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	Britt Belt
Student number	4663691

Studio		
Name / Theme	Circular and adaptable property and real estate development	
Main mentor	Hans Wamelink	DCM
Second mentor	Evelien Bruggeman	Bouwrecht
Argumentation of choice of the studio	I have chosen the theme of circular and adaptable property and real estate development for my graduation because I believe circularity represents the future of the industry. The traditional linear approach to property development, where resources are extracted, used, and then discarded, is not sustainable in the long term. We must shift towards a circular model where resources are conserved, reused, and recycled to minimize waste and maximize efficiency. Additionally, the world is constantly changing and cities are growing rapidly. It is crucial for the built environment to be adaptable to these changes, rather than being rigid and inflexible. Circular and adaptable property development ensures that buildings and infrastructure can be repurposed and adapted as needed, rather than being torn down and rebuilt. This not only saves resources, but also promotes long-term sustainability and resilience.	

Graduation project	
Title of the graduation project	Maximizing products as a service in the built environment
Goal	
Location:	The Netherlands
The posed problem,	The built environment (BE) is a big contributor of carbon emissions and

	responsible for most of the worlds raw resource extraction. There is only a limited supply and the linear model is no longer sustainable. Therefor a switch should be made towards a circular economy. New models should be developed within the built environment to make this possible, such as product service systems (PSS). However this is still not used a lot within the BE, because of the challenges that come with this.
research questions and	**Main research question:** How can product service systems be applied in the Built Environment and expended as much as possible? SQ1: What is circularity in the built environment? SQ2: What are product service systems in the built environment? SQ3: What is the importance of the stakeholders within the circular chain of PSS? SQ4: To what extend are product service systems currently implemented in the built environment and what are their characteristics? SQ5: What are the future possibilities for product service systems in the built environment?
design assignment in which these result.	This research focuses on investigating the use of product service systems (PSS) in the built environment as a solution to create a more circular economy. The goal is to maximize the use of PSS in the built environment and the research looks at how widely the model has been applied so far and what new possibilities exist. The

	characteristics and properties needed for successful PSS and factors that influence a PSS will also be reviewed.

Process

Method description

This research will use a qualitative approach and will focus on the circular economy and the workings of the circular supply chain. The literature review will be divided into two parts: a general literature review and an examination of existing cases in the literature. The study will use desk research and in-depth interviews with experts in the field. The goal is to create an overview of the properties and characteristics necessary for a product within the built environment to be used as a service, and to understand the factors that influence Product-Service Systems (PSS). The research will assess new building components that could be used as PSS and provide advice on how new PSSs can be possible and what is needed to make this a reality.

Literature and general practical preference

The literature study in this research was conducted in two parts. For both parts, keywords were selected from the thesis's purpose and research questions to search the literature. The first part of the literature study focused on finding background information and concepts related to the main research question. For this first part the research of the Ellen MacArthur Foundation, EMF, (2013) is used as a basis to describe circularity. They are one of the leading sources within the literature when it comes to the circular economy and the working of the supply chain. Furthermore also research of Geissdoerfer et al., (2017), Tukker & Tischner (2004) and Baines et al., (2017) were used to describe the concepts within PSS and the circular economy.
For factors related to PSS the research of Ploeger et al. (2019), Akkermans & van Erp (2010) was used, they brought insights in the dealings with Dutch regulations and law.

Many different researchers in the field of the circular economy are consulted. The researches varies from researches focused on creating a CE within the BE, but also researchers who look at PSS outside of the BE and within. The research on this topic is continually developed and a researcher should stay up to date with the new research.

Reflection

1. What is the relation between your graduation (project) topic, the studio topic (if applicable), your master track (A,U,BT,LA,MBE), and your master programme (MSc AUBS)?

PSSs can be a solution for creating a circular economy within the BE and therefor fits really well within my theme. My master track MBE relates to this topic as well. The topic is focussed on creating new solutions for a circular economy. This are issues It that are highly relevant to the management and operation of the built environment.

My thesis focuses on the integration of services with physical products in order to optimize performance, sustainability, and user satisfaction, which aligns with the main focus areas of MBE such as circular economy and sustainable development. Therefore, my thesis is directly relevant to the goals and objectives of the master track in MBE and master programme at the TU Delft.

2. What is the relevance of your graduation work in the larger social, professional and scientific framework.

Societal relevance

The global demand for raw materials is rising. In order to use raw materials more wisely and cheaply, the government is collaborating with a lot of different parties. The Dutch government set a target for the Netherlands to have a fully circular economy by 2050 (Ministerie van Infrastructuur en Waterstaat, 2022). To achieve this goal there is still a long way to go, the built environment is a rigid business. In this research using products as a service in the BE is investigated. This might be a solution for the BE to become circular, However there are still many difficulties to overcome. In this research the "how" will be investigated. How can we use PSSs in practice and what exactly is needed to make this possible, such as different contracts, regulations, properties and characteristics.

Scientific relevance

Circularity is discussed a lot in the literature, but still there needs to be a lot more achieved in practise, especially in the BE. Hart et al. (2019) describes barriers and drivers in the circular economy for the built environment. Also in the master thesis of Kuipers (2019) barriers and enablers for product as a service are described. Both of these researches describe that for further research practise should be connected. *"Future work will test this analysis and define what is required to put the enablers into practice and accelerate uptake of CE in the built environment." (hart et al., 2019).*

In this research the goal is to create new possibilities that could be used in practise. This research will take information from the literature, such as important factors and concepts related to PSS, and connect these to new PSSs. Research from Ploeger et al. (2019) and Griendt (2018) will be used as ground work for different possible contract models and connected to new products that might work with these models.