

Chapter 7 Reflection

The following chapter describes the opinion about success and failure of the research plan and design outcome of the thesis. It critically reflects on how collaboration with industry partners help solve a problem in real-time and being aware of challenges that cannot be predicted in academic environment. It also paves path for redirecting efforts in a direction that would enhance the applicability of the search for sustainable goals.

7.1 Research and methodology

The graduation topic is part of the circularity group of track Building Technology. Several research projects supporting the claims of circularity in building products comes under this umbrella. Even though the final design example is portrayed of a building envelope, the tool is applicable to any architecture design problem, from exterior to interior and building new to renovation. Since building envelopes contributes to 30% of the total building cost, it was more interesting to intervene with it. Facades covered a lot of objective performance challenges which if dealt with could lead to optimized building energy demands. This could then also contribute towards energy neutral goals of Netherlands. The topics proposed in the graduation by the faculty are interdisciplinary and it is this approach which leads to innovative thinking and outcomes that would help the industry become more sustainable in coming years. Hence, proposing a revolutionary approach towards how we practice architecture is necessary while we also see the advancement in computational technology in other sectors. The ideation of the studio is to break the barriers of classical approach of architecture design and think beyond the aisles to help the environment effectively.

Research framework defined by the faculty for building technology students is broadly divided in three tier spread across 6 months. The first tier is defining the main research question and objectives. The second tier required intensive literature study that would help buildup conclusions for the design process. This works perfectly when the end results in an architectural design solution. But In my case, the focus is to design a workflow that would help architects enable the use of secondary materials easily at early design stage. I followed the method defined by the faculty but I added a design stage in between the literature study. Hence, my approach was 5 tier. I defined first - my objective which is to make access for architects to explore options of secondary material that are available in the built environment. And what would be the added advantages of my concept after having information from the material bank. After this stage I did an intensive literature review on circularity goals and existing tools to measure circularity. After which I conceptualized the U/I of the tool that I want to create and identified the technological and database related gap of knowledge that exist to achieve the goal. This then brings me to the fourth stage of another intensive literature study for the kind of tool that exist for making a collaborative digital environment between architects and procurement. Also, custom BIM tools for assessing environmental impacts and sustainability of a building were studied. This stage ended with analyzing the skills that I possessed and what kind of workflows that can be

created using the existing knowledge as well as guidance from the company on the feasibility of the proposal. The end outcome should be enough to show the workability of such a tool.

The last stage would be combining all the information from various stages and designing the workflow for circular design project. Since, I followed a 5 tier approach with preliminary design thinking, it helped categorize the literature required for each question and exclude the content that does not help the research question and design. The concept of circularity is vast with a lot of angles from business model, finance, applicability and industry specific, life cycle and environmental impacts etc. From the structure of the report it can be seen that one chapter is different from the other, this is because the answers didn't lie in one type of discipline. To fill the knowledge gap it was necessary to keep an open mind, and think beyond the skills and knowledge that I had and the literature that was associated with 'circularity' directly.

7.2 Company collaboration

After the P1 presentation, I had realized that in order to achieve my research goals in time and prevent re-inventing the wheel, I need to get an industry exposure for the current state-of-the-art BIM tools and environmental assessment methods that already existed. I identified two types of collaboration that I would require for my thesis, one related to architectural BIM tools and the other from someone who maintains material database. Using the knowledge that is already there would make the research more acceptable and richer after the graduation. This aim is directly related to create a social impact with right goals and partners who have similar intent. I applied for a position as a graduate intern at ABT for getting the experience of the methods for sustainability assessment of a building and the existing BIM tools that have been created. This provided me with case studies of an existing ABT BIM tool and also a studied the circular projects within the company. In order to actually understand the material banks and database management techniques, I collaborated with BAM for sharing their knowledge and questions regarding circularity. It worked in benefit with both the companies as mentioned in the research plan.

While doing a thesis in collaboration with industry partners, also coming from a different culture, I learnt the difference in power distance that is very less in Netherlands. I was initially afraid of taking the hold of decisions w.r.t to setting up meetings, waiting for approvals etc. Also emailing different people for reviews and how accessible and appropriate was it to address them directly. It was a challenge and eye-opener that professional environment is open, you get respected for your ideas and efforts, it creates the ambiance where innovation can be born. My ethics from previous experience are quite different, where the power distance is quite huge in professional environment. But on contrary the educational institution that I come from are quite open with comments and feedback. I could literally knock at the door and ask anything, we never wrote an e-mail to our faculty for appointments. The speed of feedback was quite fast there and this posed an ethical challenge that I could not address the people directly at times at the faculty. Nevertheless, this posed as a confused approach because I could in fact address some people at higher

level of responsibility directly but some constrained to email only. I later decided to address nearby people directly to make my research feedback faster and took it positively if they didn't like it. The whole experience in two years taught me that I need to take responsibility of my project and success and extract fruitful information, from whomever and however.

