Designing an expert tool for supporting (re)location decision making in large multinational companies

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Colophon

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“Knowledge is power. Information is power. The secreting or hoarding of knowledge or information may be an act of tyranny camouflaged as humility.”

Robin Morgan
Deciding on where to locate the company's assets is one of the main issues of the corporate real estate management field. It should support aligning the organization's real estate strategy to its organizational objectives. Understanding which information is needed by the decision-makers is crucial to make a proper judgement. However, the awareness of criteria range and their relative importance is lacking in the majority of cases. Although literature recognises a number of structures based on which the criteria should be determined, this knowledge is disperse. It is not fully exploited to enrich the process, due to the scarcity of proper expert tools. As the high level of expertise and the vast amount of knowledge is required, the companies have to rely solely on available human resources.

This thesis provides the development of an expert tool, gathering state-of-art knowledge of location criteria. It strives to improve the (re)location decision making in large companies. It is done by using a hybrid research method, combining the operational research with an empirical one. The determinants for use of certain location criteria and the criteria itself are identified in the literature and linked to each other in a computer program. Through gathering the input from stakeholders, the tool suggests a prioritised list of criteria that should be used in the process.

The expert tool is tested in a pilot study at a company in order to evaluate the effectiveness and attractiveness of the model. It is done with a series of tests and interviews in connection with a pilot case. In addition, the acceptance and trust in the system are challenged.

Overall the tool is evaluated positively. It improves the location decision-making process by increasing the stakeholders understanding of the problem, transparency level, as well as empowering the decision-makers to express their needs that could have been omitted when using a traditional approach. This leads to better assessment of location alternatives. Although the tool itself requires a number of improvements before being able to be used in practice, the idea behind it was highly valued by the users.

Keywords: CREM, Corporate Real Estate, Location decision-making, Location criteria, Office, Expert tool
The following report presents the final version of my Master’s Thesis, which was focused on designing an expert tool for supporting (re)location decision making in large multinational companies. This thesis is the last step in graduating from the master Management in the Built Environment and concluding my studies at the Faculty of Architecture and the Built Environment at the Delft University of Technology.

The graduation research that lies before you is the result of a nine-month work, which combines a number of elements that built up my study experience. The bachelor’s degree in Architecture taught me creativity and ‘thinking outside the box’. The focus on the Corporate Real Estate resulted from attending certain courses from my master’s program, as well as taking part in conferences and competitions from the Real Estate Management field. From the very beginning, I knew that I wanted my thesis to be closely related to the practical world, solving a real-life problem. I also wanted to be able to see a tangible result of the work I was about to carry out.

With this short introduction, I would like to take an opportunity to express my gratitude to a group of people that helped me in the process of writing this thesis.

First of all, Monique Arkesteijn, my main tutor for making me excited about real estate management in the first place and guiding me through the entire process. It started with a simple conversation with Monique, almost a year ago, which triggered not only the thesis itself but also a series of other events, including attending fascinating conferences and taking part in an international competition. Monique is a very enthusiastic person, who easily makes connections to make things work. Thanks to her I was able to find a graduation company and grow my professional network and learn things that I would not be able to get just from the university. She was a fantastic first mentor, providing a lot of support in the initial phases of the research, where I was getting lost in the process and helping in understanding what I was working on. Later on, she stepped back, basing the guidance on asking the right questions, challenging my statements and helping in reaching the final goal. Working with her is a pure pleasure, based on a real cooperation and invaluable conversations. Thank you for unceasing support.

Secondly, I would like to thank Ruud Binnekamp, who was my second mentor in the first part of the process. He guided me through the complicated field of the Operational Researchers and triggered me to gain a further understanding of concepts and explaining things when I was getting lost. Thank you also for helping me to understand how my research outcome can look like when I was losing my track.

Another person that made this graduation possible is Rein de Graaf, who did an amazing job in stepping up to my graduation process. He took over the responsibilities of my second mentor due to the absence of Ruud. His extensive knowledge of computational modelling was indispensable. With my graduation, I have learned to programme from scratch and although the product of my work is far from perfect, Rein was able to give a lot of advice and tips for improvement that led to the creation of a functional model.

Special thanks also go to Martijn de Liefde and the group of people at FedEx and TNT. Martijn introduced me to the practical world and involved me in an exciting project, making me a part of the fascinating journey. Thanks to him and his colleagues I was able to test, improve and evaluate the tool I have created.

Lastly, I would like to thank my parents and group of closest people, who always believed in me and provided with unconditional support along the way. Without the positive energy you gave me, I would not be able to do this.

Thank you all for helping me not only to make a sound and complete report but also learning a lot through the process.

Enjoy reading,

Karolina Kmiecik
Delft, July 2018
THE PROBLEM

Aligning of the corporate real estate (CRE) strategy with the overall corporate organisational strategy is a well-recognised and researched issue of the corporate real estate management (CREM) field. It is crucial for CRE to deliver value to the organisation it serves (Heywood et al., 2009; Nourse and Roulac, 1993; Weatherhead, 1997, Ch.4; Then and Tan, 2010; O’Mara, 1999; Heywood and Arkesteijn, 2017). Especially the large multinational companies have to manage their vast portfolio, which should support the core activities. To achieve this, they usually have an in-house real estate department, created by a group of professionals, which is responsible for a portfolio management. In other cases, the organisation has to rely on the outsourced expertise (from consulting companies).

When talking about the alignment of the strategies, several things need to be considered. First and foremost, to achieve improvement of the company’s strategic competitiveness, one of the main challenges of corporate real estate management is matching the changing needs of stakeholders, dynamic strategies of organisation and unforeseen alterations, with a very static portfolio. Synchronising these elements brings an additional focus on how the decisions within organisations are made (Nourse and Roulac, 1993; Gibler and Lindholm, 2012; Ciaramella and Dettwiler, 2011). It is necessary to understand which information is needed, how it can be presented to support the decision makers, and how it should be communicated within the company, to ensure a sufficient level of understanding and acceptance. For this reason, the effective use of available knowledge, data and its resources can bring a lot of added value to the companies.

Decision-making processes are always a complex matter, especially in large organisations where multiple stakeholders with various, changing needs are involved. The management decisions at a corporate level require consideration of a wide range of factors. Those factors vary in terms being of more or less explicit and are based on diverse facts and beliefs. Even the simplest decision can be influenced by a number of components.

Deciding upon the new asset location requires analysis of a vast amount of data. As mentioned before, the real estate portfolio is very static and making an inaccurate judgment concerning location is difficult or even impossible to reverse. It brings serious consequences, related to additional costs and impacting the business operation (Nourse and Roulac, 1993; Witlox, 1998; Gibler and Lindholm, 2012; Manzato et al., 2010; Rothe and Heywood, 2015; Ciaramella and Dettwiler, 2011). For this reason, location decisions, in particular, have an effect on establishing and maintaining the competitive advantage (Rymarzak and Siemińska, 2012; Heywood and Kenley, 2008). In addition, they should satisfy all of the involved parties, despite the possibility of having disparate interests. In order to ensure that the most value is added to the organisation, a more informed process (in comparison to the traditional top-down or bottom-up approaches, focused solely on economic factors) might be needed.

There are a number of determinants for the location of offices, varying from urban environmental features, land-use policies, infrastructure characteristics, availability of an appropriate building, economic and market conditions or employment locations and other (Elgar et al., 2009; Louw, 1998; Bell, 1991). All of them, combined, define the location character. The literature provides a clear and broad overview of the location criteria that are used in various cases.

Nevertheless, for the location decisions in corporate organisations, it seems that the awareness of individuals concerning the criteria and their relative importance requires improvement (Rothe and Heywood, 2015; Rothe et al., 2015; Louw, 1998). Although literature recognises a number of factors based on which the criteria should be determined, this knowledge is disperse and difficult to find and combine for stakeholders. It is not fully exploited to enrich the process, due to the scarcity of appropriate expert tools. As the high level of expertise and the vast amount of knowledge is required in the location decision-making process, the companies have to rely solely on available human resources. This might result in basing the location decision on limited or biased information, as the decision makers rely on their own ideas and determine criteria list used for choice definition which are or could be satisfactory according to the best of their knowledge (Manzato, et. al, 2010; Brouwer et.al, 2004, Witlox, 1998 and others). However, this knowledge might not reflect the demand coming from all of the organisation parts.
The problem of how to find a suitable location for a company’s office if the stated requirements towards the location might not thoroughly express the organization’s requirements is a question that triggered this research. Thus, the research is aimed at creating an expert tool that could support organisation’s stakeholders in searching for an appropriate office location.

**THE RESEARCH**

The main research question is: How can an expert tool improve the (re)location decision making in large multinational companies? The objective of the research was to develop an expert system tool (or simply expert tool), which would support large multinational companies in their location decision-making process by establishing an adequate set of criteria. The idea is that with help of such tool, the potentially limited and biased knowledge of decision makers is enriched with the state-of-art expert knowledge, gathered in the scientific literature. The stakeholders involved in the location decision-making process are provided with a list of criteria that are recommended to be taken into consideration. This can help in underpinning their priorities, increasing the transparency of the process and addressing the needs that could have been left unstated otherwise.

The research is comprised of a design process (formal research) and an empirical research, creating a hybrid research, which combines the characteristics of both methods. It started with an extensive literature study and exploration of the current body of knowledge, providing a framework for the further study. The analysis of existing approaches, models and tools recognised in the scientific literature and their findings was conducted, allowing creation of the structure for the tool itself.

The gathered data was studied thoroughly. The patterns and links were brought up to build a framework for the expert tool. This was enriched by the information collected during the internship and the tool was tested with a pilot case project, related to the defined problem. In addition, the interviews with stakeholders involved in the case study were conducted in order to gather an input from potential end-users. The collected knowledge was stored and structured, to be subsequently displayed with the user-interface module. The tool was developed with the use of the Microsoft Excel and the Visual Basic for Applications extension that allowed the creation of a visually attractive tool for users.

**THE SOLUTION**

According to the literature, an expert system (ES) development is based on the simple idea that expertise is transferred from a human to a computer (Liao 2005). It can provide advice and explain the logic behind it, if needed, just like the human counterpart. The ES tool is software containing the basic components of an ES, where the non-numeric knowledge and reasoning methods are constructed by a set of rules formed in a tree type network (Lukasheh et al, 2001). Expert systems are mainly stand-alone, independent systems, that have an ability to turn a decision support system into a more flexible and powerful aid (Aiken et al., 1991).

According to the literature, for the location decision, a number of factors have to be taken into consideration, which are coming both from inside the company (following the added values of real estate and the driving forces of the corporate business strategy), as well as from external sources. The mentioned factors and company’s needs can be reflected very well through a set of criteria, basing on which the potential location is judged and decision is made. This can not only ensure added value for the organisation, but also minimise the adverse effect of relocation.

Although many researchers discuss the triggers and strategies that companies follow while making the (re)location decisions, rarely can one find clearly outlined links between those issues and specific location criteria. With this research, the connections between the various criteria and determinants were derived from the studied articles. The literature provided a clear indication that one should first look at the reasons of the (re)location decision and the objectives (requirements and goals) to be met with the choice of the new location.

As a result, the structure of the expert tool developed with this research is based on the reasoning in choosing and categorizing location criteria that were identified in the literature. The most relevant criteria for the decision makers are defined by assigning the relative importance in form of weights reflected in the following three layers (the result of the literature study):
1. The prevailing **REASONS** behind the location making:
   - Strategic asset seeking
   - Resource seeking
   - Efficiency-seeking
   - Market-seeking
   - Growth
   - Decrease
   - Unhappy with current asset
   - Cost reduction
   - Merger/ Acquisition/ Takeover

2. The main **OBJECTIVES** to be achieved with the location;
   - Minimizing the number of located facilities
     - Minimizing average time/ distance travelled
       - Client focus
       - Employee focus
     - Increase employee satisfaction
       - Attracting new talents
       - Retaining talents
       - Promote HR objectives
   - Maximizing service
     - Increasing flexibility
     - Promote marketing message
     - Promote sales and selling
     - Facilitate and control production, operations, service delivery
     - Facilitate knowledge work
     - Capture real estate value creation of the business
   - Minimizing cost
     - Minimizing fixed cost
     - Minimizing variable costs
     - Minimizing the total setup cost
   - Minimizing the longest distance from the existing facilities

3. The **THEMES** of the main focus criteria (or categories)
   - Costs
   - Labour characteristics
   - Infrastructure
   - Proximity to suppliers
   - Characteristics of markets/customers
   - Proximity to parent company's facilities
   - Proximity to competition
   - Quality of life
   - The legal and regulatory framework
   - Economic factors
   - Government and political factors
   - Social and cultural factors
   - Characteristics of a specific location
   - Company-specific (spatial) needs

In order to make the tool work, the decision makers have to provide information on the location search characteristics, reasoning behind the location seeking, objectives, main focus themes and constraints and preferences. The expert tool links this data with significant criteria, gathers and combines the input from up to ten different stakeholders. The final tool output is presented as a list of criteria, ordered by the points that reflect the suggested prioritisation.

Implementing the theoretical knowledge to the professional world required the development of a proper, user-friendly Graphical User Interface (GUI). The final version of the GUI was modelled in such a way to enable the stakeholders to use the expert tool intuitively. The goal is to make the state-of-art knowledge accessible for any kind of user, no matter which background he has. The GUI allows deriving a list of relevant criteria that could otherwise be a very time-consuming exercise. It brings to the user a lot of information to take into consider in the process, but also provides an insight into the relationship between needs of different users.
The model not only gives a material for the assessment of alternatives but also provides an opportunity to add the preference statement for various factors, which might be used for design purposes. Moreover, there is a possibility to analyse the input individually for each of the decision makers and see how aligned or disperse the stated needs are. This could also give an insight into how one understands the ongoing process of location decision making. Finally, one more additional feature is the possibility to add constraints to each of the criteria and express the level of detail desired level of detail by each of the stakeholders.

The tool was developed and tested according to the framework developed by Preece (1990), in an iterative way, with a help of pilot study. It was evaluated by the users, challenging the possibility of implementation of the tool in practice. The pilot study was conducted at FedEx/TNT, as the company was willing to facilitate the research and grant an insight into the current practices used within the organisation and test the features of the model.

The stakeholders that provided the input volunteered to take part in the study. As a result of interviews, a total of 68 different criteria were mentioned by the six stakeholders. It turned out that the top of the criteria listed with the tool are highly overlapping with the ones named by the experts in the process conducted by the company itself. The list that was created in the time span of several months with the traditional approach was derived within few short sessions with the help of the tool. Additionally, with the help of tool the list was enriched and included weights to underpin the priorities. An insight into understanding of the process by different decision makers, and comparison of input was granted. With the interviews, the tool was tested for its functionality and possible use in practice. All of the stakeholders accepted the outcome. It triggered a discussion about the effects of including different variables, increased understanding of the company needs and caused questioning the decision rationale applied with the traditional approach.

THE EVALUATION

The use of expert tool bases on a human-computer interaction. In order to evaluate it, several aspects have to be addressed. System acceptance and trust in the system needs to be achieved in order to ensure a successful development of the tool and accept its results. In addition, the evaluation of effectiveness and attractiveness is necessary. Those four elements were checked when the questions about the experience and evaluation were asked individually to each user.

The developed tool was evaluated positively and it was concluded that it could improve the (re)location decision making in large multinational companies. There were several elements that the stakeholders were especially positive about. One of them is the fact that the model was forcing them to think in-depth about the reasons for choices they make and get more insight into decision variables. The tool was said to be very useful and enriched the location decision-making process by empowering the stakeholders in stating their needs. It improves the participation and transparency level. Moreover, it indicates the differences in needs and stakeholder’s understanding of the ongoing process. The interviewees appreciated the way in which the tool allows underpinning the overall priorities. All these elements can improve the level of acceptance of the final decision.

The decision makers were impressed and satisfied with the idea of applying the state-of-art knowledge of the topic and the way it is given to user. Although all of the interviewees had a different background, all of them were capable of using the tool. This indicated that the tool is universal enough to be used by various kinds of stakeholders.

However, some significant improvements are needed for the tool to introduce it to the practical world. The biggest obstacle mentioned by users was the level of complexity and the amount of time that is required to fill the tool in. The stakeholders indicated that with a current version of a tool a guidance of a system engineer is needed to speed up the process, as otherwise filling the tool in is too time intensive. To solve this problem, visual adjustments and simplifications are needed to make it more user-friendly and easy to read.

Despite these small drawbacks, the tool was received with a positive attitude as it provided an insight into the needs of stakeholders. It made it possible to reconsider the current decision-making process and question the recommendation given for the location with the current decision-making process. It provided a ground for a discussion by bringing transparency and theoretical support into the highly emotional process. Such tool can improve the decision-making process and lead to achieving a truly optimal solution. Thus it is seen as adding value.
CONCLUSIONS

With this research and design project, a prototype of an expert tool was developed, gathering the state-of-art knowledge on the location decision-making determinants and criteria. The framework for the development and successful implementation of the tool was developed and implemented with help of the research sub-questions. The comprehensive literature review indicated that there is still a lot of room for improvement in the location decision-making processes. Especially awareness of real demand coming from various parts of the company is very often missing. A lot of requirements that could be addressed by the location criteria are not taken into consideration, lowering the potential added value created by a properly chosen real estate decisions and causing adverse effects of relocation.

The significant notion for the findings in this pilot study is that the graduation company (FedEx/ TNT) is a very large and globally operating company. They have an in-house real estate team that includes a number of experts. Nevertheless, the stakeholders still noticed the improvement potential brought by the tool and were willing to implement it in their projects. The results of the pilot study showed that using an expert tool in the (re)location decision making in large multinational companies can significantly improve the process. The users indicated that they would be willing to work with the tool in future as long as some ameliorations to the program are applied.

RECOMMENDATIONS

Since there is a lot of room for improvement concerning the tool, a number of further recommendations can be given. First of all, the tool was tested with a pilot study where criteria were derived to assess the available alternatives. It might be beneficial to test the tool for the design purposes, since it is possible to define the priorities with the tool, leading to optimise the company’s real estate portfolio.

Additionally, the tool should be tested with another, on-going pilot studies in order to validate the presented conclusions, as the conducted testing was unable to fully explore the program possibilities. It is also highly recommended to test the practical application of the tool with a consultancy company. It would bring the tool to the wider audience.

Moreover, turning the expert tool into application software adaptable to changing the environment, would bring a lot of benefits. It could be tested on a large scale, providing the feedback for further improvements. As concluded from the evaluation, the created expert system could be transported into another shell, improving the user interface. That point was addressed in many interviews and is a major point of criticism that could be mitigated with help of a knowledgeable program developer.
The following report consists of seven parts. Each of them represents one of the stages of this research and design project.

The first part covers the presentation of the problem to the reader, showing the problem analysis. It is called **INTRODUCTION** and provides information on the problem recognised in the CREM practice, which was a trigger for this research. In addition, the relevance of it is shortly addressed.

The second part **THE RESEARCH** describes the research structure. The main research question and the supporting sub-questions are introduced in chapters, indicating the main objectives that are to be achieved. Moreover, research methodology is explained in the Chapter 2.2., focusing on the type of study and methodologies used. At the end of this part, a conceptual model is presented.

In the **LITERATURE STUDY OUTCOME** part, the results from an in-depth literature study are outlined, providing the necessary theoretical background for this thesis.

Chapter 3.1. presents the process of location and (re)location decision making in real estate. First, the various theories and frameworks, discussed by researchers are addressed. Moreover, the importance of the organisational characteristics is brought up, to help the reader understand the complexity of the problem. Furthermore, the engagement of various actors in the process is given a closer look at. This includes also the transparency issues.

Chapter 3.2 brings a thorough explanation of the firm location factors, their driving forces and the importance of defining the proper location criteria. In this part of the report, the reader will be able to get an insight into how the theoretical back structure of the developed tool was created with a literature research.

In Chapter 3.3, the multi-criteria group decision-making problem is introduced, providing an additional and relevant knowledge MCDA and the location decision-making complexity. This is enriched by the introduction of the PAS design approach in the next chapter.

The concept of expert tools, the frameworks for its development and evaluation are outlined in chapter 3.5, establishing the next steps for this thesis.

Part number four, **PROVIDING THE ANSWER TO THE PROBLEM: RESEARCH OUTCOME**, gives an explanation of the first steps towards answering the main research question. In the beginning, in a number of successive sub-chapters, the reader can find information on how the expert tool was built, which steps were taken, which programs and calculations used. Subsequently, a description of how one can use the final version of the developed program is given along with a short discussion on the results display.

In the **TESTING THE TOOL IN PRACTISE**, the fifth part of the report, an introduction to the pilot study is provided with a case and decision processes outline. Subsequently, the interviews are delineated. The part is closed with the presentation of the pilot study observations and a number of conclusions drawn.

Part six **PILOT STUDY EVALUATION: UTILITY OF THE TOOL** the pilot study evaluation results are discussed and analysed. In addition a reflection on the results from testing and evaluation is given, addressing the successes and pitfalls of the developed tool.

In Chapter 6.3, a number of possible development directions are indicated, addressing the points of improvement listed in the evaluation.

The last part of the report main body is called **FINAL CONCLUSIONS**. Here, the final answers to the sub-questions are summarised, putting the entire research into perspective. Subsequently, the answer to the main research question is given. This conclusion is enriched by addressing a number of limitations, both to the research and the application of the tool. The chapter is closed with a list of recommendations for further research.
**ABBREVIATIONS**

<table>
<thead>
<tr>
<th>Acronym</th>
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<tr>
<td>CREM</td>
<td>Corporate Real Estate Management</td>
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<td>DM</td>
<td>Decision Maker</td>
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<tr>
<td>DSS</td>
<td>Decision support system</td>
</tr>
<tr>
<td>ES</td>
<td>Expert system</td>
</tr>
<tr>
<td>FM</td>
<td>Facility Management</td>
</tr>
<tr>
<td>GUI</td>
<td>Graphical User Interface</td>
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<tr>
<td>LDM</td>
<td>Location Decision-Making</td>
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<tr>
<td>MCDA</td>
<td>Multi-criteria decision analysis</td>
</tr>
<tr>
<td>PAS</td>
<td>The Preference based Accommodation Strategy</td>
</tr>
<tr>
<td>RE</td>
<td>Real Estate</td>
</tr>
<tr>
<td>Tetra SDM</td>
<td>Tetra Single Decision Maker: a software tool allowing application of a new theory of (preference) measurement, with the construction of measurement scales to which linear algebra and calculus are applicable.</td>
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INTRODUCTION


1.1 PROVIDING THE BACKGROUND INFORMATION

The problem of alignment of the corporate real estate (CRE) and the organisational strategy is a well-recognised and researched issue of the corporate real estate management (CREM). It is crucial for CRE to deliver value to the organisation it serves (Heywood et al., 2009; Nourse and Roulac, 1993; Weatherhead, 1997, Ch.4; Then and Tan, 2010; O'Mara, 1999; Heywood and Arkesteijn, 2017). There are multiple approaches to alignment recognised by authors and the literature provides a vast number of theoretical models (Heywood et al., 2011; Nourse and Roulac, 1993; and others). Although the importance of alignment is clear and acknowledged in companies as a whole-of-organisation activity and visible in various activities, the conscious use of theoretical approaches is very often missing (Heywood, 2011).

