Chapter 11

Critical reflection
This chapter reflects on the process and the end product of this research.

11.1. Process
The reflection of the process is divided in the personal and the research process.

11.1.1. Personal process
Several objectives on a general and personal level were set at the beginning of this research. In general the objectives were focused on broadening knowledge about environmental sustainability in the built environment, the processes of building adaptation and demolition, and the difference between these two strategies in relation to environmental sustainability. By conducting a literature study and interviewing experts from practice, I was able to acquire theoretical and practical knowledge. Since I wanted to obtain so much new knowledge, I kept on gathering literature to read. Reading one scientific article made me read two or three others as well, which became a continuous process in the first half of the research process. For me it was one of the major challenges during this graduation process to determine when I had obtained enough knowledge to continue with other research methods.

My personal objectives were focused on improving certain skills, such as interviewing experts from practice about their experience and expertise. Interviewing was a never used skill, so it was a great learning experience on how to ask the right questions to acquire the necessary input for this research. Even though an interview protocol was set up before all the interviews, it was also challenging to keep the interview going in the direction that was intended. On the other hand, sometimes it was necessary to change the intended interview direction, because the interviewee mentioned other interesting aspects or subjects regarding the research. As an interviewer it is important to anticipate and react on how the interviewee responds to the questions and to make sure that the interview continues in the right direction to acquire the necessary input for the research.

The conducted interviews had the intention to obtain qualitative data and one of the personal objectives was to learn how to analyse this qualitative data. Even though only six interviews were conducted, a lot of data was acquired. The challenge here was how to organise all the information in order to be analysed. This proved to be a major time consuming activity. It was very important to work structurally. Even though it took a lot of effort to organise and analyse the data, the content of the data was very interesting. And finally one of the personal objectives was to transform the obtained knowledge into a method. Obtaining knowledge was definitely not the difficult part of this process, but determining when this is enough to transform it into an end method is. The main challenge was to determine what knowledge needed to be implemented into the method when the obtained knowledge contains contradictory aspects. This is the difficulty every researcher has to deal with.

Besides working on achieving these objectives, this process has taught a lot about myself as well. Normally when starting a project, I like to work very structured and with that determine a planning in my mind on how the project will continue and how my study continues. One of the bottlenecks in how I work is not being able to take distance and keep continuing the process. The positive side effect of this is a constant drive and motivation to improve the research. One of the possible negative side effects is a tunnel vision and not being able to think in other solutions. At some points during the process it was necessary to take some distance, which was incredibly scary to do considering my normal way of working. But in the end the break helped to take some distance and reflect upon the research so far and provided new insights on how to continue the process.

11.1.2. Research process
The initial topic of this thesis was researching how to develop a model that could compare Adaptation and Demolition & New Build strategies for an office building on the environmental impact. However, during the literature research it became clear that there were existing assessment methods, such as GPR and the S3 model, that already used the environmental impact as a comparison. Therefore a different direction was required. By continuing the process and researching the topic more thoroughly, it became clear that a method that could assess the suitability of a strategy was missing. From there on the research was focused on developing a Step-by-Step Decision Support Plan.
It required much effort and time to acquire the necessary data for the case studies, which turned out to be almost impossible. It already took a lot of effort before the actual analysis of the data began. For the case studies it was necessary to acquire data concerning energy use and the amount and type of materials of adaptation projects. This data was not easily accessible at companies; therefore it also required a lot of time and effort from the companies to retrieve the project data. Even though people were willing to help, the process showed that helping was not one of their priorities and required a lot of time. It was important to plan the process carefully, but also to remind people to send me their data. So at the same time it was necessary to remain flexible with the planning. When the data was not yet available, it proved to be best to conduct as much preparatory work as possible. As soon as the data finally was obtained, it was possible to start the processing of the data immediately. The difficulty of acquiring the necessary data led to the fact that only two case studies could be conducted. The effects of researching only two case studies are discussed in the next paragraph.

Besides the fact that it was difficult to acquire data, having the actual data has its limitations as well. Since the data is not set up by yourself, there is no control over the quality of the data. Therefore it must be assumed that the acquired data is of the required quality for the research to produce the correct results. Also when data is obtained from a different source, it is not always as complete as would be desired. So working with the acquired data has its challenges as well.

Reflecting on the used research methods showed that it was most comfortable and at the same time most frustrating to conduct the literature research. This method was preferred over the other research method at the beginning, because there were so many interesting articles and books to read to expand my knowledge about the research subject. But the further the research progressed, the larger the pile grew of interesting information to read. Therefore it was considered as extremely difficult to stop reading so much and direct the focus to other research methods. It was difficult to find a balance between theoretical and empirical research, since the empirical research at times required to expand the theoretical research again.

