REUSE POTENTIAL OF EXISTING BUILDING MATERIALS

A research-methodological reflection

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Thesis “Make circular renovation happen at the Applied Physics building and its surroundings”

I INTRODUCTION

This paper is written as part of the Lecture Series Research Methods, to form a theoretical framework on the used research methodologies. The objective is to clarify and reflect on the methods used in the graduation project in the Architectural Engineering studio. The course opened my eyes and taught me that (scientific) research in architecture can be approached from many different angles. It also became clear in the lectures that the way you conduct research greatly influences the questions asked and therefore the outcome of the research. Through analysing the heuristic techniques used, a connection can be made between architectural design and the discovered knowledge. (Moustakes, 1990)

The research-methodological reflection will focus on the specific context of my graduation project which is part of the Architectural Engineering graduation studio. The location of the project is the Applied Physics building at the TU Delft campus. During my graduation year, I will develop a renovation strategy for the building in order to reduce its current impact on the environment. In the TU Delft strategic framework 2018-2024, the aim for the TU Delft is to have a CO_2 neutral and circular campus by 2030. With the graduation project, I intend to research the energy (electricity and heat) and material flows that currently exist in the building, how they can be reduced and reused and what is needed to close the system as locally as possible. The aim is to reuse as many of the existing materials as possible and use circular design techniques. The project will contribute to the goals for the campus of the TU Delft.

The Architectural Engineering (aE) studio has a clearly defined approach described as follows by Asselbergs (2020, 2): *"Integration of technology in architecture is the core and mission of aE. Students from aE are challenged to merge their technical fascination into an architectural composition*." My technical fascination lies with the renovation of existing buildings, Applied Physics in the case of my graduation project, and thereby exploring the possibilities of reusing existing materials. This will result in a circular, energy neutral and CO_2 neutral building. In the aE studio, students are required to write a thematic research paper. In that paper the following question will be answered: "What interventions are needed in building 22 Applied Physics to reduce its current impact by using the available flows (heat, electricity and materials) and their potential the redevelop the building into a fully circular, energy neutral and CO_2 neutral building?" In the research I have allowed the context to take the lead in the research process and this allowed me to collect quantitative and qualitative data about the physical and social circumstances of the building. (Lucas, 2016, 12)

The research- methodological discussion and reflection will focus on the research methods used to answer the thematic research question. During the research, quantitative and qualitative research methods are used. The result of the research will be a roadmap that will form guidelines that will be used as input for the design phase of the graduation. In this paper the following question will be discussed: "How do the quantitative and qualitative research methods used relate to the needed interventions for the building and material reuse?"

II RESEARCH-METHODOLOGICAL DISCUSSION

During the research process for the aE paper several methods are used: a literature review to define crucial terminology, an analysis of the building and a flow research. The thematic research question contains four terms, flows[1], circular[2], energy neutral[3] and CO_2 neutral building[4], that are defined through a literature review. The method for flow research is defined by Superuse Studios[5] and is used to research the energy (heat and electricity) and material flows in the building in order to define the current state of performance of the Applied Physics building on the topics of circularity, energy neutrality and CO_2 emissions. Though an analysis of the energy system, it is noticeable that the building has a high demand for heat and electricity, related to the poorly insulated façade and many laboratories. The relation between the quantitative and qualitative analysis and the material flow will be elaborated on in this paper.

The quantitative analysis of the building is done through studying the building drawings [6] and site visits to gather data for the material flow analysis. It gave me insight into the types of materials present in the structure and façade of the building and get a grasp on the material quantities. The data is processed in a material flow analysis (MFA) diagram (Figure 1). The result of quantitative research is

often considered to be objective. (Lucas, 2016) The MFA is useful for application in architecture, because it generates an insight into the available materials for reuse. Reusing materials reduces the impact on the environment and promotes circular ways of thinking. (Brunner & Rechberger, 2016) In order to communicate the collected numerical data for the MFA, Hooijmeijer[7] highlighted in her lecture to understand environments and visualise them in such a way that the data is easy to understand.

