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	**Anton van den Oudenrijn**
Student number	5075610

Studio		
Name / Theme	Design and Construction Management	
Main mentor	Tong Wang	Design and construction management
Second mentor	Sander van Nederveen	Integral Design Management
Argumentation of choice of the studio	In my dissertation I focus on the question how could decommissioning information be included in the IFC. Over the past years I developed growing interest in the circular economy and the application of the economy in practice. Furthermore, I think that I should expand my skill with with more knowledge and tools about BIM and circular construction to suit better in a innovative company.	

Graduation project

Title of the graduation project	Data and knowledge sharing in a circular construction supply chain: A Network analysis to identify the changes in a circular construction supply chain

Goal

Location:	The Netherlands
The posed problem,	See description underneath
research questions and	"How could the current IFC data format be expanded to facilitate the decommissioning of built assets?"
design assignment in which this result.	Not applicable

The conceptual framework of this dissertation is shown in the figure underneath. In the left side of the figure the current state of the IFC is illustrated, this shows that, according to literature, the IFC is not fully suitable to save decommissioning information. The desired situation of the IFC is outlined in the right box. This is an IFC scheme that could contain all decommissioning data to enable circular reuse.

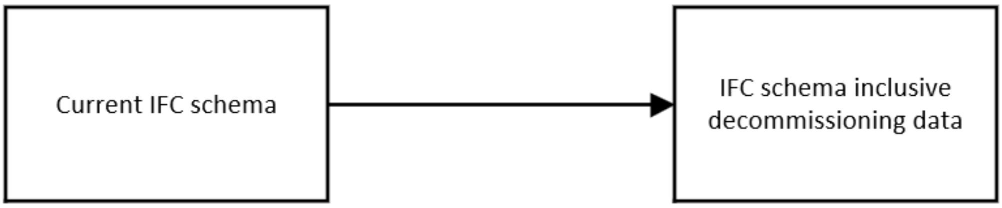

Figure: Conceptual framework of this dissertation (source: own figure)

This dissertation aims to recognize new relations between IFC entities which could save decommissioning data. Furthermore, suggestions for new relations between entities are given.

Process

Method description

To collect the information for answering the research questions a variation of research methods are used. A research method is a set of procedures which enables the researcher to collect data (Blaikie & Priest, 2019). In this dissertation the following methods are used: literature review, mapping, and semi-structured interviews. In figure 14 the framework of this dissertation is shown. This schematical model illustrates the steps which should be taken to complete this dissertation and to produce all needed deliverables.

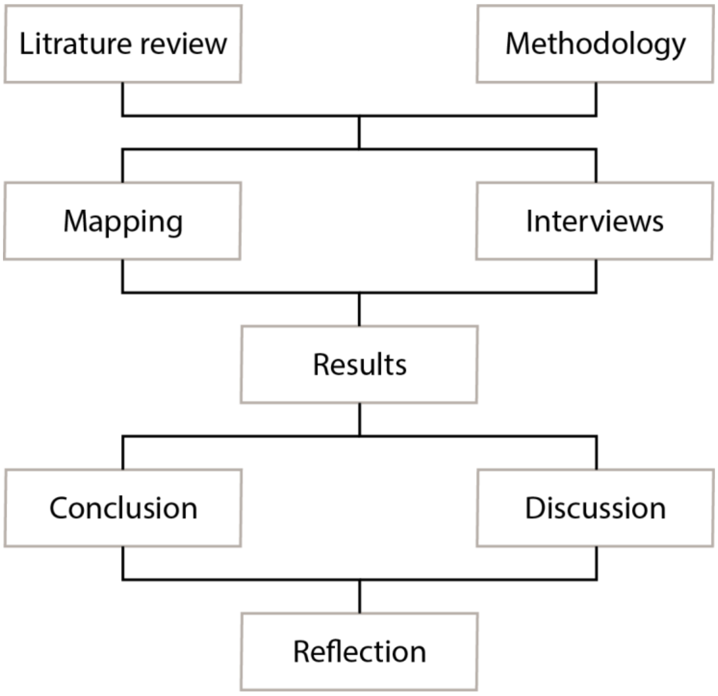

Figure 1: Research structure (Source: own illustration)

Literature review

A literature review is conducted to gain a better overall understanding of the researched topic, by describing theories, variables, phenomena, and methods used in history (Randolph, 2009). This means that the main aim of the review is to expand the existing knowledge about the topic IFC and disassembling of joints. Furthermore, during the literature review influential researchers and partitioners in the field of decommissioning and IFC are found with could help by developing an answer to the research questions.

Mapping

A map of the current IFC structure is created to generate a graphic visualization of the schema and explore how it is structured. A mapping method could be used for a variation of research designs, in this case mapping is a method to describe and explore the IFC structure (Crowe & Sheppard, 2012). When it is finished it can be used as communication element and to analyse the data presented in the structure. The connections between the different entities are visualized in the structure create a complete and comprehensive map. The map will contribute to improve the understanding of the structure of the IFC. Conclusively, it will be used to validate the research outcome.

Semi-structured interviews

To improve the understanding and increase the knowledge about the connection typologies of Durmisevic (2019), semi-structured interviews are conducted. The goal of these interviews to collect qualitative data with helps with understanding the information requirements of the joints. Literature does not mention how the code could be expanded and therefore experts are asked what possibilities could be used to expand the current coding. In semi-structured interviews, also referred as unstructured interviews, the interviewer is more flexible in asking follow-up questions to create more in-depth data form the partitioner (Braster, 2000). Furthermore, since the information about the connections is rather limited described in literature, it is more sufficient to have a more open dialog, because the underlying topics and information is unknown to by researcher (Philips & Stawarski, 2008).