11.2. Product
The reflection of the product consists of the scientific relevance, societal relevance, and the end result.

11.3.1. Scientific relevance
The objective of this graduation research was to research whether Adaptation or Demolition & New Build were suitable as a strategy for office buildings when considering environmental sustainability.

Search results in the scientific searching engine Scopus show an ascending line for the research of building adaptation, as can be seen from figure 76. In 1987 when the report by Brundtland (1987) was published, only 29 articles were published about building adaptation. This number continued growing, with a major increase in 2005 and in 2014 this number was more than 700 and this is still increasing (Scopus, 2015). This search analyses indicates that the subject of building adaptation is still scientifically relevant.

![Figure 76 Search analysis for Building adaptation (Scopus, 2015)](image-url)
<table>
<thead>
<tr>
<th>Themes</th>
<th>BREEAM-NL</th>
<th>GreenCalc+</th>
<th>GPR Gebouw</th>
<th>LEED</th>
<th>Green Star</th>
<th>ADNB Indicator</th>
</tr>
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<tbody>
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<td>●</td>
<td>●</td>
<td>●</td>
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<tr>
<td>Services</td>
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<td>●</td>
<td>●</td>
<td>●</td>
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<td>Building design</td>
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<td>●</td>
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<td>●</td>
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<tr>
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<td>●</td>
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*Figure 77 Implemented themes in methods*

The added value of this graduation research is that the comparison between Adaptation and Demolition & New Build was conducted on actual office buildings. With the results of this comparison the ADNB Indicator was developed to help actors in the built environment to make the right environmentally sustainable decision for an office building that is in need of an update. Comparing the implemented themes in the ADNB Indicator to the themes in existing methods as presented in figure 77, shows that the ADNB Indicator distinguishes itself by the implementation of Building design, Market trends, and Primary processes of the function. Therefore this research adds to the existing body of knowledge of the sustainability of different strategies and to the knowledge of sustainability assessment tools.

11.3.2. Societal relevance

It is a well-known fact that fossil fuels are becoming scarce and that the climate is changing. In order to decrease the demand for energy, land and materials resulting from new developments in the construction industry, better care should be taken of existing buildings by extending their life expectancy and using less energy (Conejos et al., 2014, p. 85; Wilkinson et al., 2014, p. xiv). That sustainability in the built environment remains an important societal issue is for instance proved by the fact that the Dutch Green Building Council organised the fifth yearly edition of the Dutch Green Building Week. This year the week was organised around the theme of the Green Challenge. Many seminars and lectures were organised to inform actors in the built environment about recent developments. Unica developed the ‘nearly Zero Energy Buildings’ for existing office buildings (DGBW, 2015). On top of that Platform 31 continues with the ‘Kantoor vol Energie’ program that is developed to make existing office buildings more sustainable by adapting them. One of the positive results of this program show that besides the reduction in energy use, the number of people calling in sick is reduced by making office buildings more sustainable (NRP, 2015a). This shows that adaptation and sustainability are still very relevant societal themes.

This research was conducted to contribute to the sustainability of the built environment. The ADNB Indicator is developed to implement the most suitable and environmentally sustainable strategy to office buildings when comparing Adaptation and Demolition & New Build as possible strategies.

11.3.3. End result

When reflecting on the end result of this graduation process, there were positive aspects and a couple of aspects that could be improved by expanding the research.

The development of the ADNB Indicator was a difficult process, which was the result of a couple of aspects. First of all, it required much effort and time to acquire the necessary data for the case studies, which turned out to be almost impossible as mentioned earlier in this chapter. The difficulty of acquiring the necessary data led to the fact that only two case studies could be conducted. Due to the difficulty of acquiring case study data, it was not possible to apply the ADNB Indicator to more than two cases. Unfortunately it was not possible to apply the ADNB Indicator to demolition projects, since the necessary data could not be found that needed to be filled in. Too many assumptions would have to be made, which would result in an unreliable result to draw conclusions.

The fact that no actual demolition and new build projects are analysed, is a limitation of this research. By conducting a simulation study, assumptions needed to be made. For the demolition simulation this resulted in assumptions about the number of working hours, transport distance and type of machines used. Even though the assumptions are based on a document from a demolition company, it is still different
than processing the actual numbers. For this research it was assumed that the Slim Slopen tool was the correct method to use to calculate demolition projects. When taking a closer look into the tool shows that when materials go to landfill, no Greenhouse Gas Emissions are indicated. On top of that, when materials or products are reused, the actual reuse is not taken into account when determining the environmental impact of the whole process. For the new build simulations assumptions regarding material density, and thickness of the used materials were necessary to fill in the Materiaal Tool. On top of that, the materials needed to be chosen from the materials catalogue, but not all materials from the case were selectable from the catalogue. By making assumptions instead of basing the research on actual facts, can give a difference in outcome. This has to be taken in consideration when processing the results of this research.