Some authors recognised that through an official examination of the existing real estate portfolio quality, one can determine the current state of alignment of the CRE. Furthermore, through a set of effective CREM actions, the alignment can become not only an evaluation method but also a design method (Arkesteijn et al., 2015; Heywood and Kenley, 2008; Arkesteijn et al., 2017). The design method allows creation of one or more alternative real estate strategies to get to the optimal one (Arkesteijn et al., 2015). This can lead to improvement of the company’s strategic competitiveness.

To achieve this improvement, matching the changing needs of stakeholders, dynamic organisational strategies and unforeseen alterations in a static portfolio becomes one of the main challenges of corporate real estate management. Aligning these elements poses an additional focus on how the decisions within organisations are made (Nourse and Roulac, 1993; Gibler and Lindholm, 2012; Ciaramella and Dettwiler, 2011). Understanding which information is needed and how it can be presented to support the decision makers becomes the main question. The rapidly advancing technology, computing and automation has created new concepts (like smart buildings, smart environments and internet of things), which have a great potential of improving the performance of portfolio organisation, allowing tracking of the information more frequently and in detail (Liao, 2005). The proper use of data and its resources can bring a lot of added value to the companies. Despite the existence of prosperous solutions, able to bring benefits, there is the lack of experience on end-user side and evidence from practise (van Dijk and Pellenbarg, 2000).

Making a decision on the asset location is a crucial matter that requires analysis of a vast amount of data. As mentioned before, the real estate portfolio is very static and making an inaccurate judgment concerning location is difficult or even impossible to reverse. It brings serious consequences, related to extra costs and impacting the business operation (Nourse and Roulac, 1993; Witlox, 1998; Gibler and Lindholm, 2012; Manzato et al., 2010; Rothe and Heywood, 2015; Ciaramella and Dettwiler, 2011). For this reason, the location decisions, in particular, have an effect on an establishing and maintaining competitive advantage (Rymarzak and Siemińska, 2012; Heywood and Kenley, 2008).

The choice of location depends on various preferences stated within the company. The deviation between those preferences and the actual characteristics of particular location pose a number of risks. Creating the match between the real estate portfolio, the business strategy and the preferences of the stakeholders involved in all business functions is of great importance (Arkesteijn and Binnekamp, 2014; Arkesteijn et al., 2016, 2015). There are a number of determinants for the location of offices, varying from urban environmental features, land-use policies, infrastructure characteristics, appropriate building availability, economic and market conditions or employment locations and other (Elgar et al., 2009; Louw, 1998; Bell, 1991). All of them, combined, define the location character.

The literature provided an exhaustive description and discussion over the processes conducted in order to find a suitable location for organization, which have been discussed in the literature exhaustively (see Appendix I) and there is a number of theoretical approaches towards site selection. Witlox (1998), van Dijk and Pellenbarg (2000), Pellenbarg et al. (2002), Brouwer et al. (2004) and Louw (1998) among other authors, profoundly explained the main theories and point out the relations with the site-selection activities. Nevertheless, the applicable tools, supportive for these activities, seem to be in a scarcity, as no operational versions of such tools have been fully developed.

The location theories are usually based on economic principles, like for example minimizing the distance for stakeholders, maximizing companies’ profit, or locating in hubs to profit from clustering. This historical, classical approach influenced the general understanding of the organization of space. On the other hand, the hard numbers connected with this theory were very restrictive and did not stand for the only factors influencing the firm’s location decisions. Other concepts emerged, introducing behavioural impacts
reflected in preferences, motives, attitudes, limited information availability, evaluations and other, enriching the solely economic principles (Manzato, et. al, 2010; Brouwer et.al, 2004).

When the behavioural factors are taken into consideration, the preferences statement becomes a significant issue. However, it can be based on the limited or biased information. The decision makers rely on their own ideas about the choice options and their characteristics. They determine own criteria that define choices which are or could be satisfactory according to their knowledge (Manzato, et. al, 2010; Brouwer et.al, 2004, Witlox, 1998 and others). These behavioural approaches are also a subject of criticism in the literature, suggesting that they do not include the firm’s characteristics, organisation or internal structure. In addition, location decisions should be made and assessed with consideration of the context and awareness of the more general business model. Such approach is required, as the location is just one of the business strategy components.

Here the problem arises: how to find a suitable location for a company if the stated requirements towards the location might not thoroughly express the organization’s requirements (considering its general business strategy).

Despite conducting an extensive research, no existing tool, gathering the vast body of experts’ knowledge, has been identified. Therefore, this study aims at creating an expert tool that could support stakeholders in the companies with delineating location choice sets in search for appropriate office space. It will allow examination of the location preferences under several aspects, which might have been omitted when using standard procedures.

1.2 THE PROBLEM STATEMENT

Companies take a variety of actions towards aligning the Corporate Real Estate strategies with overall business strategies. The decision-making processes are always complex matters, especially when a number of multiple stakeholders with various, changing needs are involved. Deciding upon the location of real estate assets in companies’ portfolio is particularly significant, due to inelasticity of such portfolio. High level of expertise and the vast amount of knowledge is required to ensure that most value is added. Although literature recognises a number of factors based on which the criteria should be determined, this knowledge is disperse and difficult to find and combine for stakeholders. It is not fully exploited to enrich the process, due to the scarcity of appropriate expert tools This usually forces firms to rely on available human resources only (in-house or outsourced).

The management decisions at a corporate level require consideration of a wide range of factors, defined by a number of different stakeholders. Those factors vary in terms being of more or less explicit and even the simplest decision can be influenced by a number of components. The final resolution concerning the location should satisfy all the involved parties, despite the possibility of having disparate interests.

There are many decision-supporting systems available on the market, which can assist the stakeholders within the company to reach the optimum solutions. Nevertheless, if a well-defined data set (necessary to use the DSS) is missing, the programs and methodologies are becoming useless.

In order to ensure that the most value is added to the organisation with the location decision, a more informed process (in comparison to the traditional top-down or bottom-up approaches, focusing on few variables or practices at a time) is needed. It should be supported by a proper level of knowledge and reasoning.
1.3 THE RELEVANCE OF PROBLEM

1.3.1 Scientific relevance

The approach chosen for this research is based on recognition of the most relevant input from existing body of knowledge, experts and professional. This is done in order to help in determining the most suitable location for an organization. For such process, one should consider not only the location features but also the firm’s unique characteristics and requirements in the analysis of alternatives and site selection.

The outcome will provide a support for the professionals and enrich the scientific world with an expert system tool. When looking at the literature, it can be noticed that the CREM-focused researches are rather limited and usually developed basing more on practical situations than scientific foundations (Heywood et al., 2011, in de Visser, 2016). A gap between the practical behaviours and information gathered in the scientific world has been recognised. The knowledge gathered by the researchers is not applied in the practice to its full potential. Provision of an expert system, captured in an expert tool can help in bridging that gap.

Moreover, it could contribute to bringing a better alignment between the practical and scientific approach to the location problem, bringing the two worlds closer to each other. Introducing the tool the scientific language to the end users can also increase the level of alignment between the two worlds. This provides another part of scientific relevance to this research project.

1.3.2 Societal relevance

It is clear that all the stakeholders within the company strive to locate their offices in places that pose an optimal solution for their business model and maximise the added value both to them and the society. The following study aims to contribute to the current state of knowledge on the office site selection processes and factors.

The societal relevance brought by this research can be derived from the potential improvement of the decision-making process. As mentioned before, it can support achieving better alignment of corporate strategies and real estate strategies, leading to increased level of efficiency in the use of the available resources. A more in-depth and knowledgeable assessment of location alternatives can bring better, more sustainable use of real estate, reducing the footprint and vacancy caused by a mismatch in demand and supply.

Furthermore, the more information from knowledgeable stakeholders is gathered, the better results can be achieved, satisfying various actors, which might result in higher profitability of the company, increasing its value.

1.3.3 Utilisation potential

This research is an example of applied research. It aims at not only improving the scientific theory but first of all, it strives at solving a problem recognised in practice. This research results in the creation of an artefact- an expert tool that contributes to solving the previously described problem.

The tool was developed by following the theoretical framework and its implementation possibilities were tested with the pilot study, on a case in practice. After the test, the users evaluated the tool in terms of its attractiveness, efficiency and trust in it. In this research the conclusions were drawn from the testing, explaining the satisfaction with the tool and its usability.

The tool was to develop it in such a way that it can be owned by a corporate company and used within it whenever needed. It has a universal character and can be applied to various cases. Additionally, there is no particular level of expertise required to use it. With the evaluation, it was suggested that it should be rather held by a consultancy company. In addition, a number of recommendations for further improvement are given in the final chapter to fully exploit the utilisation potential.
2 THE RESEARCH
2.1 RESEARCH OBJECTIVE AND QUESTIONS

The process of decision making in large companies is very complex. Location decisions made by the company are difficult to reverse and affect various stakeholders. The accuracy of the taken decision impacts not only the real estate costs but also the business operating processes and the employees’ satisfaction level. Both the relocation and establishing a new location may force the staff to travel further or even relocate, which can be undesired. As a result, the core business might be disrupted. In addition, if the real estate decision does not fit the overall business strategy, it might have a negative impact on the efficiency and profitability.

The location decisions are usually made by a limited group of people working within the company. They might relay on own, in-house expertise or use a help of outsourced knowledge. The decision is driven by the objectives and criteria established basing on their own knowledge. The bigger the company, the more stakeholders are involved.

2.1.1 Main research question

Following the problems identified in the introduction, the research questions are defined. They are covered by this research and design project.

The main research question that this research strives to provide the answer for is:

How can an expert tool improve the (re)location decision making in large multinational companies?

2.1.2 Research sub-questions

The main question touches upon three relevant topics: the process of (re)location decision, an expert tool, and the improvement of decision making in large multinational companies. This results in the definition of following sub-questions:

1. What is the current body of knowledge on the (re)location decision making (LDM) and expert tools connected to it?
   a. What frameworks and models are used in LDM?
   b. What are the criteria and objectives used in LDM processes?
   c. What can be improved in location decision making according to various authors?
2. How to develop a successful expert tool?
   a. How would such tool be perceived in practice?
3. How can the expert tool be linked with decision supportive models?

Answering these questions provides a base for the answer to the main question and gives a structure for the report. The theoretical basis is established with the first sub-question. The second and third one give guidelines for the tool development and require gathering an input from practice and conducting an iterative process, involving various stakeholders and their feedback. It is based on the outcome of the case study at graduation company.

2.1.3 Research objectives

The objective of the research was to develop an expert system tool, which would support large multinational companies in their location decision-making process by establishing a proper set of criteria. The idea is that with help of such tool the potentially limited and biased knowledge of decision makers is enriched with the expert knowledge gathered in the scientific literature. This can help them underpin their priorities, increase the transparency of the process and address the needs that could have been left unstated.
The development of the expert tool requires gaining theoretical insights into the location decision-making frameworks and processes, multi-criteria decision making, location criteria and determinants for various location choices. Thus the tool is based on an extensive literature research and case studies, rooted in the existing location decision-making processes to facilitate organisations in this complex process. It serves as a structured reference base for defining tailored decision-making criteria when multiple stakeholders from the organisation are involved. Moreover, a pilot study was conducted to test and proof of applicability of the tool and its evaluation.

The aim of the developed expert tool is to support companies with gathering qualitative and quantitative information from their own company, in order to create the location strategy, which supports the corporate goals in the best possible way. Thus an interactive system for stating and managing criteria for real estate location decision making will be created. The tool should be a universal one, which can provide a tailored input for specific needs of various multinational companies.

The hypothesis is established for this study that the expert tool created as an output of research will work as an independent, but supportive part for the existing location-decision-making models. It will create a bridge between end-user and complex models (like for example the improved PAS, Arkestijn et al., 2015) without the need to involve a human expert normally required to perform tasks. The tool would facilitate the input definition and reduce the lengthy process. This hypothesis was challenged during the development process and evaluation period.
2.2 RESEARCH METHOD

2.2.1 Type of study

A managerial problem is ‘any situation which for the management is the reason for improvement’ (De Leeuw, 2002). It can be applied whenever current situation does not differ from the desired situation. To solve the managerial problem, the system thinking can be used. Systems thinking is an approach to problem-solving, that is composed of various related (directly or indirectly) parts.

The research question clearly relates to the operation-related problems as it uses the “How can ...” type of question. It strives at creating an artefact in order to change the situation that is currently occurring in the professional real estate world. It has an operational relevance, aims at the improvement of future processes and has a prescriptive methodology. The main research question can be answered only by using the design cycle (Barendse, et.al., 2012).

When applying operations research to problems in the domain of built environment, it is crucial to look at the defined list of problem types. This list accounts for most of the encounter problems, identified by researchers (Barendse et. al., 2012). According to Barendse et. al. (2012), the list includes:

- **Optimization analysis with Linear Programming** - the general linear optimization problem;
- **Choice analysis with Preference Measurement** - the general preference measurement problem;
- **(In)dependency analysis with Regression Analysis** - the general linear regression problem;
- **Cost Quality analysis with Financial Feasibility and Discounting** - the general cost vs. benefit problem;
- **Spatial Allocation analysis with Geometric Modelling** - the limited distribution problem;
- **Network Planning and Mitigations** - the general sequencing and coordination problem;

The research conducted during my graduation deals with the Choice analysis with Preference Measurement (the general preference measurement problem).

The aim is to develop an expert system tool, through gathering the knowledge from extensive literature research, working with practitioners, conducting interviews and observing professionals during the case study. A user-friendly system will be created, to help the stakeholders prepare an input for the decision-making process. The tool will structure information from users which can serve as an input used for already developed decision supporting models. The tool itself was developed, tested and evaluated during a pilot study at one specific company.

2.2.2 Methodological structure

The research proposed in my master thesis helps in answering the question dealing with the problem of making a location decision. Such decision should meet all decision-makers’ interests in the best possible way. It is done by taking into account attributes of each alternative. The alternatives and their attributes are defined by the decision-makers’ organisation.

The objective of the research is to bring the theory-based knowledge and transparency to a highly emotional process and empower the decision makers in the process. This is based on the fact, that the use of proper criteria has a significant influence on the assessment of the performance of various scenarios that are considered as plausible.

In large organisations, there are many stakeholders involved in the decision-making process. It becomes very complex and time-consuming. In addition, the decision makers usually come from different backgrounds and departments, bringing a number of varying perspectives and demands. It is crucial to take into consideration all of those demands at an early stage as each redefinition of criteria causes delays and (as a result) additional costs for the company. To avoid this, further misunderstandings and unequal distribution of information among decision-makers, the tool can be used to assist the stakeholders in expressing their needs.

The stakeholders involved in the location decision-making process will be provided with a list of criteria that are recommended to be taken into consideration. This will give them an opportunity to express their needs that might have been omitted when using the traditional approach.
The tool was built in the Microsoft Visual Basics for Application to allow easy interaction for users. It includes all the steps and user forms for gathering the input and it already has been tested.

As mentioned before, by looking at the main research question, it is easy to determine that the research is an operational project. By answering the research question, an artefact is created. Since the artefact should solve a problem, an operational (or formal) research process should be used (Barendse et. al., 2012). Creation of the artefact indicates a framework that should be used for this research. Ackoff and Sasieni (1968) proposed a procedure involving five steps:

1. Formulating the problem.
2. Constructing the model.
3. Deriving a solution.
4. Testing the model and evaluating the solution.
5. Implementing and maintaining the solution.

In order to develop a model, an iterative approach is needed. This means that steps 2 and 4 have to be repeated several times. The fifth step will not be used, as it exceeds the scope of this research.

When looking at the research process proposed by Dym and Little (2009), the design research process should follow some of the established steps: Client statement (need), Problem definition (including clarifying the objectives, establishing the user requirements, identifying constraints and establish functions); Conceptual Design (with establishing specifications and generating alternatives); Preliminary design (modelling or analysis of design and testing and evaluating of the design); Detailed design ( refining and optimizing of the design); Design Communication (Document design); and Final Design (Fabrication Specs and Documentation) (Barendse et. al., 2012). This model outlining the process is used also in my research as it is more extensive and detailed than the one of Ackoff and Sasieni (1968) but still addresses their proposal (model is shown in Figure 2.1).

Figure 2.1 Steps of a design process (own illustration based on Dym and Little, 2004, p. 24, as shown in Barendse et al., 2012, p.3).

The design process includes feedback loops due to its' cyclical character, allowing enriching the process with information about the output in order to achieve a better result (Dym and Little, 2004). The first loop can be placed with the verification of the model designs. It can be done within the first three stages and leads to improvement of the design’s representation of reality. The second loop can be done when comparing the results of the evaluation, with the problem definition after final design (Dym and Little, 2004).
Although the stated main research question clearly refers to the operational (formal) type of research, the creation of the tool requires obtaining the input in an empirical way. Since the expert tool is based on the state-of-art knowledge, the problem and information needed to conduct the research pose a necessity to conduct a vast literature study. This empirical input consists of the identification and analysis of various location decision-making related topics. This covers amongst others: the reasoning behind (re)location, analysis of LDM processes, identification of existing tools and approaches, listing the location objectives, factors, criteria and constraints, looking at the forces influencing location decision and many others. It shows that empirical part of this research is nonetheless important than the formal one. In addition, the developed tool is tested in a pilot study. During the pilot study, the information from involved stakeholders is also obtained in an empirical way—using interviews.

As a result, it becomes clear that using only a design process (formal research) or solely empirical research approach is not sufficient to solve the identified problem and answer the main research question. The best approach is to use a hybrid research method, which combines the characteristics of both empirical and operational research.

In order to link the formal and empirical methodologies one has to use the cyclical process. It was developed by Barendse et al. (2012) and presents the interrelationship between the two research methods (see Figure 2.2 and Figure 2.3).

The operations research and the engineering sciences are part of the formal sciences, while the empirical sciences involve empirical research and the social sciences (Barendse et al., 2012). Both research processes are cyclical, creating two iterative loops. The loops visible in Figure 2.2 and Figure 2.3 are linked in four points. These interlinks form a starting point for the research framework structure.

The process presented in the cycle starts with the formulation of the client statement and leads to definition and specification of the problem. As a result, it is possible to list the specifications and bringing a conceptual design. At the same time, the empirical cycle begins with formulating the knowledge question (linked to the problem statement), based on which a hypothesis is developed. The hypothesis that is tested with this research is that the expert tool can facilitate the input definition and reduce the lengthy process of
LDM by bringing the awareness of the importance of proper criteria definition and equipping decision makers with them. In addition, the tool can support the decision makers as an independent system, with has an ability to enrich the existing location decision-making models. The outcome of the empirical part is used as an input for the design of the operational model. Continuing the cycle, the model is tested, verified and evaluated. The iterative character allows refining and optimising the design. After this step, the model can be used.

Since the main question of the research is a ‘How can...’ type of question and the main objective of the research is to design an artefact, the leading role is shifted towards the operational design process, which is only supported by the empirical component.
2.3 CONCEPTUAL MODEL

The research structure is presented in Figure 2.4. This framework is based on the formulated main question and the supporting sub-questions.

The research was conducted following the introduced model. It can be divided into four main parts with seven elements which are translated into main the report chapters. With these steps, the main question and all the supportive sub-questions of this research were answered.

The first part is focused on the development of the main concepts. In this part, the main research gap was explored and the introduction to the research is given. The research problem, objective and question were formulated. At the same time, the current body of knowledge on the topic is preliminarily analysed.

The second part relates to building of the expert tool. The main input for the development of the tool (location criteria and determinants) is gathered and structured. It is based on the information from literature and graduation internship. At the same time, the tests and interviews at the study pilot company were conducted, enriching the research with information from practitioners. The expert tool was improved in an iterative way basing on the feedback from users.

In the third part, the tool prototype was evaluated by the professionals in terms of usefulness and accuracy. The feedback was used to assess the applicability.

The last part refers to the synthesis, where the tool was validated and lessons learned are drawn. With this final conclusions and recommendations for further research were presented.

2.3.1 Approach- research process

The research is a mix of both operational and empirical research and it uses the instruments from both of them. It started with the literature study and exploration of the current body of knowledge, which provided a framework for further study. Additionally, the structure for the tool itself was established. As a result, the analysis of existing approaches, models and tools recognised in the scientific literature was conducted.

Subsequently, the data was analysed, the patterns and links were brought up to build a framework for the expert tool. This was enriched by the information gathered during the internship while working on a pilot case project, related to the defined problem. In addition, the interviews with stakeholders connected to the case study were conducted to gather an input from potential end-users.
The collected knowledge was stored and structured, to be subsequently displayed with the user-interface module. The tool was developed with the use of the Microsoft Excel and the Visual Basic for Applications extension that allowed the creation of a visually attractive tool for users.

The research can be expressed by the following conceptual model (Figure 2.5.)

![Conceptual model](image)

**Figure 2.5 Conceptual model. Own drawing.**

### 2.3.2 The internship: a pilot study case

The pilot study for this research was conducted at FedEx/TNT during an internship. It provided a relevant insight into the real-life practice. After the acquisition of TNT Express by FedEx, the European division of newly merged firm requires the application of significant organisational changes. As a result of business decisions, the organisation planned on relocating, combining and redesigning some parts of its current real estate office portfolio. The plan is to unify the department structure, relocate and shrink the real estate footprint and occupied spaces, following the restructuring of the business organisation and its centralisation.

The tool was tested with the pilot case and user who are not involved in the case, as a small field study. The pilot study included conducting tests and interviews that help in evaluating the outcome of the research. The tests were held individually with each user and were used in order to acquire input for the tool. The introduction with a proper explanation of the procedure and research was given to the stakeholders before the testing. Subsequently, the evaluation interview is conducted. The details of the tests and interviews are given later in the report.

Part of the data obtained for the study at the company during the research has a sensitive and confidential nature and will have to be encrypted.
3 LITERATURE STUDY OUTCOME
The following chapter is an outcome of the literature analysis. The publications were searched via the Scopus website, using following various combination of terms to find the most relevant articles: location/decision making/corporate real estate/location criteria/location factors/corporation/decision support system/expert tool/expert system/knowledge system/modelling/location decision.

Subsequently, the title, abstract and structure of articles were scanned to identify the most important ones. The next step was to read the articles and identify the location decision-making process frameworks and theories described in the paper. In the early stage of the research, the recognised information was represented with the models that were either reproduced or created from the scratch, based on the text of the article.

With the next step, the models were compared and overlapping concepts were clustered, establishing a framework for a further, in-depth literature analysis.

Additionally, analysing the concepts allowed understanding of how complex the location decision-making problem really is and how closely is it related to the corporate business strategies. The reoccurring topics provided an indication of what has to be considered and given a closer look when the location decision making is conducted. The most important and labour-intensive part of literature research was focused on the location criteria and is described in detail in Chapter 3.2. All of the main findings of this analysis can be found in the chapters below.
3.1 PROCESS OF LOCATION AND (RE) LOCATION DECISION MAKING IN REAL ESTATE

Making a choice on the new office location or relocation is a struggle faced by various companies in any given year. The process itself and especially its outcome might cause a notable interruption in an organisation’s life and conducting a core business, therefore it has to be considered as a significant event. Not only do the decisions concerning the location and office solution influence the present activities, but most importantly, they determine the future operating environment. This impacts various parts of the company’s elements, including real estate costs, productivity, efficiency, workforce satisfaction, and meeting the overall business objectives (Rothe et.al., 2014; Christersson and Rothe, 2013; Nourse and Roulac, 1993). In addition, there is a difference in making decisions for firms searching for their first location (new firms) and those who are relocating their business. Consequently, it is crucial not to overlook the important influence of the current location of the firm in the decision making (Elgar, et.al, 2009).