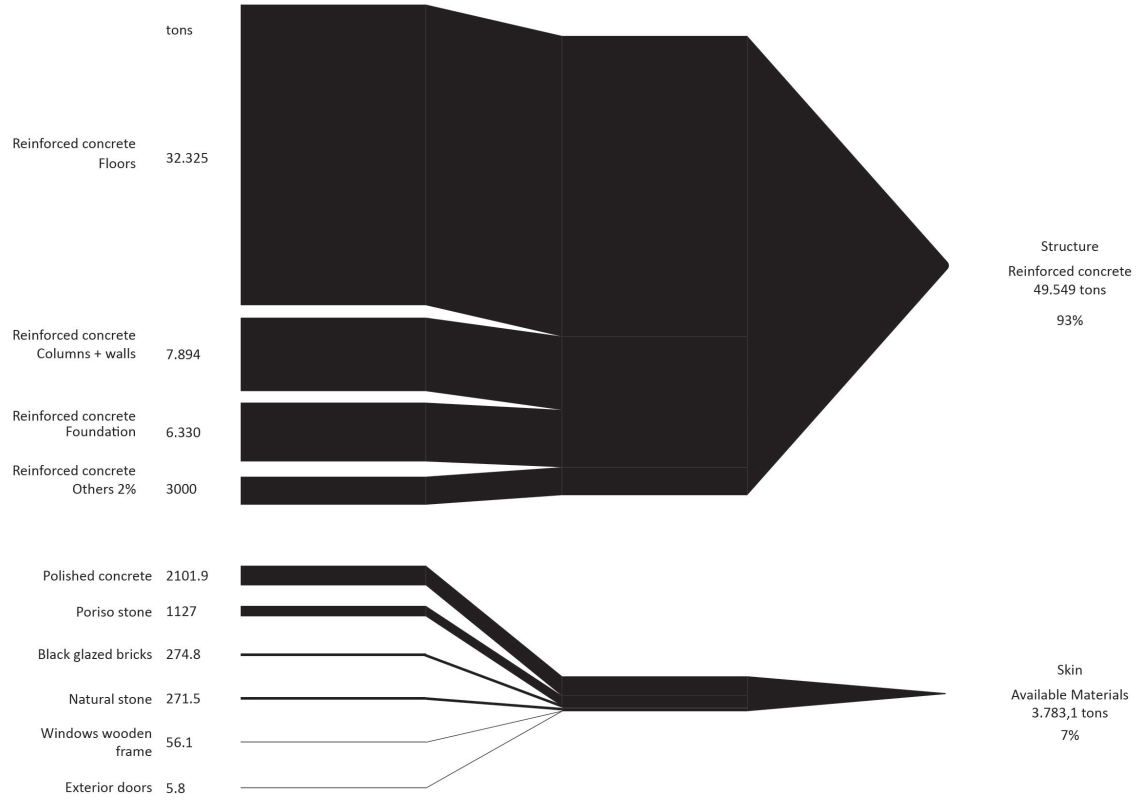

Figure 1 Inventory building materials in Applied Physics (by author, 2020)

However, it does not give information about the potential to reuse these materials in the renovation of the building. A more qualitative approach is needed to figure out what can be done with these materials and how this impacts the human experience of architecture. The value assessment of the materials is based on three aspects defined by Dronkers (2020a): viability, environmental impact and costs. [8] The value assessment is a combination between facts, such as embodied energy, but also by a more subjective interpretation of the quality of the materials because of the preference of the users when it comes to aesthetics. (Dronkers, 2020b) Important to consider when reusing materials is how they align with the view of the architect on the existing building where the materials are harvested and how they can be incorporated in the re-design of the renovation. Because I look at the renovation through the sustainability perspective of CO_2 neutral, energy neutral and circular building, the environmental part of the value assessment is therefore most important for my research. Something to always keep in mind is to create architecture of reused materials that is tailored to the user and their needs for the building and the spaces in and around the building. With a qualitative research the result is influenced by the interpretation of the researcher and can therefore be more subjective. (Groat & Wang, 2002, 219)

III RESEARCH-METHODOLOGICAL REFLECTION

The first person to look at cities through lens of Material Flow Analysis (MFA) was A. Wolman in 1965 as he saw a city as a system with input, stock and output of materials and energy. Which are now the guiding principles of the MFA. (Brunner & Rechberger, 2016) Ayres and Kneese were also important figures to lay the foundation of the MFA in 1969, which first adopted this name in the 1990s. (Fischer-Kowalski et al., 2011, 855-876) Currently, the MFA is a widely accepted tool and the method is used in

a variety of fields such as resource management, environmental management, water quality management and waste management. The MFA can help to conserve resources and protect the environment. (Brunner & Rechberger, 2016) This is increasingly relevant now as Europe needs to transition to a circular economy. (European Commission, 2019)