	Function	Organisation	Interview date	Goal
Respondent 1	-	-	-	*See text above*
Respondent 2	-	-	-	*See text above*
Respondent 3	-	-	-	*See text above*

Figure 2: Table of interviewees (Source: own composition)

The representatives interviewed should have an enough knowledge about circular construction and deconstruction. Therefore, the representatives should have participated in minimal three circular construction or disassembling projects. On the other side, researchers with sufficient knowledge about the connection typology could also be interviewed, but the researchers should have publications to support this. Before the interviews an interview protocol is constructed. This protocol ensures that the questions are aligned with each other, and a red line could be found throughout all interviews. The interviews are conducted with Dutch speaking respondents to avoid misinterpretation and are recorded.

Literature and general practical preference

For my literature research I focus on the concepts, circular economy, BIM and IFC. In the following sections the concept/definitions are briefly outlined.

Circularity

The definitions of van Buren et al. (2016, p. 3) is used to describe the CE, this definition includes all these aspects and is easy understandable (Kirchherr, Reike, & Hekkert, 2017). The definition is stated as follows:

"Reducing the consumption of raw materials, designing products in such a manner that they can easily be taken apart and reused after use (eco-design), prolonging the lifespan of products through maintenance and repair, and the use of recyclables in products and recovering raw materials from waste flows. A circular economy aims for the creation of economic value (the economic value of materials or products increases), the creation of social value (minimization of social value destruction throughout the entire system, such as the prevention of unhealthy working conditions in the extraction of raw materials and reuse) as well as value creation in terms of the environment (resilience of natural resources)." (van Buren, Demmers, van der Heijden, & Witlox, 2016, p. 3).

BIM

A Building Information Model (BIM) is a virtual 3D representation of a built asset in which all information is structured to support construction, manufacturing, procurement, and maintenance activities (Eastman, Teicholz, Sacks, & Liston, 2008). This means that the model could contain information about, dimensions, finances, construction methods, building performance, building element characteristics. The concept was firstly introduced by Chuck Eastman in 1975 (Sun, Jiang, Skibniewski, Man, & Shen, 2017) and is since then evolved to a commonly used technology in the building industry (Aguiar, Vonk, & Kamp, 2019; Eastman, Teicholz, Sacks, & Liston, 2008; Akinade, et al., 2017a; Charef & Emmitt, 2021). One important aspect of the BIM is that it enables simultaneous working on the model by different stakeholders. If the model is modified, all stakeholders are directly abreast of these changes and, this makes the BIM a practical collaboration tool (Eastman, Teicholz, Sacks, & Liston, 2008).

IFC

Industry Foundation Classes (IFC) is a SDF that is typically used for interoperational data exchange between BIM software applications in the AEC industry (buildingSMART, 2021a; Temel & Başağa, 2020; Eastman, Teicholz, Sacks, & Liston, 2008). It is an open international standard where data of an asset is structured and saved to share among the participants of a AEC project (Eastman, Teicholz, Sacks, & Liston, 2008; Temel & Başağa, 2020; Theiler & Smarsly, 2018). The data format is developed by the organisation Industry Alliance Interoperability (IAI) in the late 1980's. In 2005 the IAI changed their name to BuildingSMART and since then the IFC is increasingly seen as the standard data format for data exchange in the ACE industry (Temel & Başağa, 2020). BuildingSMART (2021a) uses the following definition to describe the IFC:

"IFC is a standardized, digital description of the built environment, including buildings and civil infrastructure. It is an open, international standard (ISO 16739-1:2018), meant to be vendor-neutral, or agnostic, and usable across a wide range of hardware devices, software platforms, and interfaces for many different use cases. The IFC schema specification is the primary technical deliverable of buildingSMART International to fulfil its goal to promote openBIM" (buildingSMART, 2021a).

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)?

In the master track "management in the build environment", and especially the master specialisation "Design and construction management", students and professors strive to find solutions for the developments in the built environment. The transformation towards a circular economy is a complex and important subject in the modern construction sector and is widely researched by academics. BIM software is increasingly used by the students in the faculty. Architecture students use BIM to design their assets and in practice MBE students generate planning, budgets and quality reports with these programmes.

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

How decommissioning information could be saved in the current IFC is still unknown (Davila Delgado & Oyedele, 2020; Akinade, et al., 2017a; Akbarieh, Jayasinghe, & Teferle, 2020; Volk, Stengel, & Schulmann, 2014), while literature highlights the need for disassembling information of an asset (Durmisevic, Transformable Building Structures Design for disassembly as a way to introduce sustainable engineering to building design & construction, 2006; Charef & Emmitt, 2021; Davila Delgado & Oyedele, 2020; Chan, De Wolf, &

Koutamanis, 2021; Akinade, et al., 2017a; Adams, Osmani, Thorpe, & Thornback, 2017; Ajayabi, Chen, Hopkinson, Wang, & Lam, 2019). This research brings new insights to how 3 dimensional models could contribute to circular design. Moreover, it contributes to the understanding how digital data should be saved for circular buildings. The second contribution is that the connection typology of Durmisevic is verified.

The other aspect of relevance is social relevance (Wilbertz, 2013). During exploratory interviews, conducted during the beginning of this dissertation, it became clear that it is currently impossible to save decommissioning information in one single document. Contractors are facing problems with saving decommissioning information their building, because it currently results in a lot of extra administrative work and complicated project structures. When this information could be saved in the IFC this could be beneficial for a variation of parties, such as deconstruction companies, building owners, public authorities, and architects (Durmisevic, Guerriero, Boje, Domange, & Bosch, 2021). The current material passport is often not complete due to missing decommissioning information. Expanding the IFC will help in herein in twofold. First, contractors will have less administrative work for circular building projects and second, the information in the material passport could become more complete for a circular AEC.