3.1.1 Location and re-location theories

It is worth starting looking at the theoretical background by analysing the location theories, which drew the attention of a number of authors (Brouwer et.al, 2004; Witlox, 1998; Manzato et. al., 2010; Greenhalgh, 2008; van Dijk and Pellenbarg, 2000).

Brouwer et.al (2004) describes the location theory as focusing ‘on the optimal location choice that is determined by the attractiveness of a site for firm location (pull factors)’. The location theory was further categorised in the following: (1) the neo-classical location theory, focusing on maximising the profit while choosing the optimal location; (2) the behavioural location theory, where firms have limited information and settle for sub-optimal outcomes instead of maximum profits; and (3) the institutional location theory, which bases on the view that ‘economic activity is socially and institutionally defined and ‘shaped by society’s cultural institutions and value systems rather than by firm behaviour’ (Brouwer, et. al., 2004).

In the neo-classical location theory, the ‘location’ factors (like for e.g. transportation cost, labour cost and market size) are the main reason for the firm relocation decision. The framework assumes acquiring full information required in the process and fully rational behaviour. As a result, the relocation becomes a costless exercise (McCann 2001 in Brouwer et. al., 2004). This theory, however, is unachievable in the reality, as it is based on the assumptions of rationality and perfect information held by a company, which is never achievable.

The second one, the behavioural location theory, focuses more on ‘internal’ factors (like age and size of the company and its characteristics). It strives to ‘understand actual behaviour of entrepreneurs and focuses on the decision-making process, that may lead to relocation’ (Brouwer, et. al., 2004). Questionnaires and detailed empirical work are more important than an explanatory model. In this case, the significant relocation costs combined with imperfect information lower the likelihood of moving or result in choosing more nearer, more familiar places (Brouwer, et. al., 2004).

In the institutional location theory economic activities are fixed in ongoing social institutions or networks and the behaviour results from firm’s investment strategies (Brouwer, et. al., 2004).

Additionally, when referring to the relocation theory, the authors point out that there is a different first step, triggering the process- the push out factor of the present location, which appears when the first location is no longer within the margins to profitability (Brouwer, et. al., 2004; van Dijk and Pellenbarg, 2000; Lloyd and Dicken, 1977).
Table 3.1 Location theories and factors influencing firm relocation (source: Brouwer, et. al., 2004)

<table>
<thead>
<tr>
<th>Theoretical framework</th>
<th>Key concepts/(factors)</th>
<th>Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neoclassical theory</td>
<td>Market situation (Location factors)</td>
<td>- Market size</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Country of location</td>
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<tr>
<td>Behavioural theory</td>
<td>Information/Abilities (Internal factors)</td>
<td>- Firm size</td>
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<tr>
<td></td>
<td></td>
<td>- Firms age</td>
</tr>
<tr>
<td>Institutional theory</td>
<td>Networks (External factors)</td>
<td>- Firm growth (positive and negative; merger; acquisition; take-over)</td>
</tr>
</tbody>
</table>

Since nowadays the majority of firms are complex organisations, most of the relocation studies are based on behavioural principles (Manzato et.al., 2010; Rothe and Heywood, 2015; van Dijk and Pellenbarg, 2000). Many individuals and groups can influence the company’s decisions, including managers, shareholders and workers’ representatives. Nevertheless, significant relocation factors can be linked to all three theories as follows: location factors (‘neoclassical’), the internal factors (‘behavioural’) and the external (‘institutional’) (van Dijk and Pellenbarg, 2000; Rothe, Sarasoja and Heywood, 2015). It is clear that the location decisions are part of the corporate real estate strategy of a company. There are another three crucial aspects that have to be considered with this topic: the real estate portfolio characteristics; the organisational characteristics and the corporate business strategy (Nourse and Roulac, 1993 p.492; Gibler and Lindholm, 2012; Ciaramella and Dettwiler, 2011; Greenhalgh, 2008), following the aforementioned direct link between the corporate real estate strategy and the business strategy.

### 3.1.2 The (re)location motives and decision-making frameworks

The decision for optimising portfolio is company-specific. Facility location refers to a series of operations focused on ‘locating or positioning at least a new facility among several existing facilities in order to optimize at least one objective function’ (Farahani et. al. 2010).

It is known from the literature that the search for an adequate location and the decision processes connected to it consist of various phases (Louw, 1998; Lloyd and Dicken, 1977; Edwards, 1983). Such complex decisions are always taken in steps (Louw, 1998).

Elgar et al. (2009) mentioned that the majority of studies concerned with the firm location recognise maximising the global utility in firms’ location decisions (Elgar, et.al, 2009). Moreover, when describing firm location behaviour, the researchers use multinomial logit (MNL) models framework. Those models are based on a number of assumptions, like maximizing active behaviour and possessing the perfect information about the real estate market conditions by the company (Elgar, et.al, 2009). According to Elgar, et. al. (Elgar, et.al, 2009), the firm location models can significantly improve their forecasting abilities by using a variety of available supportive models for newly established locations and relocating activities. This can be further enhanced by generating explicit choice sets based on the firm location history (Louw, 1998).

Greenhalgh (2008) broke down the relocation decision-making process itself in the three stages of activity: trigger, analysis, and outcome. Each of them requires decisions and is connected by the feedback loops.

**First stage: Trigger**

The trigger stage refers to the stimuli or catalyst, which provokes the initiation of the process and is concluded by the start of contemplating relocation. Townroe (1973) covered the similar actions with two stages in his classification, listing the stimulus and problem definition (Van Dijk and Pellenbarg, 2000). The locations decisions motivations, which can trigger the process can be categorised into four general groups (Dunning, 1998; Franco et al., 2008):

1. **Market-seeking**: accessing a new market or expanding into an existing one.
2. **Resource seeking**: focussing on natural resources and human resources like talent clusters.
3. **Efficiency-seeking**: rationalising the footprint of established activities.
4. **Strategic asset seeking**: acquisition or sourcing of new or auxiliary technologies and intellectual property rather than exploiting existing resources.
It seems that preferences and motives explaining companies’ presence at a particular place draw the substantial part of the researches focus (Louw, 1998). This is usually expressed in the articles as the process of establishing location factors (Louw, 1998). Louw (1998) generalised them into two groups: the (desired) functional, spatial characteristics of a location, and the price of land. The first group— the functional characteristics cover such aspects as the distance to the source of production factors or the product markets. The spatial ones refer rather to the image of a location (Louw, 1998).

Weeink et al (2017) mentioned that the first step is to analyse and understand the corporate value chain in the company and break them into business segments. In this step the key success requirements for each segment should be defined and ascertained from talents. At the same time, constraint criteria should become visible and listed. Assessing current footprint is to be done parallel. The decision is framed, when the purpose and objectives of the location decision-making exercise are becoming understandable to stakeholders and reflected in a framework. All the relaxant stakeholders should be consulted and necessary input from the business gathered (Weeink et al, 2017).

**Second stage: Analysis**

In the analysis, the pursuit is taking place. The influence of people and factors on process becomes central, when “the behaviour, personal preferences, priorities and perceptions, of key individuals” start to influence the final outcome of the decision-making process (Greenhalgh, 2008). The properly defined criteria, which are the outcome of the first stage, allow conducting the decision making when various location options are available. Again Townroe (1973) can be mentioned with following stages: search; formulation and comparison of alternatives (Van Dijk, and Pellenbarg, 2000). They can be easily compared to the orientation and selection phases named by Louw (1996) when the information about the possible location is gathered and the alternatives are evaluated.

**Third stage: Outcome**

In the outcome stage, the decision is made and process concluded. Townroe (1973) named is as a ‘choice and action’ stage, while Louw (1996) used ‘negotiation phase’ term, referring to moment when financial and contractual factors are getting more important.

Although the location decision-making process is a very complex matter, expressing it in a simplified framework stage provides an opportunity to identify elements which can be improved to enhance the decision-making outcome or missed opportunities if they are not addressed. In addition, Weeink et. al (2017) named five key issues impacting the LDM, including the stakeholder engagement, long-term planning, the quality of acquired data, mixing soft data with a scientific approach, and visual representation of information.

No matter to which framework one refers, the first steps require a vast amount of knowledge. Addressing the accurate criteria impacts the entire process. Therefore, making sure that the list of criteria taken into consideration is the most complete is crucial. This can only be done if all the business functions requirements are addressed, thus all the relevant stakeholders are taken into account.

**3.1.3 Relocation issue**

According to the literature, we can distinguish two forms of relocation: complete relocation (defined as the movement of an asset from one location to another) and partial one (when a new local unit is set up in connection to a pre-existing unit, which is not eliminated) (Brouwer, et. al., 2004). The relocation decisions vary in terms of scope. It might affect only a segment of the production or be even an effect of different types of agreements between partner firms (Brouwer, et. al., 2004). As a result, a firm might face the need to choose a specific location when they decide to move from the current location, when a new firm is established or company is undergoing significant structural changes (like mergers or acquisitions) (Brouwer, et. al., 2004).

**3.1.4 The organisational characteristics**

Weeink et. al (2017) mention that all the different activities which add value to a corporate product or service can be gathered under the term of the corporate value chain. Once again, authors point out that
maximising its’ efficiency increases competitiveness, flexibility and return. In order to improve value chain outcomes, the locations decisions have to be optimised. This cannot be done without a deep understanding of how each function operates in the wider corporate context of the organisation (Weeink et. al, 2017).

Various researchers brought up the relevance of linking Real Estate Operating Decision to Core Business: Corporate Business Strategy, which is driven by generic strategy, strategic implementation and other driving forces (results, capabilities, products and markets) (Nourse and Roulac, 1993 p.492; Witlox, 1998; Gibler and Lindholm, 2012; Manzato et.al., 2010; Rothe and Heywood, 2015; Ciaramella and Dettwiler, 2011). A number of internal and external factors, specific to the organisation must be considered.

When talking about the office building, we can define it as a physical shell in which all the office activities can be carried out without worrying outside conditions. The accommodation has an influence on the level of job satisfaction and overall productivity of the employees. If it is carefully chosen, it supports the previously mentioned business activities (Louw, 1998; Brouwer, 2004; Krumm and De Vries, 2003).

Looking closer into the organisational structure, one can say that each of the company department has its’ own characteristics and as a result, relies upon different location capabilities (Weeink et. al, 2017). A company should be aware of the relative importance of those capabilities for each of its’ business function to facilitate the location decision making in the most reliable way. This can be done by for example assigning a relative weight to the particular criteria to reveal the nuances for each type of business function (Weeink et. al, 2017).

Therefore the analysis of potential locations should be based on function, which allows companies to optimise each of it in a unique locational decision. Taking into consideration various priorities which are already embedded in the firm helps to avoid trade-offs (Weeink et. al, 2017). Such trade-off problem might appear when for example a company is co-locating variety of departments in one place, or even in one building.

Table 3.2. presents the outcome of the analysis concerning different characteristics of an organisation that were recognised by authors to be influential in the location decision making. First of all, the scale of the undertaking has to be considered. Ciaramella and Dettwiler (2011) specified three different relocations levels: intra-regional, inter-regional and international. The scale determines on which kind of criteria would one look at. This issue was also addressed by other authors. In addition, there is time constraint, an issue that is sometimes pushing companies to limit available choices due to the timely procedures. Both Brouwer et al. (2004) and Rymarzak and Siemińska (2012) indicated that company characteristics like their size, the sector it is classified under, age, size and type of market served would define what elements are relevant to be taken into consideration while making the decision. The final element is the location model, indicating whether one is looking at establishing a single location, multiple ones (working as a network of locations) or if the relocation is needed (Farahani et al., 2009). All these elements have to be addressed in the process.
Table 3.2 Location search and company characteristics recognised in the literature

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<tbody>
<tr>
<td>Ciaramella and Dettwiler (2011)</td>
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<tr>
<td>Mazzarol and Choo (2003)</td>
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<td>Brouwer et al. (2004)</td>
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<tr>
<td>Rymarzak and Siemińska (2012)</td>
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<tr>
<td>Farahani et al. (2009)</td>
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3.1.5 Stakeholder engagement

Looking at all the elements that various research cover, one can see how complex the location decision-making problem is. It is impossible to cover all the relevant issues and influential factors by consulting only part of the organisation structure. Including all the relevant stakeholders is a key issue. Management of the multiple and potentially divergent agents is not easy and might require the use of various supporting tools. The success of location choice can be determined only if all of the functional objectives are aligned and the stakeholders perceive them as satisfying. There is a need to ascertain the desires, needs and wants of relevant parties and build consensus among them (Weeink et. al, 2017).

To achieve such consensus organising a number of topic-based workshops addressing major considerations help to satisfy all with the result. The more the stakeholders are involved and supported in the decision-making, the better quality of data can be achieved, resulting in better tailored LDM outcome. The input gathered for the process must be very well structured, thought-through and presented to the end-user.

3.1.6 Various perspectives of stakeholders on real estate issues

In real life, there are many professionals engaged in the decision making in the real estate area. Each of them might come from a different background. Jensen et. al (2013) distinguished three major groups bringing different perspectives on the Corporate Real Estate topics. The division made by the author was based on different theoretical backgrounds: Facility Management (FM), Corporate Real Estate Management (CREM) and Business to Business Marketing (B2B) (Jensen et al., 2008). Each of the group can provide varying insights into the possible frameworks and challenges in the understanding of the problem of adding value to the organisation (Jensen et al., 2008). A joined action based on the interaction between FM, CREM and B2B is required to bring the added value of RE. The cooperation between perspectives gives both overlapping and complementary focus areas. In general, the FM and CREM has a strong focus on the physical aspects of assets, while both FM and B2B marketing shift to the services (not that important in CREM) (Jensen et al., 2008). Nevertheless, all three perspectives share a strong focus on stakeholders and relationship management (Jensen et. Al, 2013). The authors compared the added value parameters in the four models, developed by Per Anker Jensen (Jensen et al., 2008) (FM focused with a clear separation between FM and core business), Jackie de Vries (De Vries et al., 2008), Anna-Liisa Sarasoja (Jensen et al., 2012) and Alexandra den Heijer (Den Heijer, 2011) (all three are CREM based models). The outcome of the comparison is shown in Table 3.3.
<table>
<thead>
<tr>
<th>People</th>
<th>Process</th>
<th>Economy</th>
<th>Surroundings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisfaction Culture Image</td>
<td>Flexibility Innovation Production</td>
<td>Cost Possibility to finance Risk control</td>
<td>Economical Social Spatial Environmental</td>
</tr>
<tr>
<td>Increase employee satisfaction</td>
<td>Increase flexibility Increase innovation Increase productivity</td>
<td>Reduce cost Increase value of assets Promote marketing and sale</td>
<td>Supporting environmental sustainability</td>
</tr>
<tr>
<td>Increasing user satisfaction Supporting culture Supporting image</td>
<td>Increasing flexibility Stimulating innovation Supporting user activities Improving the quality of place Stimulating collaboration</td>
<td>Decreasing cost Increasing real estate value Controlling risk</td>
<td>Reducing the footprint</td>
</tr>
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</table>

From the table above we can see that the FM as a support function is clearly different to a core business, while CREM based models include a process-oriented view, with input and output. The model from Sarasoa focuses on maximizing shareholder value, while the den Heijer and de Vries models include multiple stakeholders. It can be concluded that CREM is a resource-based management discipline, which aims at connecting building science with business administration and economics. FM, on the other hand, can be seen as a service and process-oriented discipline (Jensen et. al, 2013). Using the different conceptual models can help to analyse and demonstrate the way in which the FM and real estate can bring an added value to the organisation (Jensen et. al, 2013).

For this reason, it is worth looking at the models introduced above as useful tools, which can guide facilities managers in developing the strategies and relationships in order to enhance the implementation of value-adding activities (Jensen et. al, 2013). With the guiding character of the model, one can start developing a value map for the definition and classification of various criteria that have to be met by the newly established location.

### 3.1.7 Transparency issues

Heywood (2011) pointed out that to achieve strategic CREM gains a transparency between stakeholders is needed. Keeping activities transparent allows achieving specific and customised solutions, required by all the organisation parts for operational reasons (Heywood, 2011). It is only possible when one understands the audience involved in the process and clearly states its priorities (Heywood, 2011). For this reason, an effective communication is one of the crucial aspects in CRE alignment (Heywood, 2011).

Increasing the interaction and transparency of location decision-making process for the stakeholders is highly valued. It raises also the corporate social responsibility and, as a result, the decisions have to be based on more rigorous and objective approaches (Nunnington and Hayens, 2011). Greater credibility and more informed action takes place in criteria-based approach. Clear, quantifiable criteria and a framework for the process should be established for the (re)location decision to reach more awareness in the process (Nunnington and Hayens, 2011).

When it comes to architecture, the evaluation and design processes regarding new building or a new urban area should be open and transparent (as far as possible). In addition, all stakeholders are to be treated equally, no matter which position they occupy within the company. This approach limits the threats of manipulation and abuse of knowledge power (Lex A. van Gunsteren, valedictory lecture 2003, in Binnekamp, 2010).

The transparency could provide fairness to stakeholders that are not necessarily always given equal treatment in the process (Heywood, 2011). In decision-making models, the input can reflect each decision maker’s interests.
It should be, however, noted that the brand values are not static. The changing visions and core business strategies have an important influence (Khanna et al., 2013). For example, while in the growth phase companies might be focused on transparency and innovation, the financial downturn can force real estate decisions to be driven by cost reduction, where transparency becomes a secondary value and more manipulation possibilities are needed (Khanna et al., 2013). The more transparent is the process, the less room for manipulation it leaves (Figure 3.1). Such situation might not be favourable to some corporate companies. Despite striving for transparency, in a corporate world, there is a difference in weight of stakeholders’ interest that should also be addressed.

![Figure 3.1 The relation between the transparency and room for manipulation (Binnekamp, 2010, p.VIII).](image)

### 3.1.8 Conclusions

The first look at the process of (re)location decision making in real estate shows how complex it is and how many issues should be considered in the analysis. The various theories indicate that one should look at a range of factors, ranging from market situation to internal and external elements influencing the company. One has to consider the impact of organisational characteristics and the overall business strategy, as well as the number of individual stakeholders (including managers, shareholders and workers’ representatives).

The decision for optimising real estate portfolio is always company-specific and so is the process they apply for the decision making. Nevertheless, they can be expressed with frameworks helping in identifying elements which can be improved to enhance the decision-making outcome. It is crucial to prepare a proper list of requirements and criteria that company perceives as relevant for their case, at an early stage.

In order to do that, the decision makers should consider the organisational characteristics, which would influence the criteria set. Additionally, one should be aware of the scale and model of the location search, as well as the time constraints related to it.

It is clear that all kinds of the firms’ stakeholders, with different backgrounds and interests, should be involved to get a full overview of company needs. This could increase the transparency in the process and raise the level of trust in the choice accuracy.

Basing on this part of analysis a number of elements were included in the expert tool structure. The scale of (re)location search was addressed in order to filter the potential criteria and ensure addressing issues with proper coverage. The time factor was also taken into consideration, as there are a number of elements that have an influence on the (re)location timeline. The expert tool includes also the company characteristics, such as the company size, age, sector and market it serves, region where it operates and type of operations it performs. Many criteria are dependent on these elements, especially when market factors are considered. The last element from this analysis that was used in building the tool is the location model type, gathering the data whether the location considers a single facility, establishing multiple assets or does it concern a full relocation.
3.2 FIRM LOCATION FACTORS

3.2.1 Adding value through Real Estate

As previously mentioned authors have been trying to recognise how the real estate related operating decisions can bring added value by aligning real estate decisions with the corporate strategy (Nourse and Roulac, 1993; Witlox, 1998; Gibler and Lindholm, 2012; Manzato et al., 2010; Rothe and Heywood, 2015; Ciaramella and Dettwiler, 2011). Nourse and Roulac, for example, defined 8 corporate strategies that can be translated into corresponding real estate strategies (Nourse and Roulac, 1993). Following their findings, De Jonge (1996, in Krumm 1999) listed seven elements of added value: increasing productivity, cost reduction, risk management, increase of value, an increase of flexibility, changing the culture and PR and marketing. They are aimed at presenting the real estate as a true corporate asset (Krumm, 1999). Lindholm and Leväinen (Lindholm, Gibler, and Leväinen, 2009; Lindholm and Leväinen, 2006) tested the use of added values in practice, redefining the seven added values of real estate related to the goal of increasing shareholders value.

The Lindholm et al. (2006) model helps to recognise and test the way in which the real estate strategies and the operating decisions can support the increase of the company's wealth and it's competitive advantage (Lindholm, Gibler, and Leväinen, 2009). The final model includes: Reducing real estate related costs, Increasing employee efficiency and productivity, Enabling flexibility, Encouraging and supporting employee innovation and creativity, Enhancing employee wellbeing and satisfaction, Supporting environmental sustainability, Promoting marketing, sales and organisational brand, and Increasing the value of the organisation’s real estate assets (Lindholm, Gibler, and Leväinen, 2009).

Den Heijer (2011) based her research on the existing findings and linked the added values of real estate: (1) decreasing costs, (2) supporting user activities, (3) increasing (user) satisfaction, (4) improving quality of place, (5) supporting culture, (6) stimulating collaboration, (7) stimulating innovation, (8) supporting image, (9) increase flexibility, (10) increase real estate value, (11) controlling risk, and (12) reducing ecological footprint, and divided them using four different stakeholder perspectives; (1) the strategic perspective of the policy maker, (2) the financial perspective of the controller, (3) the functional perspective of the user and (4) the physical perspective of the technical manager. The model was mentioned and compared with other in part 3.1.8. Following the added values of real estate, combined with the corporate business strategy and it's driving forces, it is possible to notice aspects, that have a direct influence on the companies demands a for their real estate.

3.2.2 Influences on location factors

The driving forces express the core business and the mission statement of the organisation. They determine the strategy of a company, impacting the demand for specific location characteristics (defining desired location factors) (Brouwer et al., 2004; O'Mara, 1999; Lloyd and Dicken, 1977; Rothe, Sarasija and Heywood, 2015). According to Nourse and Roulac (1993), the driving force of a company are depending on the environment, markets and other external and internal forces, which causes changes over time (Nourse and Roulac, 1993).

Rannals (1956) distinguished two groups: the internal and external commercial activities. The first group expresses the building space and the building itself in relation to its surroundings. External activities, on the other hand, influence the location of a given activity considering the customers and suppliers, while the internal define the premises, calling for the usefulness of the space (concerning building-related characteristics) (Rannals, 1956, in Louw, 1998). Later, the third category was added by researchers and defined as location factors (e.g., region) (Louw, 1998; Brouwer et al., 2004; Van Dijk and Pellenberg 2000).

