

## 8. Reflection

This research about the future value of investing in adaptivity in office building has led to a financial model that can be used to consider the investment in adaptivity in real estate developments. The financial model is a result of a literature study and a test case which has been analysed. Together with the financial experts of my internship company and from the TU Delft, we accomplished this product. This reflection reviews this research process, the methodology and the final results.

In the beginning of my graduation process, I read in the graduation booklet the possibility to do a financial research on adaptivity. During my master, I missed the financial input in the different courses so I decided immediately to choose for that subject. In the course Quantitative Research Operations, I learnt about the quantitative side of the research field and choose to do a quantitative research about the financial feasibility of adaptivity. Thereby, a financial method was mentioned in the course, called the Option theory. This sounded perfectly to apply on the problem to value the adaptivity. Unfortunately, the Option theory was not further explained in that course. Therefore, I had to find the useful literature by myself and read a lot about it. A considerable amount of the Options theory literature demands mathematical knowledge, which I lacked due to my pre-education. I lost my focus on the particular problem related to adaptivity and learned a lot about the Option methodologies with all kind of differential partial equations. This results of the literature study were not useful for my thesis, nor applicable to adaptivity. Reflecting on this literature study process, I should have made more definitive decisions about the focus of my research in an early stage of the process. Thereby, it was helpful if I used the current knowledge as a basic and from there on broaden it with new knowledge about the Option theory. The consequences of this lack of definitive decisions were a constantly change of main research questions and a generic aim what was comparable to change the whole real estate investment sector. The exploration of the Option theory was really interesting, but delayed my research process.

After my P2, I started with a graduation internship what opened the possibilities to talk to experts and led to valuable insights. This changed the whole structure of the report in a positive way. There were more definitive decisions made and narrowed the focus of the research. It resulted in a clear structure of the report and methodology. In this stage of the process the methodology became clear and was decided to do some interviews and one case. Some interviews were conducted, but only the interviews with the different investors were used in the report. It should have been more helpful to focus from the start of the period of interviews on the investors instead of interviewing also an appraiser and financial experts of the Option theory. The choice of the case could have been made faster if the definitive definitions were defined in an earlier stage of the process. The specific search for a real estate development case with flexibility included within the internship company wasn't helping as well.

Reflecting on the methodology, it stated from the beginning with a combination of a descriptive research, the literature study, and a prescriptive research, the financial model with case. The problem was that the focus was more on the prescriptive research without defining the definitions in the descriptive part. This delayed the process, but after a while the literature study and the financial model became closer by defining the definitions. In the end of the research it was only linking the theoretical knowledge of the literature study to the trial and error knowledge of the financial model. The results are therefore clear, but could be more in-depth if the assumptions for one case were defined by multiple cases. Due to the time to find a case, it was not possible to do another case. However, the financial model is a new way of thinking and with the DTA the overview for the investors should be more clear. The next step is to test this among the investors if they are interested and understand what is happening in the model. The only thing they have to do is analyse their options and decide. Currently, the demand of flexibility is growing but with the DCF method it is not easy to calculate the flexibility of an office building investment. With this research, there is a better approach to value the future value of adaptivity in office buildings.

The end product is a financial model that is comparable with a DCF method and stochastic additions. The DCF method is the most common used method and therefore well-known by the investors. The model can be used easily by the real estate investors after following the different steps. The biggest advantage of the model is the uncertainty is shown by the model. If the investor knows the uncertainty during his investment he will probably invest more certain. However, there are also some limitations of the financial model. The adaptivity part of the model is based on FLEX 2.0 from Geraedts (2015). That model is focussed on the technical side of the building and used some assumptions for the weighing of the indicators. My additions to make it quantitative is based on one case and Dutch key figures of building costs (Bouwkosten kompas). This quantitative method should be validate with a lot more cases to determine the exact investment- and transformation costs per adaptivity score. In the financial model is a common DCF method used with some uncertainties and risks based on the case. As mentioned before are these uncertainties and risks related to the building. The location aspect with its uncertainties and risks are implicated where possible. However, the assumptions related to the location are not complete. The local rental prices of the different functions are shown with their uncertainties and risks, but the zoning plan with future work related to accessibility, public spaces, housing are not included in the model. According to the recommendations, the development of a complete financial model with location uncertainties and risks is further research needed. The same applies to investors with a specific demand in future functions. If the investor demands a future building with only housing and retail, it will affect the adaptive indicators. Some specific indicators are needed instead of the general indicators in the current model.

In short, the financial model is compatible for the investor who is interested in a long term investment with the aim to develop a future proof building. To validate the financial model, there a lot more cases needed with different locations and input. If it was easier to find the different cases during one internship, I would definitely make use of that to test the financial model. For now is that a big opportunity for further research!