Nowadays, an MFA becomes more and more integrated into the daily practice of architects and engineers and has been adopted by several architectural firms like EXCEPT, Doepel Strijkers Architects, De Urbanisten, van Bergen Kolpa Architecten and Superuse Studios. (Jongert et al., 2015) The flow research methodology by Superuse Studios as discussed earlier in this paper fits within this larger body of research and has a significant impact on the way that we value material flows.

However, the strength of an MFA also is its downfall, because in simplifying and reducing data to understandable information valuable information could get lost in this process. (Fischer-Kowalski et al., 2011, 855-876) This is even more important for me as the researcher and the one asking the questions. Therefore, it is important to elaborate on the way you conduct research to create an honest piece of research and be aware of your own position towards the research. (Lucas, 2016, 43)

A body of knowledge that can help understand the qualitative aspects of this research is Material Culture and is described by Lucas (2016, 293) as follows: “An approach to research that considers materials to have something important to tell us. Often discussed in terms of materials as having a biography of narrative that includes […] any cultural associations they may have.” The Applied Physics building is designed by the architecture firm Roosenburg, Verhave and Luyt and built in 1963.[9] Looking at the materials of the façade of Applied Physics and of other buildings on campus that are built around the same period there is a clear preference for concrete like materials. This material plays a prominent role in the materialisation of the façade of the Aula (built in 1966) and the Faculty of Civil Engineering (built in 1975). The question remains, what can we learn from the way these concrete materials are used to create architecture on the TU Delft campus? These three buildings have a monumentality to them and play an important role in the daily life of many students and employees on campus. Their materialisation is a strong and reliable expression and offers a secure base for the users to work in. It is important to understand that qualitative research is based on my perception on the materials and is an analysis based on visual material. (Groat & Wang, 2002, 223)

The application of the MFA and the value assessment of the materials form a framework for design of Applied Physics. The combination of qualitative and quantitative research methods provides insights and a way of thinking that can be applied to the design. This approach is beneficial to reduce the impact of buildings on its environment and at the same time create identity and cultural value. To reuse existing materials for renovation this approach has potential and it fits with the way the architectural technology studio is run. The discipline stresses the need for a synergy “between building design, technology and community as we strive for a more sustainable and stimulating built environment.” (Emmit, 2013, 11)

IV POSITIONING

The materials that are present in Applied Physics are connected to the daily users of the building and they are valuable. The reuse of material and how to value this has an environmental side as well as a community side. The material culture of these materials carries a certain value within them such as expression, status, experience and aesthetics. How a user of the building sees these materials is different compared to the perception of an architect. These materials have certain qualities to them, a history of where they are made and how they have been used over time. In the case of Applied Physics, the building has a mediocre technical state and is in need off a thorough renovation to reduce the impact on the environment and increase its comfort of the users. The quantitative and qualitative research methods helped me to understand and asses the value of the materials and gain inside in the reuse potential based on research.

The lecture series stresses the importance of the integration of research into the design process where one is not first doing research and then moving on to design, but instead going back and forth between the two. The urban literacy methodology as presented by Havik[10] inspired me to look at the context of the building and has this made me able to step into the shoes of the different

users of the building through talking to them about their perception of the building and how they used it. With the user in mind, I looked at the building in a different way, which made me aware of the qualities the building has and improvements it needs.

As the research is taking place as part of the aE studio there is a strong emphasis on the integration of technical solutions into architectural design, whereby pressing issues related to environmental impact of building and finding solutions to future proof our built environment is leading. This should be supported by the integration into the societal context of a project and creating value for the users. This approach really fits with the way I work, and I think it will provide solutions to rethink the way we design and built buildings in order to minimise the effects of climate change. Lowering the environmental impact of a building by reusing exiting materials and looking for ways to design a CO_2 neutral, energy neutral and circular building is in my opinion essential. However, something to be aware of, that is not the focus of the studio, is the human aspect of the built environment. It could be a downfall to get lost in trying to fix everything with technology and thereby lose sight of who you are designing for. Thus, I am trying to keep the user in mind and tailoring the programmatic infill for the project to their needs. The lecture series showed my different ways of looking at and understanding human interaction with architecture and the lectures presented methods to research this.