Analysing those factors and defining criteria based on them is crucial already in the first stages of location decision making, as noted in the part 3.1.2. The more in-depth and thought-through the analysis is, the easier, faster and more accurate the up-coming decision-making stages are.

Brouwer et al. (2004) investigated the effect of firms’ factors (internal, external and location) on the probability to relocate and concluded that tendency to relocate decrease with the firm's size and age (Brouwer et al., 2004). In addition, he noted that the companies which are more prone to be affected by the ‘external’ factors (like changes in the number of employees) are more willing to relocate (Brouwer et al., 2004). Finally, location factors such as market size and region of location play a role in the decision to
relocate, indicating that firms serving larger markets relocate more often (Brouwer, et. al., 2004). This shows that the more complex the firm structure is, the more probable it is that firm will relocate. The extent to which the number of stakeholders involved in decision making influences this probability was not investigated.

### 3.2.3 Defining location evaluation criteria

Criterion (as defined by the Chambers Dictionary) is ‘a mean or standard of judging’. It can be seen as some sort of standard that enables to judge one particular choice or course of action (Belton and Steward, 2002). All the management decisions at a corporate level involve taking into account a wide range of criteria stated by various stakeholders. With the final location decision, a consensus has to be reached, satisfying all the involved parties, even when they present diverse interests. Criteria have to be defined in such a way that a proper judgement of possible location can be done.

In general, each company has its’ own unique set of demands for a location, which are the result of combined driving forces and firms’ strategy. They form a base for the LDM. Nevertheless, it is important to define the relevant criteria and factors for the specific company needs when developing a real estate strategy. Despite the fact that each company has unique needs, it is possible to find some basics for corporate companies’ real estate decisions, which are reoccurring both in the literature and practise.

The topic of location factor may be traced back to the work of Alfred Weber (1909) (in Louw, 1998), where it was defined as "a situational characteristic that could provide a company with a spatial cost advantage". Since then it was broadened, integrating a variety of topics like minimizing costs, maximization of profit (Losch, 1941; Hotelling, 1929 in Louw, 1998), institutional and individual motives (Greenhut, 1956 in Louw, 1998), role to business accommodation (Louw, 1998).

Louw (1998) noted that with the rise of the search specification and level of decision process details, less relative importance is assigned to the location factors and the accommodation factors. Those are being replaced by financial and contractual factors (Louw, 1998). Following that reasoning, gathering a vast amount of specific location requirements might shorten and simplify the process.

The literature recognises a variety of urban environmental features for the location of offices. This includes criteria such as availability of proper buildings, accessibility, land-use policies, infrastructure and traffic conditions, economic and market prospects, employment and talent pull, geopolitical situation and other (Elgar et al., 2009; Louw, 1998; Bell, 1991). They all interact together and influence business performance.

O’Mara (1999) divided demands in strategic environment and organisational demands (O’Mara, 1999). Respectively, the first one brings up the industry forces (variables like a number of customers, the rivalry between firms or barriers to entry) and the environmental constraints and opportunities (representing the regulatory framework persistent in the location or financial resources available) (O’Mara, 1999).

While defining the list of criteria, the importance of the accommodation of company cannot be omitted. In his research Louw (1998) defined the accommodation as one of the location factors. The author considered different spatial levels and concluded that when a decision about a new office location is being made at the urban area level, one should not underestimate the importance of the accommodation aspects (Louw, 1998). The higher the spatial level is, the smaller the role will be and the choice will be mainly between regions or cities, bringing up more traditional location factors of the labour market, accessibility, and proximity to product markets (Louw, 1998).

### 3.2.4 The importance of defining the proper location criteria

When determining the criteria for relocation, one has to consider the outcome of decision-based on those criteria. Christersson and Rothe (2012) examined impacts of relocation using the threefold approach of the triple bottom line for organizational success, taking into account aspects of sustainability: profit, people and planet. They are linked respectively to economic, social and environmental impacts identified in a number of research papers. As a result, a number of direct and indirect impacts have been listed. The first group include the employee retention, relocation costs, disruption, employee reactions to change, changed lease attributes (Christersson and Rothe, 2012). The indirect impact refers to accessibility for external stakeholders, productivity, organizational agility, employee satisfaction, and well-being, employee turnover,
organizational dynamics and ways of working, commuting, organizational agility, and environmental footprint (Christersson and Rothe, 2012).

Awareness of impacts allows considering such criteria in the decision making process, which would not only bring the most added values but also minimise the adverse effect of relocation.

### 3.2.5 State-of-art knowledge on (re)location criteria

In order to develop an expert tool gathering the knowledge on the location decision-making criteria, a deep and thorough literature analysis was conducted. There is a large number of research papers on this topic, listing more or less common criteria that various companies take into consideration in the location decision-making process. This section of the report provides an explanation of how the knowledge that is used to build the tool was gathered.

The process of searching for and collecting the state-of-art knowledge started with conducting an extensive literature research. In the earlier part of the research, I looked at the literature covering the topic of diverse types of the decision-making processes and frameworks. A significant number of these papers dealt also with the topic of location decision variables and criteria or referred to the papers that address those issues (Nourse and Roulac, 1993; Brouwer et.al, 2004, Farahani et. al. 2010; MacCarthy and Atthirawong, 2003; and others).

The step-by-step approach to establishing a theoretical background structure for the expert tool was as follows:

1. In the beginning, the first scan of the articles was done. Basing on the abstract, introduction and conclusions, a quick comparison of the information included in them was possible. The reoccurring themes connected to the location decision-making process, factors and criteria were found.

2. If the paper included coverage of the topic, during a second, in-depth reading, a small scheme presenting the relations between the criteria and their potential determinants was created. It was a simple, visual summary, allowing recognition of patterns and understanding of the dependencies. Some of the models were taken directly from the article and adapted for the research needs, while some of them were created from the scratch, as a summary of relevant information from the article. All of the created structural models can be found in Appendix A.

3. With the structures, it was easy to recognise repetitive indications of various determinants for using different location criteria. Those determinants focused mainly on the reasons, triggers for location search and the goals that an organisation strives to achieve with the new location. Moreover some of the authors grouped the criteria listed in the papers, which helped in the analysis.

4. The models that present the links between the determinants and criteria in the most comprehensive way were chosen as a base (see the description below). Subsequently, the patterns are drawn in the models and logical reasoning, the criteria and determinants from all the other papers were used to enrich ‘the base model’ and create a logical structure for the expert tool.

It was necessary to recognise and outline the links between the determinants and the criteria. The basic idea for the expert tool could be to create a program that simply lists all of the location factors. However, in order to ensure that the tool adds value to the process and truly supports the decision makers, it was necessary to give the users some guidance. This is done by indicating criteria to which more focus should be put and prevent getting lost between the ones that are not applicable to a particular case.

Below a number of short summaries of each article used to create the structural models mentioned above are presented.

1. Dunning (1998) studied how the changing world economic scenario impacts the international business and how it is implied in the location decision for foreign direct investment and multinational enterprise activity. He linked the motives for investments done by multinational enterprises and listed a number of contextual variables that are significant in the location decision making, including the size of the firm, the degree of multinationality, country or region of origin and destination, industry type, and different situational needs (Dunning, 1998). In addition, the author presented the outcome of his research in a form of a table, where he compared variables influencing the locational decisions occurring in the 1970s and 1990s. No major differences were spotted in the comparison. Although the research was done 20 years ago, the listed variables are still applicable and allow the creation of links between the
reasons for relocation and criteria that are taken for various reasons. The model created from this paper (see Appendix A, Figure A.1.) was done as a reinterpretation of presented table (Table 1 in Dunning, 1998, p.53).

2. Ciaramella and Dettwiler (2011) focused on the relocation model of European firms. Despite the fact that they analysed the manufacturing companies, the surveys they made and their literature study covered also the topic of office location. With their case studies, the authors mentioned a large number of causes of relocation practices. This included amongst others being unhappy with the current asset, special spatial requirements, seeking labour pools. They mentioned that relocation has different variables on different scales and specified three different relocations levels: intra-regional, inter-regional and international. In addition, the authors pointed out the relevance of the time required for relocation and how it affects the business. No model was presented in the article but based on the information given in a text, it was possible to create a small summary model (see Appendix A, Figure A.2.).

3. Mazzarol and Choo (2003) looked at the factors which influence the operating location decisions of small companies. They listed a number of location advantages that support fulfilment of broader corporate objectives. This involved increase in production capacity, additional profit, business expansion, and better service to customers, an increase in stakeholders’ wealth, cost reduction and decrease in production time. Again, the influence of (re)location scale and its impact on criteria choice was brought up. The authors presented a thorough literature study and created a table with location factors’ hierarchy (Table I, Junghirapanich and Benjimin, 1995 in Mazzarol and Choo, 2003, p. 192). This table was enriched by the information from other sources. In addition, the importance of proper variables was studied by the authors. The created model (see Appendix A, Figure A.3.) presents a summary of information on location factors mentioned in the paper. It did not recognise many of the links but provided significant enrichment of the final criteria list.

4. Another synopsis of information from the article was created from the research done by Brouwer et al. (2004) and his study of the determinants of firm relocation behaviour (see Appendix A, Figure A.4.). Once again, the company characteristics were introduced as a factor impacting the final list criteria to be taken into consideration. He addressed three factors influencing firm migration: internal factors (e.g., size of company); external factors (e.g., market size) and location factors (e.g., region characteristics) (Brouwer et al., 2004). Additionally, two forms of the movement were listed: complete relocation and partial relocation (Brouwer et al., 2004). The authors go further by naming the main forces driving firm relocation (namely expansion, the need for the more suitable premise, cost saving and government policy) (Brouwer et al., 2004). No model linking the criteria to reasons was visualised in the article.

5. In their research, Rymarzak and Siemińska (2012) tried to identify and systematise the factors influencing the choice of a location for various real estate types. They provided an insight into the classification of location factors. One more time, the company’s specific characteristics were listed. The factors were divided basing on a demand and supply side on the more general scale. In addition, the authors looked at the real estate attributes, its accessibility and traffic issues. The criteria listed by Rymarzak and Siemińska (2012) are very detailed and tables were used to show the systematisation of criteria. The model (see Appendix A, Figure A.5.) outlines most relevant information from paper.

6. Farahani et al. (2009) worked on the multiple criteria facility location problem and provided an overview of various criteria used. The authors mentioned a number of objectives and cover a comprehensive analysis of factors taken from the analysed research papers. They capture variables under twelve main themes and shortly list them while linking to objectives. Since no visualisation of connections between determinants and criteria was done, the created model is based on the text (see Appendix A, Figure A.6.).

7. Nourse and Roulac (1995) also linked real estate decisions to the overall business objectives. While doing that, the authors named a number of different real estate strategies, presenting the related objectives and actions that need to be taken to reach them. To make use of this literature piece, the listed strategies were transformed into a list of objectives that can be reached and (basing on the description included in the text) linked to the specific criteria. The criteria are derived from the operating decisions, linked to the location (as listed by the authors in the research paper). Those analyses are visualised in the model (see Appendix A, Figure A.7.).
8. In the article written by Rothe et al. (2015), the authors examined the short-distance firm relocations, the most frequent forms of relocation and its impact on employees. One of the reviewed themes touched upon the relocation drivers, location and facility search criteria and search process. Although there were not many search criteria mentioned in the article, the ones that were listed were derived from the interviews conducted with employees from different companies. They can be directly linked to the relocation process (see Appendix A, Figure A.8.). This is an important input for the tool since it is created to serve as a bridge ensuring the involvement of employees in the LDM process.

9. Van Dijk and Pellenbarg (2000) explored the determinants of firm migration in the Netherlands and linked the relocation decisions to the location characteristics. They brought up a statement that the firm internal factors are the main determinants of the decision to relocate and site related factors are less crucial. The reasons influencing the relocation decisions were divided into three groups: push-, pull- and keep-factors. The authors distinguish between the three sets of explanatory variables: ‘firm internal’ factors, ‘location’ factors and ‘firm external’ factors (similar to Brouwer et al., 2004). Again, no visualisation of connections was done but thanks to a simple classification of variables and explanation of dependencies in the text, it was possible to create a structure (see Appendix A, Figure A.9.).

10. Through the analysis of the existing literature, MacCarthy and Atthirawong (2003) presented a comprehensive set of factors that may influence international location decisions. The authors focused on the international operation and the top five major factors that may strongly influence such decisions. Although the purpose of the research was not to analyse the topic of office location, a lot of information can be drawn from it, as the authors used various sources, focusing not only on the manufacturing. MacCarthy and Atthirawong (2003) created a summary of location criteria that include a considerable amount of factors relevant and applicable to various types of industries and cases. The importance of factors identified in this research is not taken into consideration as the authors themselves point out in conclusions that it is influenced by the sector and market type and is case-specific. The key takeaway from this research for building the tool is the clear and well-organised categorisation of criteria. It was presented as a summary of analysed information in a table by the authors and transformed into a model for this thesis (see Appendix A, Figure A.10.).

11. Kimelberg and Williams (2013) examined two issues relevant for the evaluation of business location factors, measuring the relative importance of a wide range of factors and ‘the extent to which the perceived importance of a given location factor varies based on the type of facility in question’ (Kimelberg and Williams, 2013 p.92). Within the research, authors looked at how criteria vary with a change of facility. They provided a long list of criteria relevant to the location of offices, which is used in this research (see Appendix A, Figure A.11.). In addition, they group them under the theme of ‘main location determinants’, bringing a kind of preliminary classification.

After studying all of the mentioned articles and creation of the models (see in Appendix A), it was easy to notice reoccurring patterns in relation between the determinants and criteria, as well as overlaps in the criteria list. Many of the articles included a review and summary of a large number of other researches. At this point, there was no need to keep on looking into other articles. This decision was also done by taking into account the time constraint for the conduction of thesis. This part of literature analysis covered enough knowledge and variety of criteria, enabling the creation of the first versions of the expert tool.

Having all the models ready (see Appendix A), it was possible to track the links recognised in the literature. It was done separately for each criterion, one by one. Figure 3.2. presents an example of how those links were tracked.

In Figure 3.2. it is shown how the links were outlined for the criteria of public infrastructure quality and proximity (gathered under ‘Proximity to public transport’ in the final tool version). It was mentioned by 8 different authors and linked with several determinants. Dunning (1998) through the theme of ‘physical infrastructure quality’ connected the transportation topics with the ‘Market-seeking’ and ‘Strategic asset seeking’ reasons. Transportation, concerning a variety of types (land, air or water) was also mentioned by Mazzarol and Choo (2003), similarly to MacCarthy and Atthirawong (2003) as well as Kimelberg and Williams (2013). The last authors named 4 related sub-criteria. Rymarzak and Siemińska (2012) linked the criterion to the accessibility problem and site consideration. Van Dijk and Pellenbarg (2000) extended the links to the objectives of ‘Maximising employee satisfaction’ and ‘Meeting the organisational goals’, additionally they related it indirectly (through general consideration of various factor types) to the reasons. Finally, Farahani et al. (2009) named 3 related objectives, aiming at maximizing the delivered service and minimising the average (or maximum) time/distance travelled.
Figure 3.2 Tracking the links for the public infrastructure quality and proximity criteria.
3.2.6 Analysis and results: Forming the theoretical structure of the tool

Following the logical reasoning and descriptions provided by the authors, it was possible to cluster the identified determinants, categories and criteria recognised in the literature. The clustering of ideas is presented below.

As mentioned before, various authors named a number of different determinants that influence the choice of criteria on which the location decision is established. In the Appendix A the structures created with the literature study are presented. One can see that the determinants were grouped under to names: reason and objective. With the literature study it became clear that the authors focus on two types: elements that caused the location seeking (that can be related to the push-out factors) and on elements that are to be achieved with the new location (connected to pull-factors).

With the reasons for location seeking, one will be looking at the cause of process, what exactly triggered it. Naming the main objectives, helps in defining what should be achieved with the location, which goals are to be reached with the decision. Different reasons and objectives would lead to use of different criteria, as the focus will be put to different location factors. Although some of the reasons can overlap with the objectives, it is necessary to consider them separately. For example, the location search might be driven by a need of cost reduction, which of course will link to objective minimizing the cost. However it might not be limited to that objective only, as establishing new facility might help company with for example increasing the satisfaction among employees at the same time. For this reason, it would be insufficient to focus only on one group of determinants. The existence of overlap in the two groups would also help the decision makers to further consideration of the process, allowing broadening the criteria list.

RESANONS
The publication of Dunning (1998) was taken as a first step to define a comprehensive list of reasons. With the list of six triggers to look for a new location (strategic asset seeking, resource seeking, efficiency seeking, market seeking, growth, and decrease), the author addressed the causes that were also indicated by other authors (see the Table 3.4.). One could limit the list of triggers to the above mentioned, however, it was possible to notice that two additional elements should be added: being unhappy with current asset and merger/ acquisition/ takeover (especially when the relocation is considered). These elements were clearly linked to certain location criteria (like retention of the talent, intrafirm relationship, special spatial requirements or the quality physical infrastructure) and could not be omitted. In addition, despite the fact that the ‘cost reduction’ could have been incorporated in the trigger of ‘efficiency seeking’, a number of authors listed it separately, indicating its significance. For this reason, a pure need for cutting the costs was listed as a separate reason to seek for the new location.
OBJECTIVES
Gathering the list of objectives was more challenging. Various authors use different terms to describe the same issue and work on the different level of detail. While some of them generalise the goal as, for example, ‘minimizing cost’ (Mazzarol, Choo, 2003, Brouwer, 2004 and others), others break it down to ‘minimizing fixed cost’, ‘minimizing total annual operating cost’ and ‘minimizing the total setup cost’. These caused a need to group and combine the identified goals. The most complete lists were provided by Farahani et al. (2009) and Nourse and Roulac (1995). The list of potential objectives that can be achieved with a new location derived from the work of those actors is enriched by the information from other articles. The full list with the sources can be found in Table 3.5.

CRITERIA
The most important element is, of course, a thorough list of location criteria. With all of the literature research, an extensive number of 110 different factors were gathered. These criteria cover all the identified aspects of location, allowing analysis and assessment of alternatives. This is applicable not only when considering which country or region to choose from, but also when substantiating the choice between neighbourhoods or even specific assets. With the help of literature analysis, some of the factors can be defined to a great level of detail. For this reason, the sub-criteria allowing further specification were included (they are not additional criteria but provide a possibility to particularize given criterion). In order to ensure an easy access (for the user) to the knowledge gathered in a tool, a structure through categorisation into themes has to be done.
Table 3.5: The list of objectives for location seeking identified in the literature.

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<td>Promote sales and selling</td>
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<td>Facilitate and control production, operations, service delivery</td>
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<td>Facilitate knowledge work</td>
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**LEGEND:**

- Mentioned directly
- Mentioned indirectly
- Not mentioned at all

**CATEGORIES**

The comprehensive and detailed classification of the criteria under categories (which are also called as *criteria themes* in this research) was done by MacCarthy and Atthirawong (2003). It is used as a base for the core structures of the tool. What authors called as ‘main criteria’ (with a number of ‘sub-criteria’) is used as ‘criteria themes’ to create a tree-like structure for the tool. The division into thirteen themes done by researchers already provides a division for a rich pool of location variables. For this reason, it was considered as an appropriate starting point. The themes used by MacCarthy and Atthirawong (2003) are:

- Costs
- Labour characteristics
- Infrastructure
- Proximity to suppliers
- Proximity to markets/customers
- Proximity to parent company’s facilities
- Proximity to competition
- Quality of life
- The legal and regulatory framework
- Economic factors
- Government and political factors
- Social and cultural factors
- Characteristics of a specific location

Majority of criteria were assigned to the groups straightforward, following a logical reasoning. Nevertheless, two types of criteria themes seemed to still be missing. The research of MacCarthy and Atthirawong (2003) was done on the specific market topic and the character of the market that was not perceived as one of the criteria. This was however pointed out as an important issue by other authors (Mazzarol and Choo, 2003;
As a result, since there was a slight overlap in the criteria, the theme ‘Proximity to markets/customers’ was changed to ‘Characteristics of markets/customers’. Moreover, when the location of the office is being chosen, one cannot overlook the importance of company-specific (spatial) needs (Ciaramella and Dettwiler, 2011; Rymarzak and Siemińska, 2012; Nourse and Roulac, 1995). This topic might be related to the elements like a type of ownership, striving for purpose-built premises, looking into intrafirm relationships and others. Thus, the ‘company specific (spatial) needs’ are also added as a separate category.

In Table 3.6, all the criteria identified in the literature are listed and linked to the relevant article, where it occurred.

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<td>Alliance and close spatial proximity to the specific company</td>
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Having the full list of determinants and criteria established, the content of the tool is ready to be implemented. As mentioned before, the links between characteristics, reasons and objectives were based on the literature study. For example a suggestion to look at ‘provision of investment allowance’ would be given to a company who is looking for a new location because of ‘efficiency seeking’ (Dunning, 1998), or striving for ‘minimizing cost’ (Farahani et al., 2009; Brouwer et al., 2004; Van Dijk and Pellenbarg, 2000), or simply focussing on the aspects of costs (MacCarthy and Atthirawong, 2003; MacCarthy and Atthirawong, 2003). Similarly, considering ‘Proximity to business service suppliers’ would be advised to a decision maker who marked any of the ‘strategic asset seeking’, ‘resource seeking’, ‘efficiency seeking’, or ‘market seeking’ as a reason to search for a new location (Ciaramella and Dettwiler, 2011; Rymarzak and Siemińska, 2012). Additionally, if ‘maximizing service’ through ‘increasing flexibility’ or ‘facilitating and controlling production, operations, service delivery’ (Mazzarol and Choo, 2003; Ciaramella and Dettwiler, 2011; Rymarzak and Siemińska, 2012;), or ‘minimizing fixed cost’ (Rymarzak and Siemińska, 2012; Van Dijk and Pellenbarg, 2000) was marked as objective to be reached, this criterion would also be emphasized.

The described process of literature analysis allowed the creation of a complex map of relations between criteria and their determinants, translated into the structure of the content for the expert tool. It was
created following the same rules as for Figure 3.2. and put in the Excel program, which allowed conducting calculations within the tool as described later in the report, in Chapter 4.1. and Chapter 4.2.

### 3.2.7 Conclusion

Several conclusions can be drawn from the analysis of the state of art knowledge on firm location factors. First of all, the real estate can bring added value to the organisation in several ways. Following the added values of real estate and the driving forces of the corporate business strategy, it is possible to notice aspects that have a direct influence on the company’s real estate demands. A number of factors have to be taken into consideration, coming both from inside the company, as well as from external sources.

The mentioned factors and company’s needs can be reflected in a set of criteria, basing on which the potential location is judged and final decision is made. It is necessary to consider the outcome of decision based on those criteria, as properly determined criteria can not only bring added value but also minimise the adverse effect of relocation.

Despite the fact that many researchers discuss the triggers, reasons for the (re)location, objectives, and strategies that companies follow in the (re)location decisions, rarely can one find a clearly outlined links between those issues and specific location criteria. The authors hardly ever do find a reason to investigate in depth how varying triggers and demand shape the final list of criteria or tried to provide an overview of that matter. It posed a challenge for the creation of the expert tool structure as many of the links had to be derived from the text. The links between the criteria and determinants were drawn only if they were indicated directly in the text or there was an indirect relation, matching the logical reasoning.