7.3 Societal impact and applicability

The broader objective of the research project is to preserve our natural environment which is getting depleted day by day due to afforestation, mining and burning fossil fuels. All this is leading to global warming and rising sea level. The climate action promotes synergy between different stakeholders to become more sustainable and finance institutions and projects related to Circular economy. The Netherlands itself produced 12.2 tonnes of greenhouse gases per capita in 2016. The graduation project is directed towards re-using the full potential of any made product and keeping it in loop in an informed way as long as possible. By doing this, we are already further in becoming sustainable. These efforts then can be visualized on a large scale in Circularity indicators set by the European Commission, specifically Circular Material Use rate, which indicates the contribution of recycled material in total material demands.

Due to the industry collaboration, it made sure that the goals are achievable and not superficial. Also it optimized the time spent on certain internal questions which could only be answered by experts in the field. To achieve Netherlands goal of 100% circular, we need to accelerate the use of secondary material. It was a simple goal with a lot of interdisciplinary research. For example, I never worked in the construction sector and didn't know how their internal organization is set up. Both the companies are actively working on the circularity goals of Netherlands and making a change in the way we administer our resources.

The impact of the research is directly on how we procure circular material keeping in mind the design freedom. If applied in the industry it would accelerate the use of secondary material in all architectural projects as well as revolutionize the way we design on a blank canvas. In order to make this widely useable, a stakeholder powerful as BAM is capable of implementing this proposal and also fit with BAM's goal to be a circular company. The tool becomes a guideline for the architects to procure architectural components at beginning of the design and use it as the Lego bricks for building. It directly informs architects about the circularity and environmental impacts of the chosen secondary material and compared with a similar virgin source. It creates the social awareness within the design process itself and creative procurement while designing. Hence, procurement becomes the essential part of a continuous design process.

The cultural change that can be expected is that how we retrieve materials from the existing building. The documentation process becomes more important because gradually the discarded components will have more value in creative hands. At present, the demolition activities only take into account the mass retrieved from buildings. This gives less or no

information about the geometrical properties of these components, which is essential for it to be re-used in another design. Adding the parameters mentioned in the research will add value to the product. In the changing economy, secondary material is going to become more valuable because of the rising expense of virgin materials. Hence, use, maintenance, refurbishment and re-sale of a product become primary management process for any product. To accelerate this process and keep the material in economical loop it becomes essential to have standard set of labels for everything. Otherwise, it is a loss for the manufacture and of course affect environment adversely.

In the coming time when CO₂ taxes are going to escalate on raw material, re-using existing raw-material and products will no longer be goodwill, it will no longer be economical to use virgin material for various products. Hence, it is better to be prepared to use secondary materials efficiently and effectively.

7.4 Outcome

The outcome of the research can be seen in two parts. Firstly, the literature studies that was designed to address the state-of-the-art from various disciplines. This showcased the abundance of potential interventions to achieve sustainable goals in the built environment. The literature can be used as a starting point for other research projects. It also shows how to link a different research to benefit another different study. The scientific aspect of the research is to discover the potential of relative research that wouldn't be recognized otherwise. This was done by identifying the concepts that were indirectly related to circularity but may not have been derived from the concept initially. The final tool depicts the importance and need of a Circular Building Platform that does more than a stagnant library of materials. This goal was also agreed by both the company collaborations. It was intended to come up with a solution that could be immediately implemented in the industry and also identifying the potential of an advanced custom tool to further minimize the steps of workflow. The thesis can be used as a proof of concept for custom BIM application/plugin that would facilitate all the steps in single interface to procure and assess circular products.

Beyond the process of identifying a problem and proposing a solution which is the main assessment criteria of this Sustainable Graduation Studio of track Building Technology, taking it to another level of practicality is dependent on the students. The freedom of networking and accepting questions from a company adds up to the potential of future collaboration with these partners over sustainability. It trained me for the professional career and gives a glimpse of personal skills that are valuable.