For the research a total of six experts were interviewed. The group of experts consisted of a sustainability expert, a sustainability assessment expert, two adaptation experts, one demolition expert and one demolition, adaptation and sustainability assessment expert. It would have been interesting to interview strategic decision makers or developers. By interviewing more and different types of experts, the ADNB Indicator could have been developed based on more different perspectives and could have been broader in scope.

Due to the limited available case study data, the limited number and type of interviewed experts the ADNB Indicator is not significantly founded. The research would have to be expanded with more case studies, and extra interviews to become more robust. However, the results of the validation sessions with the experts and the feedback sessions with the students indicate that the development of the ADNB Indicator is designed in the right direction to apply it in practise. The built up of the ADNB Indicator showed to be clear and logical to all experts and students. Most of the experts and students saw potential in the application in practise. Therefore this research proves to be a great starting point to develop this type of decision support for actors in the built environment.

Developing a weighting in the ADNB Indicator resulted in various reactions from students and experts. Most experts and students considered the weighting as a necessary feature, since certain aspects are more important than other aspects. But some concerns regarding the implementation of weightings were expressed. It was mentioned that it is possible that the scoring of the statements need to be adjusted instead of implementing weightings. For instance, when the location of the office building proves to be inadequate, the adaptation potential should be 0%. Or when a building proves to be not adaptable, the adaptation potential should be 0% as well. An option would be to make important statements selectable according to user preference and these statements will become veto criteria as well. How this would affect the result provided by the ADNB Indicator is unclear. More research is necessary to implement or reject this option for the design of the ADNB Indicator.

For the design of the ADNB Indicator it was decided to only attach a weighting to the aspects and not to the statements as well. This would make the plan more complicated, while the objective was to maintain model simplicity. But the difference in number of statements per aspect result in the fact that even though a weighting is attached to an aspect, statements are weighted as well. For instance, when a weight of 10% is attached to an aspect with 4 statements, each statement can be considered with a weight of ¼ of 10%. While an aspect with a weight of 20% and 10 statements results in a weighting of 1/20 of 10%. The weighting of the individual aspects requires more research, which would not have been feasible to conduct during this research.

There was no consensus between the experts about the implementation of an adjustable weighting. Since the ADNB Indicator is not designed to benchmark office buildings in order to compare offices with each other, the uniformity in the end result is less important than in other methods. The design is intended to indicate the suitability of an office building for the two strategies when concerning environmental sustainability, and also to indicate suitability when concerning user demands. This can be realised by implementing an adjustable weighting and is therefore remained in the ADNB Indicator. However, the bandwidth of the adjustable weighting is an aspect that requires more research, since the bandwidth is only based on the provided weighting of the experts.
Service life is a very important aspect in building sustainability, but the implementation of the service life remains a difficult topic. A research on its own could be conducted on this topic. Since that was not part of the scope of this research, this was not realised and implemented. Due to the importance of the topic, the Estimated Service Life was integrated in this research by connecting the developed ADNB Indicator with the S3 model developed by Sascha Jansz in 2012. With the implementation of the S3 model it is assumed that this method is the correct method for determining the Estimated Service Life. However, the S3 model itself is also based on assumptions and certain limitations. The S3 model is developed with the implementation of the lifespan model of Dobbelsteen (2004). The lifespan model itself incorporates a reference lifespan; therefore the determination of the Estimated Service Life in the S3 model is based on a reference lifespan. This is one of the assumptions made in the S3 model. This results in the fact that the results from the S3 model need to be interpreted as estimations. This critical note needs to be taken into account when applying the S3 model after the ADNB Indicator.

The Estimated Service Life is implemented after the final step in the ADNB Indicator. But considering the importance of the subject, the Estimated Service Life might have to be implemented earlier in the ADNB Indicator. Perhaps the (Estimated) Service Life should be connected to the weighting of the aspects or maybe even determine the weighting. It can be considered that the importance of the aspects depends on how long the building is intended to function. However, this was outside the scope of this research. It was a great and interesting learning process in how to develop the ADNB Indicator that could help actors in the built environment with sustainability issues regarding office buildings, even though it was difficult. Interesting insights were developed by conducting this research and can be applied in future research.

"An investment in knowledge pays the best interest"
- Benjamin Franklin -