Nevertheless, the literature study provided a clear indication that while considering the location criteria, one should first look at the reasons (triggers) of the (re)location decision and the objectives (requirements and goals) to be met with the choice of the new location. Those elements, as well as criteria categorisation, were used to create the tool structure.
3.3 MULTI-CRITERIA GROUP DECISION-MAKING PROBLEM

The chapter introduces the concept of Multiple Criteria Decision Analysis (MCDA), the problem it relates to and approach to solving it. It is linked directly to the next chapter, where, the Preference Based Accommodation Strategy Model is introduced. Analysis of those fields will help in answering two of the sub-questions: ‘1. What is the current body of knowledge on the (re)location decision making (LDM) and expert tools connected to it?’ (in particular first part of the question 1.a What frameworks and models are used in LDM?) and provide some introduction to answering 3. How can the expert tool be linked with decision supportive models? When the decision making requires taking into account multiple objectives, which might be contradicting and impact the process it might, the Multiple Criteria Decision Analysis is used.

3.3.1 The MCDA concept

As mentioned before, a significant amount of factors, defined by a number of different stakeholders have to be taken into consideration when the management decisions at a corporate level are being made. Those factors vary on the level of specification. A small change of requirement can influence even the simplest decision. The final location decision should satisfy all the involved parties, despite the possibility of having disparate interests. This can only be achieved by balancing those multiple factors.

A simple example considering the office location decision with conflicting criteria might be as follows: a company has a need to attract the talented employees (crucial for human resources departments), which would be aligned with locating an office in the city centre. This, however, might be in conflict with a willingness to minimize the total occupancy costs (relevant to financial controllers). As shown in the example, the multiple criteria for decision making could have a contradictory influence on the process outcome. This is applicable in many areas, including the real estate. In such situations, simple reasoning and traditional top-down or bottom-up approaches are not sufficient anymore. The higher the stakes are, the more likely it is that the decision maker will require a tool that would help in making the final decision.

This research helps to answer the question that deals with the problem of making a location decision that meets all the decision-makers’ interests in the best possible way. It is done by taking into account each of the relevant attributes of alternatives and evaluating them. Since deciding results in making a choice and criteria help in reflecting the interests, it seems reasonable to expect, that MCDA approaches can help to solve the problems occurring in the Real Estate Management.

Belton and Stewart (2002) studied the Multiple Criteria Decision Analysis (MCDA), which can be considered as a way to support the decision makers in solving the problem. It is a collection of formal approaches, which by definition “seek to take explicit account of multiple criteria in helping individuals or groups explore decisions that matter” (Belton and Stewart, 2002, p. 2). It can provide a transparent way of measuring subjectivity and include it in the decision-making process.

3.3.2 The MCDA and LDM procedure

The MCDA process is an iterative one and can be divided into three main phases: problem identification and structuring; model building and use; development of a plan of actions.

Belton and Steward (2002) explained that the MCDA brings focus and a room for discussion in the decision-making process. The aim is to support the decision makers in understanding the problem situation, discover prevailing values and judgements and guide them in identifying a proper course of action (Belton and Steward, 2002). It allows testing the ideas created within the institution and not replacing intuitive judgement or experience. A more reasonable approach, with better considered, justifiable and explainable decisions is provided. The authors stressed also that approaches should be conceptually simple and transparent, but do not question the necessity of possession of non-trivial skills to make effective use tools in a complex environment (Belton and Steward, 2002).
There are several benefits coming from the use of MCDA. For example, with Multi-Criterion Decision Analysis all the discrete, qualitative criteria and options for a decision are evoked by the decision makers (Belton and Steward, 2002). In addition, learning achieved with the analysis allows comparisons. There are a number of varying methods that are used to create an overview of decision maker preferences, which are related to a set of assumptions (e.g. reference level, value measurement, outranking) (Belton and Steward, 2002). Because of the deficiency and imperfection of the possessed knowledge a number of areas of ignorance, uncertainties might appear, with MCDA they are recognised and addressed.

In order to judge the overall performance of an alternative, one needs to consider its’ different attributes. The attributes are called ‘criteria’, which are means or standard of judging. In MCDA, they can be expressed in a tree-like structure, with a division to different levels, i.e. main criteria, sub-criteria, sub-sub-criteria and further on (Barendse et. al., 2012).

All the optimization models include only one objective function, so it can only produce single-criterion design solutions. This situation is able to fully satisfy only a single decision-makers interest and this technique does not apply to the group decision making (Barendse et. al., 2012).

Since criterion or decision maker is associated with its own objective function, using multiple optimization models is needed. However this approach brings confusion and the negotiations will not involve compromise solutions as each of the solutions can fully satisfy only one decision maker (Barendse et. al., 2012).

In this situation, the use of constraint method, operating by optimizing one objective while all of the others are constrained can be used (Barendse et. al., 2012). According to Barendse et. al., (2012), choosing the values for the constraints is completely arbitrary and usually still relies on unstructured negotiation (Barendse et. al., 2012).

The practical application of decision theory is called decision analysis and ‘aims at finding tools, methodologies and software to help people, or groups of people, make better choices’ (Barendse et. al., 2012, p.22, 23). In order to use the mathematical modelling of measurement, the empirical system (with a set of empirical objects together with operations) has to be reflected in a mathematical model with a help of proper scale. This enables the application of mathematical operations (Barendse et. al., 2012).

The formal procedure of MCDA consists of several steps, which include (Binnekamp, 2010):

1. Specification of alternatives;
2. Defining the decision-makers criteria tree;
3. Rating of the decision-maker preferences for each alternative in relation to each criterion;
4. Assigning the decision-maker weight to each criterion;
5. Using an algorithm to draw an overall preference scale. 
In a group decision making, each stakeholder involved rates his preference for the alternatives against each criterion.

By using the weights in the process, the relative importance of each criterion and the relative significance of decision-makers can be included. Applying an algorithm considering rating each alternative's performance on each criterion and criteria relative weight, the overall performance of an alternative can be determined (Binnekamp, 2010).

It is crucial to realise that the MCDA outcome only reflects the decision established on the basis of the criteria listed by the users themselves. In addition, there is a possibility that more than just one solution to the defined problem exists in an environment with multiple criteria, as several solutions might achieve the same final rating score.

### 3.3.3 Weights vs. measurement units (coefficients)

In the real estate area several MCDA models can be found (Arkesteijn and Binnekamp, 2012). Those methodologies enable combining ‘the performance rating of alternatives on different criteria into an overall performance rating’ (Arkesteijn and Binnekamp, 2012), which are rated on preference on each criterion. As a result, the criteria become properties by which the portfolio's performance is measured (Arkesteijn and Binnekamp, 2012). The MCDA approaches help in identifying the actions that align the portfolio with the organisational objectives in the best possible way (Arkesteijn and Binnekamp, 2012).

In his doctoral thesis, Binnekamp (2010) focused on the problems related to the third step of the MCDA framework, namely the preference measurement. He pointed out that some of the MCDA models use the weighted arithmetic mean to obtain an overall preference scale.

When using the MCDA it is crucial to recognize the difference between the coefficients in a linear expression, which are applicable to scales, from the measure of importance applicable to criteria. It is possible to assign a weight to the criterion in order to reflect its relative importance in comparison to the other criteria. While the criteria can be a variable that is scalable and measured in set units (like distance reflected in length or time), the weight is a relative expression. Those concepts should not be mixed, as it can lead to fundamental errors (Binnekamp, 2010). Separation of criterion weight from its unit allows sustaining the assigned values of weight even when the unit of the coefficient is changing.

Those concepts can be summarised and used in this research in the following way:

- **Weights** - which are relative measurement, expressing the importance of criteria. They are used in an ‘intra-criteria’ way, which means that it tells how the relevance of different criteria is changing. Weights can also be applied to objectives, expressing focal points and giving them order; or decision makers, giving some to some of the decision makers more decision power than others.
- **Values** - which are assigned ‘intra-criteria’, and are bound with alternatives. Values are assigned as characteristics of the alternatives connected to one specific criterion.
- **Preferences** - are used as the unit used for rating the alternatives. They are also known as utility, value and are non-physical variables that describe a psychological or subjective property of an object (Barzilai, 2010, pp. 1, 25). Ratings are given by a person evaluating the performance of each alternative against a specific criterion.

### 3.3.4 The interactor design environment and design space

The interactor design environment relates to several problems: one of the society experiencing the design problem; of the group involved in the design problem; and of the organisation striving to solve the design problem. It has a complex nature due to a multifaceted character of the design problem. The environment determines the background (social, historical) and related constraints of the design problem. Also, all the actors related to the design problem are included in the environment. As a result, the solution to the problem should also be able to fit back into the environment (Binnekamp, to be published b).

When more than one person is getting involved in the decision making or design situation, several conceptions of the problem environment will result in more than one design problem. The created
‘interactor design situation’ turns into ambiguous and multi-interpretable. Sometimes the conceptions interrelate or are perceived by stakeholders to do so. It is worth looking for an all-encompassing, integrated solution (Figure 3.4.).

When looking at the identified problem that this report refers to, the fit of the definition is easily perceptible. Several actors are involved in the complex location decision-making process. The different perspectives, interests and requirements result in different perceptions of the problem environment.

It is possible to approach the ambiguity of the interactor design problem in an operational way, through the use of resources and goals. In order to do that, we should be able to recognise the individual origins of goals and links to the individual actor. One must be capable of relating the individual goal contents with the actors (the parties) involved. The developed tool allows this by gathering the input from decision makers and reflecting them in the report (Binnekamp, to be published b).

As mentioned before, varying interests or decision variables can result in varying goals, making it hard to define a shared solution vision. In order to solve a multi-actor design problem, the different goals must be connected and create an overall whole. Identifying the connections and overlaps in various parts is possible when the input from a number of stakeholders is gathered, creating a possibility of finding the final solution.

To derive a specific network of goal relationships, some ordering in a complex network is necessary. One of the forms of order is based upon the actors and analysing the relationships between their goals group by group, clustering in a sub-network. The tool does this by allowing the representatives from different part of the organisation to provide their input to the process.

Binnekamp (to be published b) recognised two organisational and professional frameworks: the methodological individualism approach and the methodologically hierarchic approach. The first one based on the idea that decisions are taken by all individuals and groups of individuals together and not by leaders and representatives. As a result, everyone’s needs can be met as far as possible, making the decision making an open and ‘neutral’ (no particular outcome defined in advance by a small group will be pushed through). The second approach assumes that certain indifference to ‘the whole’ prevails and it is preferred that only a specified group take decisions. They are expected to act as expert leaders of the organisation qualified representatives, limiting the number of involved actors and increasing the efficiency in the process. Maintaining the competition between the leaders and representatives is crucial in order to come to an optimum solution (Binnekamp, to be published b).

The expert tool is tailored to assist the second of the mentioned frameworks, as in large organisations, the individual approach is impossible to adapt. There is always an existing structure, defining the leadership appointed within the company. Allowing various parts of the organisation to express their needs via representatives is of a great importance and therefore possible with the use of the tool. Although the methodological individualism approach provides the most complete communication and information flow.
(Binnekamp, to be published b), we have to assume that in a large organisation, the appointed representatives should be able to express the information from ‘below’ and incorporated into their work.

In addition, the tool helps in to bring the participatory link with the decision-making environment to the actors’ attention by meeting certain conditions (Binnekamp, to be published b):

- Underlying a multi-party character of the design process to the project initiators and leaders;
- Bringing focus to the importance of the background of the decision (views, motives, values etc.);
- Allowing a provision of information on various stages of the process and adjusting them at a later stage; this provides a starting point for location decision-making process;
- Information is given in context (not as a neutral input), deriving its significance from actors’ position and role in the process.

3.3.5 Conclusions

The chapter helps in providing the answer to two of the sub-questions: ‘1. What is the current body of knowledge on the (re)location decision making (LDM) and expert tools connected to it?’ (in particular first part of the question 1.a What frameworks and models are used in LDM?) and provide some introduction to answering 3. How can the expert tool be linked with decision supportive models?

Decision-making in the field of the corporate real estate requires considering multiple objectives. They are very often conflicting and come from stakeholders driven by various goals. For this reason, the concept of Multi-criteria Decision Analysis was introduced to support the decision maker in solving the problem, by taking explicit account of multiple criteria to make the most suitable decision, by measuring subjectivity and include it in the decision-making process in a transparent way. With this approach, the alternatives are assessed against the defined criteria set to choose the best one. There are several MCDA tools recognised in the literature. They make use of weights, rates and preferences to come to a solution.

This research is connected to problem-structuring methods, which includes analysing the impact of soft Operational Research methods in the real-life context. As a result, a detailed description of the method applied to a real-life problem situation is provided. The outcome of research (the expert tool) is designed to help with the second step of MCDA (defining the decision-makers criteria tree) and the fourth one (assigning the decision-makers weight to each criterion).

All the decisions made within the interactor design environment and design space. The expert tool helps in understanding and overcoming the complexity of such environment.
3.4 THE PREFERENCE-BASED ACCOMMODATION STRATEGY DESIGN APPROACH (PAS)

The architectural domain poses the problem of a large number of stakeholders having to choose the option that best fits their common, group interests (Arkesteijn et al., 2013). According to the literature, the performance measurement creates a scientific foundation of selection (Arkesteijn et al., 2013).

One of the multi-criteria design approaches is the Preference-based Accommodation Strategy design approach (PAS) developed by Arkesteijn et al (Arkesteijn et al., 2015). The procedure is a design methodology that aims to solve strategic portfolio design/decision-making problems. It is based on preference function modelling (PFM) and was initially formulated for one decision maker (Arkesteijn and Binnekamp, 2012), subsequently improved and adjusted to serve multiple stakeholders in creating portfolio strategy. It supports more collective thinking and reasoning, allowing the identification and assessment of alternatives in order to select the best one (Arkesteijn et al., 2015).

3.4.1 Rationality in decision making

According to Arkestein (2017), when talking about the problem of decision making, the concept of rationality has to be addressed.

Kickert (1980, as cited in Meijler, 2017) described rationality in decision making as a concept, which deals with behaviour. It copes with making a choice between alternatives and the way one chooses between different options. Therefore, rationality focuses on the process of reaching a certain goal. The process of choosing the location that suits company's needs in the best possible way can be described using rationality.

De Leeuw (1992, as cited in Arkestein, 2017) classifies rationality into three levels on which the decision-making process can be formed:

- **Substantive rationality**, which is dealing with the choice of an (optimal satisfactory) alternative. This type is characterised by the fact that there is only one decision maker and the time aspects are mostly ignored. It focuses on the strategy and process leading to an answer (Arkestein et al., 2017). This rationality is applied in the research by using the model that is leading to achieve an optimal solution.

- **Procedural rationality** in decision making indicates the elements to be taken into consideration and sets an order leading to reach alignment (Arkestein et al., 2017). In general, it can be used to determine the best procedure of decision-making and ensure that no step is taken without meeting the necessary precondition. In this research, it is expressed steps that need to be taken.

- **Structural rationality** ensures that process consists of proper communication networks, enabling linking and integrating strategies to reach collaborative results. It helps to define who performs which activity and when is it performed (involved actors and actions they take part in) (Arkestein et al., 2017).

In the PAS design approach, the three types of rationality are combined to clearly define how the best option can be chosen (Arkestein et al., 2017). It is done as follows: the procedural rationality consists out of steps, which describe what the involved stakeholders' actions and their order (Arkestein et al., 2017); the structural rationality indicates the actual activities of connected to previously mentioned steps, dividing them in interviews (i) and workshops (w) (Arkestein et al., 2017). In addition, PAS is supported by the mathematical model is, in which all information is gathered, assisting the stakeholders in making a decision (Arkestein et al., 2017). The procedure uses scales for direct measurement of added value/preference and allows the accumulation of a set of individual ratings into a one, overall performance rating (Arkestein et al., 2015).

In the Preference-based Accommodation Strategy design approach (PAS) decision makers define the decision variables on their own in the series of workshop and interviews (Arkestein et al., 2015). They have a possibility to iteratively test and adjust their variables. This approach, however, does not guarantee that
all the variables which are relevant to the stakeholder are named, as we cannot assume that he possesses all the relevant information and might be unable to list all the crucial issues.

### 3.4.2 Data type: soft and hard data

In general, people have a tendency to rely on the hard data (quantified information in graphs and tables) and take it for granted. However, the hard data often has a narrow scope and lacks certain richness. Moreover, the collected data is usually aggregated and the information looses place (Mintzberg et al., 2005, pp. 120-121). As a result, managers often rely on soft data. This kind of data includes, for example, oral communicated information, speculations, gut feeling, knowledge derived from own experience etc. In reality, the data relevant to the strategy-making almost never become “hard”. It cannot be however neglected that the soft data is prone to downsides coming from human errors and biases. Therefore, the strategy should ideally be based on both kinds of data (Mintzberg et al., 2005, pp. 120, 124).

With the use of PAS, the soft data is made transparent and turned into hard data, providing additional interaction with other stakeholders. The first steps of PAS allow the stakeholders to translate their preferences (soft data) into preference curves (hard data), providing transparency. Subsequently, the resulting preference data is used to rate the portfolio alternatives (Arkesteijn et al., 2015, p. 118; Valks et al., 2014, pp. 13-14). The real estate strategy defined as a result of PAS is based on the design constraints and variables provided by the stakeholders. They can be based on both hard and soft data, determining the feasibility of the design alternatives. The output of the PAS model is reflected again with hard, quantitative information.

The PAS procedure seems to be capturing both qualitative and quantitative elements in one rating. The combination of both types of information enriches the output quality. However, as this output consists of hard information, making sure that the quality of data used as input (both ‘soft’ and ‘hard’ data) is thoroughly defined is of a great importance.

### 3.4.3 Conclusions

The Preference-based Accommodation Strategy (PAS) design approach was developed (Arkesteijn et al., 2016) and is one of the MCDS methods. As the process of choosing the location that suits company’s needs in the best possible way, it can be described using rationality. Relating to this, the PAS consists of three elements: steps (procedural rationality), activities (structural rationality) and a mathematical model (substantive rationality). The described approach allows recognition of the preferences of a company and defining the optimal portfolio.

PAS model makes use of both qualitative and quantitative data that has to be gathered from the stakeholders. The more accurate criteria list is defined, the better preferences can be expressed for the PAS model, leading to the more accurate outcome.
3.5 THE EXPERT TOOL

The location decision making can be classified as a complexity activity, involving many decisional variables, constraints and objectives. Facing difficulties in the process might push the decision makers towards more traditional approaches, which focus on few variables or practices at a time and appear to simplify the task. However, such approaches are not always suitable to support decision making in large multinational companies (Golini and Kalchschmidt, 2015). According to the literature, information technology is already being widely used to support these functions. In general, the decision theory is concerned with recognising the best possible choice to take (Barendse, et al., 2012). It is also known as decision analysis, which aims at finding tools, methodologies and software to support both individuals as well as large organisations in making proper choices (Barendse, et al., 2012).

This research strives to solve the problem of LDM complexity by developing an expert system, which would provide the theoretical support for multinational firms, to help them identify the most suitable location for their offices. This research is based on the hypothesis that an expert system is able to consider at the same time all of the relevant requirements involved in a location decision making that are already identified in the literature (Golini and Kalchschmidt, 2015).

3.5.1 What is an expert system

The expert system is defined as ‘a computer programme that represents and reasons with knowledge of some specialist subject with a view to solving problems or giving advice’ (Jackson 1999). It is sometimes recognised under terms like “knowledge-based-system” or "rule-based-system", which might be more adequate as it reflects the essence of the approach (Curry and Moutinho, 1991).

Despite the fact that expert systems and decision support systems have evolved into a workgroup and virtual team applications, the individual tools, make the majority of the systems developed (Golini and Kalchschmidt, 2015). The individual tool is defined as ‘usually small-scale systems that are developed for one manager, or a small number of independent managers, to support a decision task’ (Arnott and Pervan 2008)

The existing expert models are limited by the fact that they are usually mathematical or agent-based models. In general, the literature lacks the knowledge-based models in the real estate area (e.g. Liao 2005). This discrepancy is even more significant, considering the fact that many research papers discuss the location decision-making criteria, but it seems that none of them has tried to create a source of information for an expert system or strive at creating the expert system itself.

The ES development is based on the simple idea that expertise is transferred from a human to a computer. The vast body of task-specific knowledge is stored in the computer program can be accessed by users for specific advice they require. It can provide advice and explain the logic behind it, if needed, just like the human counterpart (Turban and Aronson, 2001). A knowledge-based expert system is based on modelling and data mining (Liao 2005). It allows obtaining solutions to a variety of problems that often cannot be dealt with a traditional approach. The applications can be critical in the process of decision support and problem-solving. Thanks to the ES, the expert knowledge can be represented in a common and easy way to facilitate various activities by providing advice on an expert-level to the user of the system (Golini and Kalchschmidt, 2015).

In ES the non-numeric knowledge and reasoning methods are constructed by a set of rules formed in a tree type network (Lukasheh et al, 2001). The ESs have a conceptual nature, basing on the fragmentary dataset and provided solutions bring some degree of uncertainty (Lukasheh et al, 2001). This information given by the user is compared with the knowledge contained in the base and aims at deducting a logical conclusion (Lukasheh et al, 2001).

3.5.2 The expert system methodologies

Liao (2005), through the literature review, identified and classified ES methodologies in eleven categories: rule-based systems, knowledge-based systems, neural networks, fuzzy ESs, object-oriented methodology, case-based reasoning, system architecture, intelligent agent systems, database methodology, modelling, and ontology. He looked also into their applications for different research and problem domains (Liao, 2005).
Nowadays, companies have access to a diverse and complex data, involving big data as well as open or linked data in their decision making. This raises a question about storage, analytics, presentation, visualization, governance and management of all the information. The database methodology (one of the methodologies identified in mentioned research) is focused on collecting of data and organizing it to efficiently serve many applications by centralizing it and minimizing redundant information (Liao, 2005).

The database methodology is closely related to the knowledge-based systems, which include all the organizational information technology applications helpful in managing the knowledge assets of an organization (Liao, 2005) and supporting various activities including the decision making, which is crucial in this research.

3.5.3 From expert system to expert tool

The ES tool (shell) is ‘a software development environment containing the basic components of an ES’ (Lukasheh et al, 2001). They help to improve the productivity for preparing the knowledge base and allow the system developers to concentrate on gathering and structuring the knowledge rather than programming the system. This might reduce the flexibility but will shorten a time-intensive task (Lukasheh et al, 2001).

3.5.4 Decision Support Systems (DSS) and expert tools

As mentioned by Aiken et.al. (1991), the majority of expert systems are stand-alone, independent systems. There are some researchers that focus on the development of large, complex systems which go far beyond that basic scope and work on the integration of Expert Systems with DSSs. This step toward combining relatively disparate information technologies brings the major opportunities and benefits, especially in areas beyond single-user. The overall system can be greatly enhanced by taking advantage of the heuristic expertise from ES technology in combination with decision-making support for groups. It provides synergies in areas like database management, model base management, user interface, system development, and system monitoring (Aiken et.al., 1991). An ES can turn a DSS into a more flexible and powerful aid. While DSS including a number of various tools can be restricted by their ease of use and the lack of human facilitators’ expertise, adding ES might facilitate the use of such systems (Aiken et.al., 1991). The ES can help in monitoring a decision process, analysis of the content, and direct the stakeholders in the direction of the desired goal (Aiken et.al., 1991).