To conclude on the relation between quantitative and qualitative research methods used to assess the reuse potential of materials, a combination of the two is necessary. There is a difference in research results being perceived as more objective or more subjective. Even though quantitative research is data driven and considered to be more objective, the perception of the researcher has an influence on the results. This is because the researcher makes choices about which data to include in the research. When doing qualitative research Berkers[11] made clear in her lecture that it is important to take the role of a critical observer and be aware of the way you look at this through your personal acquired knowledge. Moreover, it is important to explain your used methodologies to objectify the findings from the qualitative research and thereby to be aware of your own position.

FOODNOTES:

[1] Definition flows: “the movement of physical mass, energy of value per time unit” SuperUse Studios, Jongert, J. (2015), Inside flows [online] Available at: https://issuu.com/2012architecten/docs/inside_flows [accessed 09-04 2020]

[2] Definition circular campus:
‘Circularity = renewable which is defined as following: 1. Energy needs to come from a renewable source like: sun, wind, tidal, OTEC, biomass, hydro power and geothermal energy. 2. Air, water and soil must be intrinsically renewable, minimally cleanable to initial quality. 3. Biological materials may only be used up to the level that they can regrow. 4. Technical materials must be everlasting recyclable.’ Luscuere, P., (2018), Nederland circulair in 2050, Wat betekend dat en kan het überhaupt? p. 17-27 in Circulariteit op weg naar 2050?, publisher TU Delft Open voor TVVL
"The circular campus means a campus that relies on the linear economy to close material cycles. Insofar as new materials or products are required, only sustainably produced products are contracted. After this, the life of the available raw materials is maximized without harmful emissions to the environment. In both construction projects and purchases, it is a requirement that constructions are adaptable and demountable. " Campus and Real Estate, (2019), KPIs duurzaamheid TU Delft: versie maart 2019. TU Delft

[3] Definition energy neutral building: “A building that produces, via a sustainable source, the same amount of energy it needs over the period of a year.” Yanovshtchinsky, V., Huijbers, K., Dobbelsteen, A. van den, Hart, S. ‘t, (2012) Architectuur als klimaatmachine, Amsterdam : publisher SUN

[4] Definition CO_2 neutral campus/building:
"We interpret TU Delft's CO_2-neutral campus as a climate-neutral campus. This means that no CO_2 or other greenhouse gases are emitted anymore as a result of the direct activities and facilities. The energy for electricity and heat comes from sustainable renewable sources. This also applies to the energy required for research (primary process). " Campus and Real Estate, (2019), KPIs duurzaamheid TU Delft: versie maart 2019. TU Delft & Blom, T., Dobbelsteen, A. van den, (2019), CO2-roadmap TU Delft

[5] SuperUse Studios, Krieger, J. de, (2019), Introduction presentation aE research, 03-03-2020 & 2012 Architecten, & Goossens, F. (2009). Recyclicity: Industrial Ecology applied in the urban environment. [online] Available at: https://issuu.com/2012architecten/docs/recyclicity_research [accessed 09-04 2020]
“1. Understanding the processes and flows in an environment [ecosystem] 2. Identifying the losses (pollution & destruction of value) and the needs and pains in that environment 3. Identifying which losses can be turned into resources and value [niche] 4. Proposing an intervention both in a spatial and systemic way (by adding or changing program) 5. Choosing the proper site, form, construction and materialisation to host the intervention 6. Evaluating the effect”

[6] found in the city archive of Delft and TU Delfts personal archive
[7] Hooijmeijer, F. (2020), Territorial scales, Lecture series research methods February 20th, 2020
[8] Based upon multiple studies on reuse potential: Addis, 2006; Guy & Esherick, 2006; Gorgolewski, & Morettin, 2009; Hobbs & Adams, 2017
[9] TU Delft, (2018) Architectenkaart campus, https://campusdevelopment.tudelft.nl/wp-content/uploads/2018/05/Architectenkaart-campus-18-04.pdf
[10] Havik, K. (2020), Investigating Spatial Narratives, Lecture series research methods March 5th, 2020
[11] Berkers, M. (2020), Praxeology, Lecture series research methods February 27th, 2020

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