared for further research. When it appears

that other universities want to contribute to the research and that this is possible in terms of time, more cases will be approached.
The information obtained per case will be documented in a standardized way in terms of layout with short, long textual answers/ descriptions and images to clarify the results. An example of this layout is given in Appendix III. An overview of the cases is shown in *Table* ***Error! No text of specified style in document.****-2* **Error! Reference source not found.**, of which the other organizations have yet to be determined. Using the same method with the corresponding interview protocol and template, it is possible to discover whether a university or organization has made progress concerning the SCT 2.0 research.
The interview protocol includes questions showing whether universities or organizations have made changes by COVID-19, which contributes to the hypothesis's support. Also, the additional requirements and objectives of COVID-19 can be positioned.
The purpose of the additional questions to the interview protocol is whether universities or organizations use smart campus tools due to the changes in demand and supply (as a result of COVID-19) also, whether COVID-19 confirms the added value of smart tools even more or not.

Using this method, the following subquestions are addressed

- What progression have the universities made compared to previous research?
- To what extent do these smart tools meet the needs and use of universities?
- To what extent do these smart tools meet the needs and use of other organizations in the Netherlands?
- What progression have other organizations in the Netherlands made compared to previous research?

Table ***Error! No text of specified style in document.****-2: Case studies (adapted*

Country	Universities abroad	Abbreviation	Universities Netherlands	Abbreviation	Other organisations
Denmark	Aarhus University	AU	Erasmus University Rotterdam	EUR	Dutch Government
Denmark	Technical University of Denmark	DTU	Leiden University	LEI	ABN AMRO
United Kingdom	Sheffield Hallam University	SHU	Radboud University Nijmegen	RU	EDGE Technologies (former OVG
United Kingdom	Cambridge University	CAM	Tilburg University	Uvt	
United Kingdom	Oxford University	OXF	Twente University	UT	
Belgium	KU Leuven	KU	Delf University of Technology	TUD	
			Eindhoven University of Technology	TUE	
			University of Amsterdam	UvA	
			Vrije Universiteit Amsterdam	VU	
			University of Utrecht	UU	
			Wageningen University	WUR	
			University of Groningen	RUG	
			Maastricht University	MU	

and adjusted from (Valks et al., 2018)
Synthesis
Possibly another brainstorming session with also more questions focused on changing the perception of space on campus, and striking results from the interviews.

Synthesis
In the fourth phase, in the synthesis, the findings of the literature study on smart campus tools and cases will be combined in a cross-case analysis to formulate statements for the campus manager.

From the synthesis, it should be revealed what the progression is concerning the parties among themselves, corresponding reasons of delay or no use of pre-conceived Smart campus tool, corresponding methods of use of reservation. Also, whether there are comparisons in the changes to information needs and the use of smart campus tools for this purpose.
Subsequently, a conclusion, discussion, and recommendation will be made. This last part will also reflect on the findings and recommendations that offer the potential for further research.

Reflection

Scientific

This research focuses on universities and organizations that, since the COVID-19 crisis in a short period have experienced a change in the way of education and as a result of which the supply of campus real estate is hardly or not used. During a brainstorming session with universities, several problems and developments emerged to which this research will contribute. This research aims to find out whether universities or organizations use smart campus tools due to the changes in demand and supply (as a result of COVID-19). Also, whether the demand for smart tools is changing or whether the universities' demand is changing for information to be obtained. New observations in what way smart tools have added value. Since this is a current situation and little or no research has yet been conducted into the choices made in smart campus tools, experiences, developments, and problems. This research contributes to a recently created gap in scientific knowledge caused by COVID-19. But also, this research also contributes to increasing knowledge on this topic from a CREM/FM perspective. In this field, the technologies are still sparsely researched.

In addition to research at universities, other organizations are also interviewed where new information will be gained. According to Hamersma, Haas, and Faber (2020), the positive aspects of working from home are more autonomy, less travel time, and more flexible working hours are experienced. This will also influence the method of working after the COVID-19 crisis. Insight into how other organizations use smart tools in this situation, the experiences and limitations and how organizations' demand might change to the information obtained from smart tools, will contribute to the science.

Societal

As a result of the extremely rapidly changing situation due to COVID-19, education has had to take other forms, but this also impacts social relevance. There are problems such as psychological problems, social isolation and study delay (Dartmouth College, 2020; NOS, 2020 ; Remie & Veldhuis, 2020; ScienceGuide, 2020).

Research shows that universities are more than a place to learn and play an important role in providing nutrition and providing care about the student's physical safety, social and mental health and well-being (Dorn et al., 2020a). In a hybrid form of education, it is therefore important that these aspects continue to exist and that it continues to encourage learning (Dorn et al., 2020b). In today's education the focus is on personal interaction between teachers and students. In the lockdown period,

teachers and students have experienced that online alone does not work well and is tiring and that depth and discussions are lacking (NOS, 2020b; Omroepwest, 2020a). Students experience that through social context, you can learn for yourself by looking at others, how they approach something, how they work, and how they get better (Herzog et al., 2020).

From the brainstorming session with universities, opinions show that teachers experience difficulties finding the same energy as for physical teaching in online teaching (Valks, 2021). In addition, online teaching is still experienced as heavy and exhausting. In this way, this research will contribute to universities' decisions, which will also contribute to the social context.