3.5.5 Verification and validation of expert systems

Effective decision support systems rely on a successful collaboration between the system and the users of the system. Therefore, the users need to accept the system and trust the system (Riedel et al., 2011).

There are many research papers focused on validation and verification of expert systems (Golini and Kalchschmidt, 2015). Preece (1990) proposed the practical framework, creating the expert system life-cycle, and emphasising the need for evaluation. In this element, he included following steps: development of the prototype, logical testing, laboratory, and field testing, and maintaining the system (see Figure 3.5.). The order of tests reflects their efficiency and costs.

The logical methods are used first so that if errors are found, one can modify the prototype and re-test it using the same approach (Preece, 1990). It is the most efficient and cheapest test. It covers checks for ‘inconsistent, redundant and subsumed rules; cyclic inference chain detection; missing rule detection (so-called ‘completeness checking’); and other problems such as unobtainable data items, unsatisfying rule conditions, data type clashes or missing goals’ (Preece, 1990, p.216).

Subsequently, the system can be tested empirically and again, it may be modified tested once more from the beginning. The empirical testing covers running a prototype system on a number of selected test cases to check output accuracy and assessing the results. It can also be helpful in assessing the level of user acceptance (Preece, 1990).
Only when a system is both logically and empirically sound, extensive field tests be applied. They require significant human and organizational resources, so should be the last to conduct, due to related costs (Preece, 1990).

Figure 3.5 The expert system life-cycle, emphasising evaluation needs. Own drawing based on Preece (1990)

The importance of verification and valuation cannot be omitted if the produced expert system is about to be useful and bring the understanding of the effects of its use for decision aids in its domain.

### 3.5.6 Trust, acceptance and evaluation of a system

Riedel et al. (2011) review the literature on DSS, focusing on the problem of the user acceptance. He based his research on the Technology Acceptance Model, analysed the user involvement in the development process of Decision Support Systems and looked at the role of trust in accepting the technology. Based on this research, Riedel et al. (2011) created a model that captures all the factors that are crucial to the acceptance and use of DSSs. The model reflects the four perspectives recognised in the literature:

1. User participation and involvement in system acceptance, where participation is understood as an observable behaviour and activities, while involvement is a psychological state of the actors, regarding the importance of the system (Riedel et al., 2011, p. 247, 258).
2. The Technology Acceptance Model (TAM), that enables identification of system acceptance determinants. In general, the user behaviour depends on his behavioural intentions. TAM combines perceived usefulness (that defines the degree to which a person believes by using a particular system, his/her job performance could be enhanced) and perceived ease of use (showing the degree to which a person believes that using a system is effortless) (Riedel et al., 2011, p. 249). The acceptance of the system leads to system use and final user satisfaction.
3. Cybernetics includes the perception of control. This perception influences the behavioural intentions, the behaviour and the perceived usefulness. It is, on the other hand, determined by the level of participation (Riedel et al., 2011, p. 254). With the participation, the confidence in the model is built, allowing learning how changes in decision variables affect the outcome and improving the representation of own perception (Riedel et al., 2011, p.254).
4. The apprenticeship model, which relates to the interaction between the model designer and the user, increasing the usefulness of the system (Riedel et al., 2011, p. 257).

According to Riedel et al. (2011), it can be said that the user participation and involvement have a direct impact on the user satisfaction. It is also dependent on things like the system complexity. At the same time, the complexity is influencing the satisfaction. The perceived usefulness and ease of use are good indicators for technology acceptance. In addition, Riedel et al. (2011) stated that ‘the perceived control is a decisive factor for perceived usefulness, attitudes, and behaviour’ (Riedel et al., 2011, p.258).

The mentioned four approaches are merged into a model (Riedel et al., 2011) presented in Figure 3.6. The core of the model relates in a dynamic way the participation, involvement, perceived control, perceived usefulness, and behavioural intentions (Riedel et al., 2011). It is crucial to mention that satisfaction leads directly to the state of participation and involvement, resulting in more complex solutions.

With rising involvement, a better-represented perception is included in the model characteristics, improving the complexity. This positively impacts also the perceived control and raises perceived usefulness and behavioural intention.
It is possible to notice two interrelated loops in the model of Riedel et al. (2011), showing how all the elements are influencing each other. It can work in both positive and negative way. If, for example, the model is too complex, it will lead to a decreased satisfaction, followed by a lower participation level.

Although the research done by Riedel et al. (2011) addresses the acceptance of DSSs, all the observations and established framework can be directly applied to all kind of the computer programmes supporting the human activities (including the expert systems).

The same applies to the trust issue, which was also researched by Riedel et al. (2011) and poses a significant influence on the quality of human-computer interaction. The author defined trust as ‘an attitude toward automation (or toward the system) that affects reliance and that can be measured consistently’ (Riedel et al., 2011, p. 268). When looking at the operational systems, trust can be understood as the expectation that the user puts on the system performance outcome, regarding the tasks made on his/her behalf.

The three elements that one has to look at when talking about trust in a system are: performance, process, and purpose (Lee and Moray, 1992, as cited in Riedel et al., 2011, p. 270). All of those elements should be addressed in the evaluation of the system.

- **Performance** indicates the competency or expertise of system, showing its ability to achieve the goals of a user. It includes such characteristics as reliability, predictability, and ability (Riedel et al., 2011, p. 270).

- **Process**, indicating ‘the degree to which the automation’s algorithms are appropriate for the situation and able to achieve the operator’s goals’ (Riedel et al., 2011, p. 270), reflecting the way system operates. The more understandable the algorithms are, the higher the trust tends to be (Riedel et al., 2011).

- **Purpose**, showing the level to which the system is used within the scope of the intent of the designer. It is very often related to the clarity of communication of the designer’s intent towards the user (Riedel et al., 2011).

A slightly different approach for an evaluation of computer models was proposed by Joldersma and Roelofs (2004). The authors proposed in their research that the impact of ‘soft operations research’ methods on problem structuring can be measured in the following four topics:

1. experiences with the method;
2. the attractiveness of the method;
3. participant’s observations on the effectiveness of the method;
4. observer’s perceptions of the effectiveness of the method (conducted at an individual level)

Experience is directly related to the participation and involvement, mentioned by Riedel et al. (2011) and allows evaluation of users’ own perception of the use of the system and interaction.
Attractiveness and participant’s perception of the effectiveness of the method are closely related and expresses the ‘liking’ of the method. Attractiveness measures if the users feel comfortable with the use of the system, and can be linked to the perceived control and model acceptance (mentioned by Riedel et al., 2011). If the system is perceived as attractive, it is very likely that it will be used again, which reflect also the trust placed into it. With the evaluation of this topic, performance, process and purpose should be addressed. When talking about the user’s perception of effectiveness contribution of the method to the outcomes (Joldersma and Roelofs, 2004, p. 698).

Observed measurements of effectiveness relate to the amount and quality of the ideas produced in a defined period of time, changes in participant’s attitude and improved probability of acceptance of the results (Volkema, 1983 as cited in Joldersma and Roelofs, 2004, p. 698). In Table 3.7, variables of each topic are listed (based on Joldersma and Roelofs, 2004, p. 698).

*Table 3.7 Interview variables (based on Joldersma and Roelofs, 2004, p. 698).*

<table>
<thead>
<tr>
<th>EXPERIENCES</th>
<th>ATTRACTION</th>
<th>OBSERVATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Ownership</td>
<td>• The likelihood of acceptance of the results</td>
<td>• Quality of ideas in certain time</td>
</tr>
<tr>
<td>• Acceptability of the model</td>
<td></td>
<td>• Quantity of ideas</td>
</tr>
<tr>
<td>• The facilitated speed of work</td>
<td></td>
<td>• Improved ownership</td>
</tr>
<tr>
<td>• Facilitated communication between people</td>
<td></td>
<td>• Likelihood of acceptance of the results</td>
</tr>
<tr>
<td>• Provision of a structure for managing interventions</td>
<td></td>
<td>• The attitude of the participants</td>
</tr>
<tr>
<td>• Supported steering of the thinking process</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Greater understanding of other people’s views and perspectives</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Satisfaction with several components:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>o visible results</td>
<td></td>
<td></td>
</tr>
<tr>
<td>o facilitation of results</td>
<td></td>
<td></td>
</tr>
<tr>
<td>o technical procedures</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.5.7 Conclusions

The expert system is a computer programme dealing with and working on the bases of knowledge of some specialist subject. It has an ability to solve problems or provide advice, also known as “knowledge-based-system” or “rule-based-system” (Jackson 1999; Curry and Moutinho, 1991). The expert systems can make a DSS a more flexible and powerful aid by simplifying the use of such decision support systems. The ES allows can help in monitoring a decision process, analysis of the content, and direct the stakeholders to the desired goal (Aiken et.al., 1991).

The expert systems elements can be gathered in ES tool (shell), improving the productivity, preparing the knowledge base for the processes and concentrate on gathering and structuring the knowledge rather than programming the system (Lukasheh et al, 2001).

The use of expert tool bases on a human-computer interaction. In order to evaluate the computer programme, several aspects have to be addressed. The system acceptance, trust and satisfaction need to be achieved in order to use the tool with certainty and accept its results. Table 3.8. presents a combination of researches done by Joldersma and Roelofs (2004) and Riedel et al. (2011) that were analysed in this chapter. Only the elements applicable to the expert tool are addressed. The four elements: system acceptance, trust in system, effectiveness and attractiveness are linked to each other. In addition, the table indicates whether the tool itself (model) or its outcome is evaluated.
User participation and involvement is crucial in gaining the acceptance of the system and influences the overall experience. This characteristic relates to the tool itself. Perceived control and complexity affect also the attractiveness and system acceptance. The higher the complexity, the less comfortable the user might feel when using the tool. On the other hand, if there are more involvement and participation might improve the tool by adding more variables and increase complexity. In addition, the perceived usefulness and ease of use (relating back to the complexity) impact the system acceptance.

Trust in the system is assessed by addressing both the system usage, the characteristics of both the model and the user. By looking at the feeling of being familiar with backside of the system (addressed through the experience), the performance reliability (if the user goals were achieved), the model purpose (aligning with the intended goals) and justification of outcome (understanding of how the outcome was derived), one can assess the level of trust. The trust is applicable both to the tool (model) and its outcome. This judgement, however, can be influenced by the abilities of the user an understanding of the model is crucial.

The Table 3.8. is used for the evaluation of the developed expert tool with the case study (see Chapter 6.1. and Appendix B)

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<table>
<thead>
<tr>
<th>Lp.</th>
<th>Characteristic (Riedel et al., 2011)</th>
<th>Evaluation category (Joeldersma and Roelofs, 2004)</th>
<th>Resulting effect (Riedel et al., 2011)</th>
<th>Concerning the Tool (T)/ Output (O)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Participation and involvement of users</td>
<td>Experience (Ownership, Facilitated communication between people, Greater understanding of other people's views and perspectives)</td>
<td>System acceptance</td>
<td>T</td>
</tr>
<tr>
<td>2</td>
<td>Perceived control</td>
<td>Attractiveness (Acceptability of the model, Attitude of the participants)</td>
<td>System acceptance</td>
<td>T/O</td>
</tr>
<tr>
<td>3</td>
<td>Familiarise with the backside of the system</td>
<td>Experience (Provision of a structure for managing interventions, Supported steering of the thinking process, Satisfaction with components)</td>
<td>Trust in the system</td>
<td>T/O</td>
</tr>
<tr>
<td>4</td>
<td>Complexity</td>
<td>Attractiveness (Feeling comfortable about using.)</td>
<td>System acceptance</td>
<td>T</td>
</tr>
<tr>
<td>5</td>
<td>Perceived usefulness</td>
<td>Attractiveness (Quality of the problem solving, Willingness to use again)</td>
<td>System acceptance</td>
<td>T/O</td>
</tr>
<tr>
<td>6</td>
<td>Purpose</td>
<td>Attractiveness (Satisfaction, Willingness to use again, Impact of intervention, Acceptance of the results)</td>
<td>Trust in the system</td>
<td>O</td>
</tr>
<tr>
<td>7</td>
<td>Perceived ease of use</td>
<td>Attractiveness (Liking, Feeling comfortable about using )</td>
<td>System acceptance</td>
<td>T</td>
</tr>
<tr>
<td>8</td>
<td>Performance reliability</td>
<td>Effectiveness (Facilitated speed of work, Supported steering of the thinking process, Number of ideas, Quality and quantity of ideas in a certain time)</td>
<td>Trust in the system</td>
<td>O</td>
</tr>
<tr>
<td>9</td>
<td>Justification of outcome</td>
<td>Attractiveness</td>
<td>Effectiveness</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>--------------------------</td>
<td>----------------</td>
<td>--------------</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Confidence in performing a task, Impact of intervention)</td>
<td>(Supported steering of the thinking process, Greater understanding of other people’s views and perspectives, Number of ideas)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trust in the system</td>
<td>O</td>
<td></td>
</tr>
</tbody>
</table>
4 PROVIDING THE ANSWER TO THE PROBLEM: RESEARCH OUTCOME
In developing the tool, the framework developed by Preece (1990) and discussed in the sub-chapter 3.5.5. is used. Figure 4.1. presents how each step included in the framework was approached in this research. Firstly, the prototype was developed in the form of the Tool 1.0. The development was based on an extensive literature research, own learning on programming, building and coding the tool in the Excel Visual Basics for Applications. Subsequently, the tool was tested and adapted using trial and errors in order to ensure its proper functioning and readiness for testing. In the third step, the tool was tested twice with a pilot study (version Tool 1.0 and Tool 2.0). The fourth step, field testing, was done only after the results from tests at the company were obtained, mistakes corrected and suggestions for improvement applied. The fifth step of the framework goes beyond the scope of this research. In the following chapter, all the steps are described and discussed in details.

Figure 4.1 Framework for the development of the location decision-making expert tool (own illustration, based on Preece, 1990).
4.1 STEP 1 AND STEP 2: BUILDING THE TOOL

With this part, a reference to the previously explained types of rationalities in decision making can be found. In particular, the substantive and procedural rationality can be found. The first one is delivered by providing a theoretical backbone for the tool and relating to them with computations, which in the end should lead the user to choose an (optimal and satisfactory) alternative basing on derived criteria. The second type of rationality is given by providing the tool with a framework consisting of several steps that need to be taken to get to the final output. The structural rationality is ensured by dividing the steps between the users and allowing several decision makers to insert their input.

![Figure 4.2 Framework for the development of the location decision-making expert tool. Steps 1 and 2 (own illustration, based on Preece (1990)).](image)

4.1.1 Establishing the basis

To solve the managerial problem, the system thinking can be used. Systems thinking is an approach to problem-solving, that is composed of various related (directly or indirectly) parts. A model can be defined as ‘an abstraction of reality or a representation of a real object or situation’ (TU Delft, 2017a). There are many different types of models. The mathematical models represent one type of model group, among which we can find descriptive, optimization, deterministic, probabilistic and others (TU Delft, 2017a). As mentioned before, the practical application of decision theory is called decision analysis and aims at finding tools, methodologies and software to help people, or groups of people, make better choices (Barendse et. al., 2012). This is where my research is placed.

In order to use the mathematical modelling of measurement, the empirical system (with a set of empirical objects together with operations) has to be reflected in a mathematical model with a help of proper scale. This enables the application of mathematical operations (Barendse et. al., 2012).

Barzilai (2004, 2005) developed a new theory of (preference) measurement, with the construction of ‘measurement scales to which linear algebra and calculus are applicable’ (Barzilai 2004, 2005, in Binnekamp, 2010, p.51). The theory was followed by the development of a practical methodology for constructing proper preference scales (Preference Function Modelling, PFM), and a software tool- Tetra SDM (Single Decision Maker) and Tetra GDM (Group Decision Making) (Barzilai 2004, 2005, in Binnekamp, 2010).

In order to use the Tetra for decision making, the listed seven steps have to be followed (information taken from the tool description):

1. Creation of a model.
2. Defining the decision makers who will be involved in the process (Tetra Group Decision Making version only).
3. Defining the alternatives to be considered in making the decision.
4. Defining the criteria upon which the decision will be based. These criteria may be defined in a tree-like structure, using main criteria, sub-criteria, sub-sub-criteria and so on.
5. Defining the weights for all the criteria. These are defined relatively, specifying how important each criterion is in relation to others. The weights are defined in each node of the criteria tree.
6. In Tetra Group Decision Making version decision-maker weights must also be defined.
7. The decision makers enter their ratings for each alternative with respect to each criterion.
8. Solve the model that has been created by the previous steps to compute the overall scores and get a numerical rating of the alternatives that corresponds to the combined ratings of all of the decision makers.

The steps include defining the design criteria, variables, attributes. These variables are supposed to express each decision-makers’ interests in the design. It is possible to represent the most suitable design alternative, by optimizing a combination of variables. In such situation constraints, goals, and objectives are used in the optimization process.

Following the definitions established by Zeleny (1982, pp. 225-226; in Binnekamp, 2010), the following is information is used:

- **a constraint** is ‘a fixed requirement which cannot be violated in a given problem formulation’. It helps with the classification of available solutions as feasible or infeasible.
- **a goal** is ‘a fixed requirement which is to be satisfied as closely as possible in a given problem formulation.’
- **an objective** is ‘a requirement which is to be followed to the greatest extent possible (either by minimization or maximization)’ given the problem’s constraints.

The tool, which is developed with this thesis, helps with defining the design variables, constraints and objectives in order to achieve the goal, aspiration or reference level for the decision makers. In addition, the tool allows assigning the weight to the criteria.

### 4.1.2 Mathematical background

In this paragraph elements of the problem are translated into a mathematical structure. The aim of the mathematical structure is to find the solution to the issue at hand, providing the relevant outcome. The underlying structure of OR models can be expressed as (Ackoff and Sasieni, 1968 p. 9; in Barendse et. al., 2012).

\[ U = f(X_i, Y_j) \]

Where:
- \( U \) is the utility or value of the system’s performance
- \( X_i \) are the variables that can be controlled
- \( Y_j \) are the variables (and constants) that are not controlled but do affect \( U \)
- \( f \) is the relationship between \( U \) and \( X_i \) and \( Y_j \)

The formula used above, suggests that a decision-making problem depends on two variables: the elements determined freely by the decision maker (Xi) and ones that he has no power to define (Yj). The second type of variables Yj is given and come from ‘outside’. According to Binnekamp (to be published a), this formula can be transformed to a function where the utility or value of the system’s performance depends on decision variables (Di), result (output) variables (Rk) and the fixed (input) variables (Fj).

\[ U = f(D_i, R_k, F_j) \]

In a decision-making problem, the identification of the fixed variables (the uncontrolled variables) and the freely determinable variables (the decision variables) is related and dependent on the context of the problem. This includes amongst others the determination of actors’ roles and positions.

The decision variables, defined by the decision makers, are understood as criteria or factors. They represent the output that is derived from the stakeholders in the location decision making. Therefore, the focus of the tool is placed on the freely determinable variables and enriched by definition of actors’ roles and positions.
4.1.3 **Formulating the tool framework**

The tool is created with the help of Excel VBA (Visual Basics for Application), the programming language of Excel and other Office programs. Its’ structure is based on the categorisation of location criteria identified in the literature. The most relevant criteria for the decision makers are identified by assigning the relative importance as weights reflecting on the following three layers:

1. The prevailing **REASONS** behind the location making;
2. The main **OBJECTIVES** to be achieved with the location;
3. The criteria **THEMES** of the main focus

The established three layers are the result of the literature study. The empirical part of the research, described in the Chapter 3.2., helped in identifying the links between those issues and all the criteria that are crucial in the location decision-making process.

4.1.4 **The background structure: criteria determination**

This part of the report presents the way in which the final result of the tool is being determined. Following the links identified between the determinants on three levels (the company characteristics, (re)location reasons, and objectives) and criteria listed, simple operations are performed on the numbers given by the stakeholders.

Firstly, with the characteristics of the company and the (re)location type, the criteria are preliminary filtered. This done by looking at:

- the type of relocation (new facility or relocation),
- scale of the operation (intra-regional, inter-regional/national, or international)
- possible time constraints (fixed end date/ no time pressure)

As explained in the literature analysis, the characteristics are linked to certain criteria. If, for example, the (re)location is happening at a regional level, a criterion that is relevant only on a national scale but not on a regional or neighbourhood level will be ignored (like for example the country’s ‘political stability’ or ‘strength of currency’). The elimination of the criteria is done by assigning a negative number of -100 points, which results in placing the criterion on the bottom of the list after sorting them by the points assigned. Similarly, if a new facility is being established (not a relocation procedure), criteria like ‘retention of talent’ will be filtered out. At the same time, if the decision makers indicate that a fast relocation is needed, criteria facilitating speeding up the process will be awarded more points and listed higher in the end. The characteristics of (re) location serve more as a ground for exclusion of irrelevant criteria.

**Explanation of computations done by the tool:**

The general prevailing rule is that once the link between criteria and determinants (reasons behind the (re)location and objective) exists, the weight assigned by the user of the tool is multiplied by one. If the link does not exist, the weight is multiplied by 0, which results in no points being assigned to the criterion

- **Tool 1.0.**

Apart from the general rule, with the first version of the tool, the decision maker had an opportunity to indicate which criteria themes are most relevant for him and assign the weights according to his own focus. This score determinant was treated as the most relevant. All the criteria, which were classified with the literature review under this theme, were awarded points resulting from multiplying the weight assigned to the criterion by five (the number derived after trial and error approach). If no particular link was assigned to the criterion no points were being assigned.

Example 4.1 illustrates how the points are awarded to the two criteria chosen as examples: ‘Proximity to public transport’ and ‘Business climate’.
Example 4.1:
The following weights assigned by the stakeholder are presented below:

- Reasons
  - Strategic asset seeking: 30
  - Resource seeking: 0
  - Efficiency-seeking: 20
  - Market-seeking: 0
  - Growth: 0
  - Decrease: 20
  - Unhappy with current asset: 0
  - Cost reduction: 10
  - Merger/ Acquisition/ Takeover: 0

- Objectives:
  - Minimizing the number of located facilities: 10
  - Minimizing average time/ distance travelled
    - Client focus: 0
    - Employee focus: 0
  - Increase employee satisfaction
    - Attracting new talents: 10
    - Retaining talents: 5
    - Promote HR objectives: 5
  - Maximizing service
    - Increasing flexibility: 10
    - Promote marketing message: 5
    - Promote sales and selling: 0
    - Facilitate and control production, operations, service delivery: 10
    - Facilitate knowledge work: 5
    - Capture real estate value creation of the business: 10
  - Minimizing cost
    - Minimizing fixed cost: 5
    - Minimizing variable costs: 5
    - Minimizing the total setup cost: 10
  - Minimizing the longest distance from the existing facilities: 10

- Themes
  - Costs: 5
  - Labour characteristics: 0
  - Infrastructure: 30
  - Proximity to suppliers: 5
  - Characteristics of markets/customers: 0
  - Proximity to parent company’s facilities: 5
  - Proximity to competition: 0
  - Quality of life: 15
  - The legal and regulatory framework: 0
  - Economic factors: 5
  - Government and political factors: 0
  - Social and cultural factors: 5
  - Characteristics of a specific location: 20
  - Company-specific (spatial) needs: 10

Figure 4.3. presents the identified links and background for computations coded in the tool.

