7. REFLECTION

The following chapter reflects upon the research process and used methods as well as the societal, professional and scientific relevance and transferability of the findings. Moreover the relationship between the research project and the graduation studio and master programme is outline.

The connection to the research group
This graduation research project was carried out within the BOLD (Big, Open, Linked Data) Cities graduation laboratory (AR3R010) at the department Management in the Built Environment (MBE). The aim of this graduation lab is to bring together the perspectives of big data, architectural and planning information, smart cities, information technologies, urban area development and governance into demonstrations explaining the potential emerging from these new developments.

By exploring and illustrating the opportunities and challenges of data innovation and developing a conceptual alternative that is capable to provide a more holistic understanding of the complex process of EE interventions and thereby act as a supportive tool towards a climate-neutral built environment this research follows the central idea of the BOLD research group.

The research approach and methods
Due to the novelty of the subjects related to data innovation an exploratory research type was chosen. This approach proved to be adequate in enabling a gradual approach to the subject and the central research question while leaving flexibility to constantly refine the final product. The process was facilitated by using a multi-method design based on a literature study, qualitative expert interviews and the development of a model. Looking back the selection of these methods still seems to be adequate. There are however improvements that could have been made having the knowledge of today.

These improvements concern in particular the literature study which turned out to be extremely time intensive. The reason for that is the rather limited upfront knowledge and need to get are solid overview of the topic and the context in which it is embedded before even being able to start the actual research. During this preparation phase a vast amount of literature was consumed which after all could only partially be used in the context of this research project. With today's knowledge on the topic this phase could have been organized and focussed more precisely on specific aspects of the topic which would have enabled a more effective use of time.

Regarding the interviewee selection and process finding applicable experts proofed harder than expected. From the twelve organizations that were contacted only five responded positively and agreed to participate in the research.

In the beginning this was considered to be a problem but due to the fact that all conversations lasted between 60-90 minutes and were all very rich in information and thereby required a lot of post processing it might also have helped to keep the project manageable. Another challenge during the interviews was the fact that all interviewees had a very specific focus or perspective. This means for example that whereas one interviewee was very knowledgeable regarding the multiple benefits of energy efficiency another was rather knowledgeable in the field of data innovation. Due to this reason a shared meeting in form of e.g. a focus group in which the interviewees could speak directly to each other might have been an interesting addition to the individual interviews and maybe even more adequate. However due to the limitations of this research this could not be organized within the given timeframe. This experience clearly showed that knowledge from a wide range of different areas is needed for the development of new and innovative monitoring solutions for energy efficiency interventions and can only be successful by collaboration and cross-disciplinary research. After all it can be concluded that the conversations with the experts led to both valuable first hand-information for this research but also and maybe most important to new personal insights and learning experiences.

The idea of the subsequent model development was to apply the findings of the literature study and expert interviews to a specific aspect and thereby enable a more in-depth exploration and provide an illustrative example of the challenges and opportunities of the alternative approach. The development phase was planned as an iterative process in which the model is gradually improved based on feedback of the experts. Due to the limited timeframe of this research it was however necessary to reduce the number of feedback rounds. Looking back and with the knowledge of today this phase could also be im-

proved to ensure a more effective use of time. After all it was clear beforehand that this graduation project would be very explorative and without a very clear idea of the end product. This was also supported also by the structure of the BOLD Cities graduation lab which offered me a lot of freedom to develop the subject by myself and dive into topics that I am interested. At the same time this freedom required a lot of energy in order to stay on track and not to get lost in the vast amount of information which was sometimes overwhelming. Despite the obviously many new insights on the topic itself this open process was a valuable exercise for me in structuring and gradually approaching an unknown topic.

Relationship between the project and the social, professional and scientific context

Mitigating the consequences of the anthropogenic climate change remains one of the most challenging problems faced by humanity. The devastating consequences of the changing climate are hard to deny and so it the urgency to change our current energy consumption patterns. In the globally adopted GHG reduction plans the built environment plays a crucial role. In theory the combination of the two central components aimed to drive the energy transition (1) reducing our primary energy demand and (2) increasing the share of renewable energy sounds simple.

Yet in reality evidence on the actual performance of implemented interventions is scare and there are increasing signs that indicate that they are often not able to deliver their ambitious targets. A central weakness and source of uncertainty seems to be the highly simplified approach to assess their process which is unable to deal with the complexity of the invention in a dynamically changing environment. Given the fact that solid information is vital for effective management and thereby to the success of the ambitious GHG reduction goals this exploration of emerging

opportunities with the potential to improve our understanding of the process is with no doubt a valuable and relevant addition to the academic body of knowledge.

Potential applications in practice

After all the given information problem that was dealt with in the context of this research concerning the inability of the conventional monitoring approach to capture and understanding the dynamic process and complex relationships of residential EE retrofit interventions can easily transposed to various other challenges humanity is faced with such as climate change or transport. In this sense the findings of this research as well as further research on the subject is likely to also offer valuable insight for other fields of application where decision-makers are faced with challenges characterised by a complex set of factors and poor availability of data.

The personal learning process

For me personally the last months have been a fascinating yet also challenging journey through a vast amount of different topics related to this graduation project of which many have been completely new to me. Looking back I have to admit that I sometimes had a hard time developing the topic of the research from the first idea to the final product. This had on the one hand to do with the topic in general which was in many parts completely new to me but also with my personal ambition to produce actually usable results. At one point during the graduation process

I had to realize that in the given timeframe of this project this goal might have been too ambitious especially due to the complexity and the novelty of topic. After all I had to accept that this graduation project will be primarily about my personal learning experience than about the production of actual additional academic knowledge. Even though this might sound negative I am grateful for the opportunity to use the context of my graduation to follow my curiosity for an in-depth exploration for several topics outside the traditional boundaries of the built environment. By doing so I had the chance to develop a much broader understanding of the topic and its context than by staying within the limitations of my own domain. This was especially valuable to me because I believe that complex challenges like e.g. the energy transition in the built environment are not to be solved by people working within the boundaries of their own fields of knowledge but by intensive collaboration that facilitates the exchange of ideas and expertise.

I hope that with this graduation project I could lay the foundation for my own contribution in this transformational process. After all I can say that even though there have been moment in the course towards this final product which have been very challenging, confusing and sometimes even frustrating in the end overcoming these challenges always lead to some new valuable learning experiences or insights. Once again I want to point out that I am very grateful for this unique opportunity.