The scores for the shown example and mentioned criteria (‘Proximity to public transport’ and ‘Business climate’) would be were calculated by the tool as follows:

- Proximity to public transport:

  **Total score**: \((scores \ from \ reasons)+(scores \ from \ objectives)+(scores \ from \ themes)=
  (30x1+0x0+20x1+0x1+0x0+20x0+0x1+10x0+0x0)+(10x0+0x1+10x1+5x0+5x1+5x1+10x0+5x0+0x0+10x1+5x0+10x0+5x0+10x0+10x0)+(5x0+0x0+30x5+0x0+5x0+5x0+0x0+15x0+0x0+5x0+0x0+5x0+20x0+10x0)= 245\)
- Business climate (excluded in intra-regional re-location):

  **Total score:** \((\text{scores from reasons})+(\text{scores from objectives})+(\text{scores from themes})=\)

  \((30x1+0x1+20x1+0x1+0x1+20x0+0x1+10x1+0x0)+(10x0+0x1+0x0+10x1+5x1+10x1+5x0+0x0+10x1+5x0+10x0+5x0+10x0+10x0)+(5x0+0x0+30x0+0x0+5x0+5x0+0x0+15x0+0x0+5x0+5x0+20x0+10x0)=125\)

- **Figure 4.3** A scheme of score assigning to criteria: ‘Proximity to public transport’ and ‘Business climate’.
In the end, the scores resulting from the multiplications were summed up and the criteria are sorted from highest score to the lowest, basing on the points gained. The first 20 criteria were displayed for the user. Next to the displayed 20 criteria, the weighted 'relevance score' was shown, calculated through the division of the gained score by the sum of the scores of 20 criteria (weight as a percentage value of 20 top scores). Although this computation might seem to be overcomplicated, in this way the decision maker gets a possibility to re-assign the weights (summing up to 100) for further use in a decision making process, possible with PAS or Tetra models.

Once the top 20 criteria from every stakeholder were gathered, their scores were combined. Again from the available pool of variables chosen by stakeholders, the 20 criteria with the highest scores were derived for the further process of choosing the location.

The final list was limited to 20 most important criteria in order not to overwhelm the decision makers with a lot of information at once. All the criteria with their assigned points were still accessible for the users, allowing them to extend or shorten the list. The limitation was posed also due to the fact that with each criterion, the amount of the information about the alternatives that need to be obtained is growing, increasing the costs of the market research that the company would have to cover.

- Tool 2.0 and Tool 3.0
The computations done in the second version of the tool worked in a very similar way. After the decision-maker assigns the weight to reason and objectives, he is directed to the window where he assigns weights to themes of focus. At this point, he has a possibility to access the list of the criteria classified under each of the themes. In this version, the program does not limit the list to 20 criteria by itself but allows the stakeholder to see all the criteria available in the tool. Nevertheless, all the criteria have suggested weights, distributed within the criterion. The weight is calculated in an analogical way, as explained above.

Following the data from the Example 4.1:

- Proximity to public transport:
  \[ \text{Total score:} \frac{(30 \times 1 + 0 \times 0 + 20 \times 1 + 0 \times 1 + 0 \times 0 + 20 \times 0 + 0 \times 1 + 10 \times 1 + 0 \times 0)}{(10 \times 0 + 0 \times 1 + 0 \times 1 + 10 \times 1 + 5 \times 1 + 5 \times 1 + 10 \times 0 + 5 \times 0 + 0 \times 0 + 10 \times 1 + 5 \times 0 + 10 \times 0 + 5 \times 0 + 10 \times 0 + 10 \times 1)} = 95 \]

- Business climate (excluded in intra-regional re-location):
  \[ \text{Total score:} \frac{(30 \times 1 + 0 \times 1 + 20 \times 1 + 0 \times 1 + 0 \times 1 + 20 \times 0 + 0 \times 1 + 10 \times 1 + 0 \times 0)}{(10 \times 0 + 0 \times 1 + 0 \times 0 + 10 \times 1 + 5 \times 1 + 5 \times 1 + 10 \times 1 + 5 \times 0 + 0 \times 0 + 10 \times 1 + 5 \times 0 + 10 \times 0 + 5 \times 0 + 10 \times 0 + 10 \times 0)} = 100 \]

This points would be then expressed as weights within the theme (gained score as a percentage of all scores gathered by criteria under one theme). The decision maker can reassign the weights to the criteria according to his own preferences.

Subsequently, the scores of criteria are calculated by multiplying the weights assigned within the category by the weight of that specific category. The multiplication of the category for the final version was by one instead of five (as in the first version), as in the tests it occurred that too much focus was given solely to the categories in the previous version. In the end, all the criteria are stored on the list and the final score represents the percentage of the all scores assigned. In this way, the scores and an organised list of criteria are established for each of the decision makers.

Going back to the example, if the ‘Infrastructure’ category would have had the weight of 20 assigned and the sum of all points assigned to the criteria would be 19650, the criterion ‘Proximity to public transport’ would get the final score of:

\[ \text{Final score:} \frac{(95 \times 20 \times 100)}{19650} = 9,67 \]

The final score calculations offered by the tool represent simple combining of the scores assigned to each of the criteria by all of the users and ordering them based on those scores. This is done by summing the multiplication of the weights assigned to each of the criteria by the weight of each stakeholder. The weights of decision makers are assigned to the tool users by the process manager. A detailed description of tool use can be found in the next chapter.
### 4.2 USING THE FINAL VERSION OF THE TOOL

The developed tool requires gathering the input from a number of stakeholders involved in the decision-making process. The model of the expert tool is able to gather input from up to 10 decision makers for one project. By assigning the weights based on the relative importance of the previously mentioned layers, the stakeholders are provided with a list of criteria suggested being taken into consideration. They are derived on the basis of their input and they might be omitted when using the traditional top-down or bottom-up approach.

When assigning the weights during the process, it is assumed that a higher value indicates a greater importance of the element. The use of weights does not represent trade-offs (Belton and Stewart, 2003, p. 234). Their interpretation should express in this situation a form of ‘voting power’ allocated to each criterion (Belton and Stewart, 2003, p. 234).

All the steps that need to be taken by the users are summarised in Figure 4.4. Below a detailed step-by-step description of the use of the tool is presented.

**Figure 4.4 A scheme of steps taken with the expert tool model.**

**STEP I**

The first thing the user can see is the ‘User Form’ sheet, a starting point (Figure 4.5.). This part of user interface provides access to all the elements of the tool. The decision maker can open the Tool Description window (Figure 4.6.) in order to get familiar with the steps he will have to follow in order to come up with the desired outcome. This part is available for or the users.

**Figure 4.5 The expert tool starting page.**

**Figure 4.6 The description of the tool.**
STEP II

After clicking the ‘Company characteristics’ button a new window appears (Figure 4.7.). The coordinator of the decision-making process is asked to fill in the information about the company. This information does not influence the outcome of the tool but allows gathering information that will be derived with the summary of the decision-making process at hand. Each of the appearing windows is equipped with a ‘READ ME’ button that opens a window with tips, instructions and explanations of more complicated issues (Figure 4.8.). This part was added after the second round of interviews when it was suggested by the interviewees that not all of the terminology used is clear for them.

**STEP III**

The same process coordinator should also fill in the information concerning the (re)location character (Figure 4.9.), appearing after clicking the third button on the starting page. The choices made at this level already have an influence on the final criteria list, filtering the criteria that are not relevant for the specific case (see more details in the section 4.1.1.). With this step, the scale of the undertaking is defined and linked to the relevant of (re)location variables (whether it is on (intra)regional, national or international level). In addition, the type is specified (establishing a new facility or relocation of the current asset), which is also influencing the order in the final criteria list. Similarly, the procedure works with time constraints. An indication of a number of facilities is added more for an informative reason, but not influencing the scores of criteria.
STEP IV

After the general information about the (re)location is filled in by the process coordinator, each of the involved decision makers can provide his input. The list of available decision-makers forms (Figure 4.10.) can be accessed from the starting page by clicking the ‘Decision-makers list’. If the square next to the button is white, it means that the form has not been filled in yet and can be used. To do that, one should click the corresponding button which opens the decision-makers forms.

**STEP IV.1**
The first step for the involved decision makers is to fill in the personal information. This will allow tracking back the origins of the defined criteria included in the process. Additionally, the information about the date of filling in or editing the input is generated automatically. All this information is also produced for reporting and documenting reasons (Figure 4.11.). The specific ‘Code’ is assigned to the stakeholder and visible on every window related to this specific user. With this code, also the interlinked spreadsheet used for calculations is named.

**STEP IV.2**
Subsequently, the user is asked to focus on the personally perceived reasoning behind the (re)location seeking. He has an option to assign weights to the reasons identified in the literature: Strategic asset seeking; Resource seeking; Efficiency seeking; Market seeking; Growth; Decrease; Unhappy with the current asset; Cost reduction; or Merger/ Acquisition/ Takeover. The distribution of weights is left to the decision maker but the sum of weights must be equal to 100. The user form can be seen in Figure 4.12.

**STEP IV.3**
The third step (Figure 4.13.) is very similar to the previous one, but this time the decision maker has to assign weights to the main objectives that he would like to strive for with the new asset. Similarly, the distribution of weights is left up to the decision maker and the sum of weights must be equal to 100. The objectives are based on the empirical research and listed as follows: ‘Minimizing the number of located facilities’; ‘Minimizing average time/ distance travelled’ (with ‘Client focus’ or ‘Employee focus’ in mind); ‘Increase employee satisfaction’ (by ‘Attracting new talents’, ‘Retaining talents’, or ‘Promoting HR objectives’); ‘Maximizing service’ (including ‘Increasing flexibility’, ‘Promoting marketing message’, ‘Promoting sales and selling’, ‘Facilitating and control production, operations, service delivery’, ‘Facilitating knowledge work’, or ‘Capturing the real estate value creation of the business’); ‘Minimizing cost’ (with ‘Minimizing fixed cost’, ‘Minimizing variable costs’, and ‘Minimizing the total setup cost’); or ‘Minimizing the longest distance from the existing facilities’.
STEP IV.4

Afterwards, the user has a possibility to assign the weights (on the similar terms like before) and indicate which criteria category he finds the most important from his own perspective. This step allows bringing focus to the criteria that the stakeholder might already have in mind (Figure 4.14.). There are fourteen ‘themes’ of criteria, listed as follows: Costs; Labour characteristics; Infrastructure; Proximity to suppliers; Characteristics of markets/customers; Proximity to parent company’s facilities; Proximity to competition; Quality of life; Legal and regulatory framework; Economic factors; Government and political factors; Social and cultural factors; Characteristics of a specific location; and Company-specific (spatial) needs. Here the user has also a chance to see what kind of criteria are classified under each category by clicking the button with sign ‘>’. This gives him the access to all of the criteria collected in the expert tool. It is important to note that if a weight of 0 is given to a category, all of the criteria listed in that group will be ignored, no matter how much weight is assigned to them within the category itself.

The factors on list appearing under each of the categories (Figure 4.15.) have a specific number assigned. This number suggests how crucial the criterion should be for the specific decision maker based on his input. The numbers reflect the weights assigned through the links identified with the literature research and provide an order to the list. The stakeholder can follow the suggestion or completely reassign the weights according to his opinion.
With each of the criterion, the user gets a chance to add more details and specifications, where suggestions of focus points from the literature are expressed. This is done by clicking on the ‘SPECIFY’ button, which gives an access to sub-criteria (a total of 166 sub-criteria are included in the program). In a newly opened window (Figure 4.16), one can express his needs and define design constraints that are applicable for the location decision making. He can either include or ignore the proposed sub-criteria. In addition, the tool is able to gather input for the preference statement. This input can be used for evaluation of existing alternatives of the design of the new location for the office. If the user is unable to provide more details at this point, or not using the Preference-based Accommodation Strategy nor is he familiar with it, it is possible to leave the specification part out.

**STEP IV.5**

As a result of the input from the decision maker, the program derives a list of criteria ordered according to the final weight reflecting the importance (Figure 4.17). The scores are a result of operations made on input, basing on the links between different levels and criteria that were connected to them (more information on the operations can be found in section 4.1.1). The list of first fifty criteria can be accessed immediately. The user can view his final list by clicking the ‘TOP 50 list’ button in his window. If he thinks that the list is not aligned with his demand he can still change the input and see how the list changes with his actions. When he is satisfied with the outcome, he can click ‘FINISH’ button. This concludes gathering the input from each of the decision makers.
STEP V
After all the involved decision makers filled in their forms, the process coordinator can distribute the weights between the stakeholders, specifying how important their demand is. It can be done in the window that appears after clicking on the ‘Decision-makers weights’ button at the main page of the tool, the user form (Figure 4.18.). This concludes inserting the information into the model of the expert tool.

STEP VI
The final list is created by combining all the information from all users and the decision-makers weights. A simple catalogue of criteria can be accessed with the ‘RESULTS’ button. If the user wants to access all the details, they can be found under the ‘RESULTS’ Excel spreadsheet.

THE TOOL OUTPUT
Once all the decision-makers provide their input and the criteria have the points assigned, all the scores are summed up basing on the decision-makers weights and their indications, and an overall list is created. It can be found under on the ‘RESULT’ sheet, where one can see the all of the criteria with scores, weights assigned by the tool, adjusted weights, related sub-criteria and all of the specification, constraints. Additionally, it is possible to view output for each decision makers individually, gathered in different Excel sheets.

The output of the tool reflects the structure and demands of the specific multicriteria decision–making process. The acquired output can be used in various ways. The most basic use would be to trigger the discussion with the derived criteria and follow the indicated factors in the decision-making process. This can bring more understanding, transparency and involvement from the stakeholders’ side to the undertaking. In addition, if the users fill in the specifications, the process coordinator can use them further with various decision supporting systems (like for example Tetra SDM that or PAS Matlab model developed by Hylke de Visser (de Visser, 2016)), which could be used to assess the available location alternative.
In the Figure 4.19, the Input-Throughput-Output model of the expert tool is presented. In order to make the toll work, the decision makers have to provide information on the location search characteristics, reasoning behind the location seeking, objectives, main focus themes and constraints and preferences. The tool links this data with proper criteria and combines the input from different stakeholders.

Implementing the theoretical knowledge to the professional world requires the development of a proper, user-friendly Graphical User Interface (GUI). The final version of the GUI was modelled in such a way to enable the stakeholders to use the expert tool intuitively. The goal was to make the state-of-art knowledge accessible for any kind of user, no matter which background he comes from.

The GUI allows deriving a list of relevant criteria for decision makers that could otherwise be a very time-consuming exercise. It brings to the decision makers a lot of information to consider in the process but also provides the insight into the relationship between needs and criteria that should be considered.

The model gives not only material for the assessment of alternatives but also gives an opportunity to add the preference statement for various factors, which might be even used for design purposes. Moreover, there is a possibility to analyse the input individually for each of the decision makers and see how aligned or disperse the stated needs are. This could also give an insight into how one understands the ongoing process of location decision making. Finally, one more of additional features is the possibility to add constraints to each of the criteria and express the desired level of detail by each of the stakeholders.
5 TESTING THE TOOL IN PRACTISE
In this chapter, the third step of the expert system life-cycle is conducted (see Figure 5.1.). The laboratory testing of the model is done with a pilot study. In order to check the possibility of implementation of the tool in practice, it was necessary to find a company that would be willing to facilitate the research. It had to grant an insight into the current practices used within the company and test the features of the model. The following chapter provides an introduction to the profile of company chosen for the pilot study, description of its current location decision making the approach and the ongoing real-life case, which was used with this pilot study. Additionally, a short breakdown of the decision process in comparison with the research process is given. By testing the model with a company, an attempt to bring the structural rationality principles into the decision-making process is made.

![Figure 5.1 The expert system life-cycle, emphasising evaluation needs. Own drawing based on Preece (1990).](image-url)
5.1 PILOT STUDY

TNT Express B.V. (TNT Express) was chosen for conducting the pilot study. It is an international courier delivery services company, which operates on the market for more than 70 years (founded in 1946) (TNT Holdings B.V., 2018a). It offers an international door-to-door network in more than 200 countries and regions all around the world and hires more than 58,000 employees in various countries (TNT Holdings B.V., 2018b). Its focus lies on international express transportation, small-package ground delivery and freight transportation (FedEx Corporation, 2018a).

In April 2015, FedEx announced its intention to acquire TNT Express for €4.4bn and the deal was completed on 25 May 2016 (FedEx Corporation, 2018a). The purchase was finalised near the end of 2016 and it was the largest acquisition in the history of the company (FedEx Corporation, 2018a). It was driven by expectations of significant benefits, by lower its cost in the European markets by increasing density in operations and speeding up the global growth (FedEx Corporation, 2018b).

The operating income of the TNT Express segment for the 2017 fiscal year (ended May 31) was 84 million (FedEx Corporation, 2018a). The headquarters of TNT Express (as a FedEx Express segment) are located Hoofddorp, Netherlands.

5.1.1 Case introduction

Following the acquisition deal, a long and complex integration process started, led by a multi-year TNT integration plan. The integration is expected to be completed by the end of 2020 (FedEx Corporation, 2018a). It spans over 200 countries and involves combining the operations, air and ground networks, and finance, back-office and secondary business systems. Each of these parts is affected at different levels. The integration decisions made at the corporate level strive to support the core business of FedEx Express and its TNT Express segment.

In order to ensure the optimal functionality and support for the core business, the company’s real estate portfolio (consisting of office, various warehouses and smaller sites) has to be optimised and rationalised. Both FedEx and TNT have a number of strategically located assets all around Europe. Because of the acquisition, the company faces a situation where it has a doubled amount of properties in the same locations.

Part of the integration plan covers the reorganisation of the office structures and asset location. Both FedEx Express and TNT Express have a number of regional head offices, which future is also addressed in those plans. Significant changes to the office real estate portfolio are required to lower the real estate footprint, costs and limit the number of occupied buildings. It is a very complex and delicate matter, which impacts a large number of employees. Due to this sensitivity and confidentiality of the issue, no detailed information will be disclosed in this report.

The goal of all the steps taken in the integration process is to act in such a way not to hamper the productivity of the employees or disturb the core business. In the end, the new strategy for the real estate should be facilitating operations of the main business. For this reason, the company decided to conduct a pilot study on one of the core European cities (which from now on will be referred to as a ‘Pilot City’). In
this pilot study a group of employees from various departments, working both in the ‘Pilot City’ and main headquarters, from both FedEx and TNT side, were brought together to come up with a proposal of integration strategy focused on the ‘Pilot City’.

The group of employees (which will be referred to as an ‘Integration Team’) included representatives with diverse background and driven by disperse mindsets and goals. They were asked to establish a common understanding of the problem and an input to the integrated plan of actions to be taken on both organisational and real estate level. It was agreed that once the organisational strategy is agreed upon, the real estate team will come up with the proposal for a new housing strategy. The crucial point was to bring up and state all the demands, coming from various sides and address them in the process. Although the decision concerning the (potential) new location of the office in the ‘Pilot City’ was understood as a secondary matter to the team members, it could not have been ignored. The real estate strategy was strictly related to the core business organisational strategy.

5.1.2 The implemented decision-making process

The process was initiated during a full-day workshop. It was organised to develop a cross-functional transition scenario for the Pilot City. An integrational team composed of representatives from 12 different departments, supported by people from the real estate team and engaged consultants, discussed various scenarios for the future. The integration team organised meetings, where people joined personally or through a phone call.

The crucial assignment for the real estate team was to present the mismatch in current supply and current demand, and current supply and future demand. The plan for future supply was needed. The real estate team provided a visualisation of the mismatches to bring full understanding and transparency. In addition, a timeline for leases expiry dates, commitments and available real estate options were discussed.

The integration team included stakeholders, who were directly impacted by any of the possible decisions that were to be taken. The important notion is that the employees involved in this process were not only the policymakers but also the end users of new asset.

The consultants were involved for several reasons: they assisted the team during the meeting to help in bringing the transparency and minimise the information inequalities; and they provided information from the market research (used to establish the location alternatives), according to the stated criteria.

Some of the most crucial objectives were named by the team members. However, it should be pointed out that they were stated by a small group, representing only part of the stakeholders. The listed objectives (to be supported by the location) were: maximising the retention of talent; minimising the costs; promote the integration objectives; maximise the service delivery and improve the profit; and rationalisation of the RE footprint (minimising the number of facilities).

During the meetings, it was visible that representatives from different departments were driven by different priorities. In addition, there was a significant disagreement when establishing common objectives and alignment of goals. The stakeholders noticed and pointed out the clash in the ‘soft’, ‘people’ approach presented by some of the team members and ‘business owners’ approach, driven by ‘hard numbers’. The need for transparency and clarity of decision drivers was brought up several times, making it essential to properly substantiate any proposal established. In addition, due to the character of the company, any of the decisions made for the Pilot City was about to have a collateral impact on other regions, increasing the pressure on choosing an optimal solution. In the end, three possible scenarios were defined as an outcome of series of meetings, later narrowed down to two. The real estate options were to be established for each of them.

The Real Estate team prepared a list of possible locations in the Pilot City, following the criteria stated by the stakeholders, enriched by the in-house experts and consultants. In the end, the list included:

- time constraints;
- rent levels, TOC;
- moving costs;
- relations within the company- intrafirm relationship;
- retention of the talent;
- legal regulations in the potential locations;
- amount of employees impacted by various scenarios;
- distance to the employee's homes;
- the capacity of buildings;
the flexibility of buildings;  
new office standards- aligned with the FedEx office standards;  
availability of talent;  
attracting new talent;  
turnover rates;  
branding possibilities.

Unfortunately, no full agreement on the location choice was reached by the integration team. The number of different needs made it hard for the stakeholders to reach alignment and accept one of the options. The initial engagement and transparency were slowly lost in the process.

The final recommendation developed by the RE team was presented to the policymakers in the company, who followed the presented reasoning and accepted the proposal. However, the option did not get the full support from the integration team due to the lack of common and thorough understanding of the problem. The final decision was made on the ‘higher level’, turning back to a traditional approach to the decision making.

5.1.3 Company decision process vs. the graduation process

The company provided access to the meetings, documents and stakeholders at a very early stage of the research. While still working on the literature research, I have been attending the team meetings and getting familiar with the case. When the tool was being built, the decision process was in an advanced stage. At the time when the model was ready to be tested, the meetings of the integration team were over. Despite the fact that the real estate department already had a conceptual strategy for consolidation opportunities in place (which was accepted at the end of April), the research was used for the evaluation of the decisions made. It was agreed that the tests can also check the potential of the tool for the future use in decision making for other cities.

It was understood that the tool can bring a ground for more detailed analysis of all alternatives that were taken into consideration. In addition, it was agreed by the Real Estate team that the tool can bring more focus to the elements that might have been omitted in the conducted selection of location. As a result, the tool was tested from March to May. Only four of the involved stakeholders tested the tool, due to the busy schedules and various work locations. However, two of the other employees, who were not a part of ‘integration team’, were willing to test it and support the research. A further and more detailed description of the criteria consideration can be found in Chapter 5.3.

5.1.4 Conclusion

When looking at the chosen location decision-making process, it can be concluded that the company dared to try out a new approach and empowered the employees (that are directly impacted by the decisions) to provide their input. This attempt was taken in order to ensure the employees that the sensitive matter is handled with the inclusion of all stakeholders’ representatives. However, it seemed that members of the integration team struggled with defining their needs and preferences in the process. This lead to the situation where the final decision did not satisfy all of the stakeholders, as the full transparency was not provided.

For the research purposes, all the physical data on the current buildings and the contract details were made available. In addition, an easy access to employee data and relevant information was granted where necessary, and some employees offered support to facilitate the research. The information, however, had to be excluded from the report as the mentioned processes are still not finalised and the disclosure can hamper them.
5.2 INTERVIEWS, EVALUATION AND IMPROVEMENT SESSIONS

In the following part of the report, a detailed description of the conducted tests of the tool and interviews can be found.

5.2.1 Approach

As explained in the introduction to the chapter, with the third step of the tool development, the testing of the tool with the chosen pilot study was done. The interviews were used in this research as a main instrument for the testing. They were conducted to improve the tool content and design. They were also helpful in providing the answer to the main research question. The outcome was used in an iterative manner to improve the developed prototype (from step 3 of the Figure 5.1, back to step 1). The interviews included two parts: the testing of the tool and short evaluation. During the interviews the following elements are addressed:

- Specifying the decision variable(s);
- Assigning the decision-makers relative weight to each variable;
- Determining the design constraints and specifications;

Those elements were adapted to the specific needs of the research, as the creation of the expert tool and its use are closely related to the first four steps of PAS. The full structure of PAS design approach (Arkesteijn et al., 2015) consists of the following steps:

1. Each decision maker specifies the decision variable(s) he/she is interested in;
2. Each decision maker rates his/her preferences for each decision variable as follows:
   a. The decision maker establishes (synthetic) reference alternatives which define two points on a Lagrange curve:
      i. A “bottom” reference alternative is defined, which is the alternative associated with the value for the decision variable that is least preferred, rated at 0. This defines the first point of the curve (x0, y0);
      ii. A “top” reference alternative is defined, which is the alternative associated with the value for the decision variable that is most preferred, rated at 100. This defines the second point of the curve (x1, y1);
   b. The decision maker rates the preference for an alternative associated with an intermediate decision variable value relative to the “bottom” and “top” reference alternatives. This defines the third point of the curve (x2, y2);
3. Each decision maker assigns weights to his/her decision variable. The subject owner assigns weights to each decision maker;
4. Each decision maker determines the design constraints he/she is interested in;

The two remaining steps were not addressed:

5. The decision makers generate design alternatives group wise and use the design constraints to test the feasibility of the design alternatives. The objective is to try to maximise the overall preference score by finding a design alternative with a higher overall preference score than in the current situation; and
6. The decision makers select the design alternative with the highest overall preference score from the set of generated design alternatives.

Thanks to the tool, instead of specifying the list of variables, using a very often limited or based knowledge, the user is provided with a tailored list, organised accordingly to the perceived relevance. Since the tool itself is related to four steps of PAS, the gathered input from interviews can help in answering the sub-question of integration of the tool with the decision supporting systems, with the example of PAS approach.

The Table 5.1. presents the framework used for the tool testing. The framework is based on the flowchart developed by Arkesteijn et al. (2017, p. 248) for the PAS. Although the original flowchart referred to the PAS approach, it was used to present the chosen tool development framework, as it shows the relationship between the stakeholders, steps taken in the tool, activities and the model building in a very clear way.
Table 5.1 The framework used for the tool testin (based on Arkestein et. al. 2017, p.248).

<table>
<thead>
<tr>
<th>Activity</th>
<th>Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steps in the tool</td>
<td></td>
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<tr>
<td>Defining the firm characteristics</td>
<td></td>
</tr>
<tr>
<td>Defining the (re)location</td>
<td></td>
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<tr>
<td>Defining the decision maker</td>
<td></td>
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<tr>
<td>Reason for (re)location objective</td>
<td></td>
</tr>
<tr>
<td>Criterion themes</td>
<td></td>
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<tr>
<td>Criterion list</td>
<td></td>
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<tr>
<td>Enriching the criteria pool</td>
<td></td>
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<tr>
<td>Tool building</td>
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<tr>
<td>Theory background</td>
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<tr>
<td>Literature research</td>
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<tr>
<td>Internship observation</td>
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<td>STEP 1, STEP 2</td>
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<tr>
<td>Theoretical background</td>
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<tr>
<td>STEP 3</td>
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<td>Interview 1</td>
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<td>Tool assessment 1</td>
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<td>Interview 2</td>
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<td>Assessment 2</td>
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<td>S 2</td>
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<tr>
<td>Interview 3</td>
<td></td>
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<tr>
<td>Assessment 3</td>
<td></td>
</tr>
</tbody>
</table>

As can be seen in the table, the three versions of the tool are planned to be tested:
- Tool 1.0. was the first approach to the tool and tested within the TNT
- Tool 2.0. an improved version after first TNT test tested again at TNT
- Tool 3.0. an improved version after the second TNT test

In the first round of interviews, each stakeholder was able to define decision variables (criteria), their value and constraints (if needed, depending on the type of the criterion). The derived decision variables were addressed in the process of decision making. Moreover, the weights perceived by the stakeholder were assigned to each variable. The gathered input was compared with the data used in the decision-making process conducted with the pilot study.

In the second round of interviews, the stakeholders were presented shortly with the outcome of the first interviews and implemented changes. Subsequently, some of them (those that took part in the first round of interviews) were asked to validate and redefine (if needed) their criteria again using an improved, second version of the tool. Stakeholders that have not used the tool before provided a new input in the tool. Again the outcome was compared with the outcome of the first test and the initial information from the case study.

Finally, in the third round of interviews at TNT stakeholders got the opportunity to see the outcome of the first and second interview. They were asked to assess the tool.

As mentioned, during the interviews the stakeholders were asked to evaluate the tool with regard to: their experiences of working with the model, the attractiveness of the method used, perception of the
effectiveness of the tool (Joldersma and Roelofs 2004, pp. 697-698), acceptance and trust in the system (Riedel et al., 2011).

Interviews were conducted individually with each of the decision makers. The stakeholders were free to modify their decision variables, constraints and weights in all the stages. The decision makers were asked to reflect on the outcomes of their work after seeing the results of the assessment.

**5.2.2 Testing the tool 1.0.**

![Diagram of the expert system life-cycle](image)

*Figure 5.3 The expert system life-cycle, emphasising evaluation needs. Own drawing based on Preece (1990).*

In the first quarter of the academic year, I took part in the ‘Operations research methods’ course (AR3R058 at TU Delft), where I had an opportunity to make the first attempt to determine how the tool might look like in the end and how it could be built. The work was carried out with the help of three programmes: Microsoft Visio, which was used at a preliminary stage to create the structures from the literature and visualise links described in the Sub-chapter 4.1 (allowing further analysis); Microsoft Excel, where the identified interdependencies between determinants and criteria were transformed into tables and formulas also described in the Sub-chapter 4.1; and Excel Microsoft VBA, which was used to create a user-friendly Graphical User Interface (GUI).

The first version of the model was ready to be tested at the beginning of March. The tool structure was established allowing the calculations. The user interface was in a draft version, still lacking several features like, for example, explanation windows and there was lacking uniformity between the windows, impacting its visual appeal. It was, however, possible to work with the tool in order to determine next development steps basing on the stakeholders’ input. All of the interviews and assessment sessions were recorded to allow further use of the received feedback.

The first version of the tool differed from the final one, which is described in Chapter 4.2. Figure 5.4. presents the steps that need to be taken in the first version. As can be seen in the figure, up until the step 6, all the tasks assigned to the stakeholder are the same as in the final version. However, with the Tool 1.0., the stakeholder was not given an access to the entire pool of the criteria. Unlike in the Tool 2.0., when specifying the theme of focus, the decision maker could not see which criteria will be given points. Basing on the input from steps 1 to 6, the tool was assigning weighted points to the criteria pool and displaying a list of 20 top ranked criteria to the user. At this point the decision maker could indicate which criteria from the displayed list he wants to ignore, replacing them with next best scoring criteria. Subsequently, a possibility to specify the constraints and express the needs for the chosen list of the top 20 criteria was given. The user also got a possibility to redistribute the weights between the criteria.
Interview 1

For the first test, the request to take part in the interview was sent to the entire integration team. Because of being located in various cities and busy schedules, people were reluctant to participate. In the end, four stakeholders from different departments agreed to provide their input. All of the decision makers involved in this interview were part of the integration team set up for the Pilot City pilot case. Each of them came from a different department, had various backgrounds and priorities.

The group included:
- Decision Maker 1 (DM1): a person from the Real Estate team
- Decision Maker 2 (DM2): a lead of the integration team
- Decision Maker 3 (DM3): a person from Internal Communications
- Decision Maker 4 (DM4): a person from the Legal department

The interviews were conducted during an individual face-to-face meeting organised in the company headquarters. Each of them took around 30 minutes. The information about the company characteristics and the location characteristics were put into the tool before the meeting. It was filled in by me, acting as the coordinator of the process. All of the stakeholders were given the same weight.

Prior to the interviews, the stakeholders were introduced to research objectives and the relevance of the input they provide, since the interviewee needed to understand what the purpose of the project is and what his role was. After that, the interview started. In the first attempt, a short explanation of the tasks of decision makers was given. They were introduced to the tool on a computer screen, guided through each step of the tool, working with the help of the process coordinator. The observation of the interaction took place. A heuristic approach to the interview was used, to expand people’s thinking and improve understanding (Joldersma and Roelofs, 2004).

The decision makers were aware that the tool is supposed to empower them in the decision-making process. To achieve that, the interviewees were asked to provide the input from their personal point of view, not trying to satisfy the general needs that they were introduced to during the team meetings. In addition, they could determine the values for the constraints and add specific annotation if they were able and felt the need to do so. When some of the terms or requests in the tool were not clear, the users could ask for clarification of the task.

There were two main objectives of the interviews. Firstly, the formal objective of the interviews was to use them to get input for the location decision-making process. This was done by collecting the outcome: the criteria. The second, empirical objective was to evaluate the expert tool in order to answer the main research question. This achieved by asking the interviewee what is his first impression of working with the tool and what would he expect from it.

<table>
<thead>
<tr>
<th>Formal Objective</th>
<th>Empirical Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specify decision criteria</td>
<td>Goal</td>
</tr>
<tr>
<td>Determine weights</td>
<td>First reactions</td>
</tr>
<tr>
<td>Determine design constraints</td>
<td>Expectations</td>
</tr>
</tbody>
</table>
During the interview three of the stakeholders followed the request and worked with own point of view. However, the representative from the DM3 made an attempt to cover the topic from all areas and ‘to satisfy everybody’. This approach was motivated by the position held within the company, as explained by the interviewee. The same person had most problems with understanding the terms used. He seemed a bit resistant in the beginning to work with the tool, preferring to state own criteria, rather than defining the weights of determinants. At the same time, he put the most focus to on every criterion that appeared as derivative of the tool, questioning the outcome and putting most effort to adjust the final list by ignoring a total of nine criteria and reassigning new weight distribution.

The rest of users were eager to work with the tool and discover its possibilities. The DM4 put a lot of focus into the distribution of weights between the determinants and ignored only two criteria from the derived ‘top 20’. At the same time, he significantly redistributed the final weights.

The DM1 was familiar with the topic of the location decisions and has a vast knowledge of the relevant criteria. He was the only one who decided to enter the specification section and define constraints and details of criteria. The other users claimed to have insufficient knowledge. The DM1 started assigning weights to determinants in a rushed way without much consideration. However, after a while of a more detailed, thought-through input was given in each level. He decided to ignore 7 criteria before the final top 20 was established, as he realised that a lot of crucial aspects appear to fill in the list.

The DM2 asked a lot of questions about the tool functions and the way it works in order to understand what he can expect as an output and build trust in the used system. All the information provided by this decision maker was thought-through from the very beginning and the long thinking process preceded final statements. The user mentioned several times that a personal opinion is being reflected, and not the ‘general needs’. Only three of the criteria from the final list were ignored, although the decision maker was not sure if all the relevant criteria are mentioned.

5.2.3 Building the tool 2.0.

Several things were pointed out during the first round of interviews that had to be improved in the tool. All of the interviewees indicated that the terminology used within the tool is not always clear for them, making the filling in the tool a challenge. For this reason, each of windows was equipped with a ‘READ ME’ button, which opens a window with explanations and instructions.

Additionally, after all of the users requested information of what is categorised after each of the criteria themes, the tool structure was changed. The access to the entire criteria pool was given to the user (as seen in Chapter 4.2). This decision was also aligned with the definition of the expert tool, which gives the insight into the available state-of-art knowledge.

Since the tool can gather detailed information from the stakeholders, and it is supposed to be linked with decision supportive models, a new feature was added - a possibility to express preferences with a preference score (0, 50 and 100). Apart from that, the user interface was improved, providing uniformity between the window and clarity in the display.

The final changes concerned the outcome. With the first round of interviews, the choice of a number of twenty criteria to display was questioned. For the second version of the tool, the list was enlarged to fifty, as it was noticed that the weights were never distributed between more than that. After filling in the input, the decision makers can see an overview of their outcome and still go back to the previous step to adjust the input if needed. This quick overview shows the fifty criteria with the highest weights.

5.2.4 Testing the tool 2.0.

After those improvements were incorporated in the expert tool, the second round of interviews was planned. The stakeholders were again asked to define their criteria using an improved, second version. The objectives of the interview remain the same as in the first round (see Table 5.3.).
For the second round of interviews, the same group that took part as in the first round was contacted. Unfortunately, the DM3 was unable to meet again due to a busy schedule. The DM1, DM2 and DM4 got involved again. In addition, a stakeholder that was not part of the integration team but is directly impacted by the final location decision was involved. The DM5, the local facility manager that is working in the Pilot City, agreed to work with the tool during his visit to the head office.

The time required for the second round of interviews was much shorter. The interviewees that worked with the tool before were able to fill it in around 20 minutes. For them, a short introduction to the applied changes was presented, after which they started working with the tool, again with guidance.

The decision makers could adjust the weights they assigned on each level. The DM4 decided to leave the distribution of the weights on each level as they were stated in the first interview. The DM2 made some small adjustments to the weights assigned to the reason for location seeking, as he wanted to add one of the reasons he did not include before. Similarly, small adjustments were put to objectives in order to include two more. Surprisingly the DM1, who has the highest level of expertise made very significant changes, completely shifting the focus points.

All the decision makers who tested the first version appreciated the possibility to see which criteria are hidden under each category. Despite this, only the DM1 redistributed the weights between the criteria themes after getting access to the criteria list.

After distributing the weights between the themes, the users adjusted them between the criteria within the themes they find relevant. At this point, they started realising the growing complexity of the task. Each of them did not give further specifications, pointing out that they are satisfied with the current level of detail for the criteria derivation. They agreed that further details can be given when the input from all of the stakeholders is gathered and the most important criteria are chosen. Nevertheless, the DM2 asked where he can put constraints and details as he was confused by the changes applied. The overview of the criteria choice done by the stakeholders can be found in Chapter 5.3. and Appendix D.

The DM5 needed 35 minutes to fill in the tool. He was provided with a longer introduction, as he was not familiar with the research or previous version of the tool. He was guided through the tool and put a lot of focus and consideration to each of the number stated. He did not open any ‘READ ME’ windows but preferred to ask questions to the process coordinator directly.

### 5.2.5 Building the tool 3.0.

After the second round of interviews, no major changes were applied. The most important feature was to program the tool, making it possible to gather the input from all the 10 decision makers available and combine it automatically, which wasn’t possible in the previous version. In addition, after some small adjustments to the program code were done, to better assist the decision makers in the process (like for example rounding the weights assigned preliminary to the tool).

Moreover, the tool was equipped with a presentation outlining the research problem and goal, to explain the tool origins. A thorough description of the scheme of steps to be taken and instructions was made available from the user form. With these adjustments, the final version of the tool was created.

### 5.2.6 Testing the tool 3.0.

The third version of the tool was ready to be tested outside the case study. Since the objective was to make the tool available for all kind of company employees and let them use the tool on their own, for this round, the employees who have not seen the tool before were contacted. Again, the interview objectives remained the same as in the previous two.
Table 5.4 Objectives and necessary information.

<table>
<thead>
<tr>
<th>Formal Objective</th>
<th>Empirical Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specify/ adjust the decision variable(s)</td>
<td>Attractiveness of the tool</td>
</tr>
<tr>
<td>Determine/ adjust weights</td>
<td>Perception of the usefulness of the method</td>
</tr>
<tr>
<td>Determine/ adjust design constraints</td>
<td>Experiences</td>
</tr>
</tbody>
</table>

In addition, one person that was not involved in the integration team provided his input (DM6).

No guidance was provided, only an introduction to the tool possibilities was given. The DM6 was given the tool and asked to interact with it. He started by reading the tool description and (after understanding his task and its relevance) he started feeding the program with information. The interview took 45 minutes as the user needed time to read and understand the instructions. There was no time pressure on the user.

The DM6 took significantly different approach than the previous interviewees and decided to get familiar with all of the available criteria, checking the final outcome and readjusting his input several times, in order to make sure that he is fully satisfied with it.
5.3 PILOT STUDY OBSERVATIONS AND CONCLUSIONS

This chapter of the report focuses on the description of conducting the first pilot study with the newly developed expert tool for location decision making. The main purpose of this process was to test the effectiveness of the tool.

The stakeholders that provided the input volunteered to take part in interviews. The four users (DM1, DM2, DM3, DM4) were part of the integration team for the Pilot City case. The DM5 is a person directly impacted by the decision made (working in the Pilot City), while the DM6 is an employee, who was not connected to the case study but tested the tool for its capabilities.

After each interview, the users were asked for an evaluation of the tool and its outcomes. The protocol from the evaluation can be found in the Appendix B. Chapter 6 presents the outcome of this assessment.

Table 5.5 The outcome gathered with the expert tool tests: scores assigned to criteria.

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<th>CRITERION NUMBER</th>
<th>Stated-in-house consultants</th>
<th>DM1</th>
<th>DM2</th>
<th>DM3</th>
<th>DM4</th>
<th>DM5 (Interview (I + II)</th>
<th>DM6</th>
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<td>I</td>
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The derived outcome from the pilot study can be presented in a form of a table, where all the mentioned criteria are displayed (see Table 5.5). Due to the confidential character of some of the information, a full display of input from stakeholders and the criteria list was shown only in the Appendix D with restricted access. The reason for gathering and analysing the collected outcome was to present it to the involved decision makers and test the expert tool outcome. The objectives of this task are presented in Table 5.6.

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</tr>
<tr>
<td>58</td>
<td>0.25</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>59</td>
<td>0.25</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>0.25</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>61</td>
<td>0.10</td>
<td>0.02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>62</td>
<td>1.44</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>63</td>
<td>8.00</td>
<td>1.30</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>64</td>
<td>8.00</td>
<td>1.30</td>
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<tr>
<td>65</td>
<td>1.10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>66</td>
<td>1.08</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>67</td>
<td>0.90</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>68</td>
<td>0.90</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 5.6 Objectives and necessary information.**

<table>
<thead>
<tr>
<th>Formal Objective</th>
<th>Empirical Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compare the list of criteria used in the conducted LDM with a list derived from with the help of the tool.</td>
<td></td>
</tr>
<tr>
<td>Test the expert tool outcome</td>
<td></td>
</tr>
</tbody>
</table>

As a result of interviews, a total of 68 different criteria were mentioned by the six stakeholders. In the first round stakeholders, 41 of them were named, the second round of interview enlarged the list to 62 (13 new were added and one of the previously mentioned was ignored). For the analysis of the pilot study, all the stakeholders were given the same weight.

When looking at the result obtained from the input provided by the users related to the Pilot Study, several conclusions can be drawn:

- First of all, the company has been working on the integration of the offices from the Pilot City for a couple of months, before the tool has been introduced to the team. A number of possible scenarios were considered before any specific criterion or requirements were named. When an integration team was discussing the possible options, the real estate representatives were trying to find the most feasible scenarios, slowly developing a list of criteria, responding to the needs stated by the decision makers. Just before the first testing of the tool, a list of 18 criteria was taken into consideration (the list can be found in the Table D.1. in Appendix D). While the tool was under development, the consultancy company was appointed to bring more expertise and detailed analysis to the process. They addressed again the criteria previously mentioned by the in-house team, specified them and added five more (as seen in Table 5.5.).

After the tool testing, it turned out that the criteria listed by the five decision makers (involved in the case) are highly overlapping with the ones named by the experts. Out of 23 criteria used in the
LDM process, only one of them was not named with the help of the tool.

The list that was created in the time span of several months was derived within a total of only 2.5h with the help of the tool. Additionally, the list was enriched and provided with weights to underpin the priorities. The fact that the used 22 criteria appear in the span of ‘top’ 31 criteria indicates that the outcome reflects the applied practice.

- There were significant differences in the stated reasons for the location seeking (Table 5.7.) While one of the stakeholders decided to limit the specification to only one reason, others considered five or even nine of them. There was much more alignment in the statement of objectives and the themes of focus. An interesting note can be stressed: the decision makers who were part of the integration team were quite uniform with their input, indicating the focus points for the process. Despite the fact that DM1, DM2 and DM4 clearly stated their focus, while DM3 (as mentioned before) adapted dissimilar approach, striving to ‘satisfy’ various stakeholders with his statement. Additionally, DM5 pointed out issues that were not taken into consideration by the team members, substantially enlarging the criteria list. His point of view was influenced by personal situation and different knowledge on the problem. Aside from considering the business-related aspects, he brought attention to the more soft side of the problem, social and site-specific themes.

<table>
<thead>
<tr>
<th>REASON</th>
<th>DM1</th>
<th>DM2</th>
<th>DM3</th>
<th>DM4</th>
<th>DM5</th>
<th>PILOT CITY</th>
<th>DM 6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>II</td>
<td>I</td>
<td>II</td>
<td>I</td>
<td>II</td>
<td></td>
</tr>
<tr>
<td>Merger/ Acquisition/ Takeover</td>
<td>20</td>
<td>50</td>
<td>25</td>
<td>25</td>
<td>100</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Efficiency seeking</td>
<td>10</td>
<td>25</td>
<td>10</td>
<td>25</td>
<td>40</td>
<td>40</td>
<td>30</td>
</tr>
<tr>
<td>Cost reduction</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>10</td>
<td>30</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Unhappy with current asset</td>
<td>30</td>
<td>25</td>
<td>25</td>
<td>10</td>
<td>10</td>
<td>2</td>
<td>7,40</td>
</tr>
<tr>
<td>Strategic asset seeking</td>
<td>10</td>
<td>25</td>
<td>15</td>
<td>10</td>
<td>2</td>
<td>5,00</td>
<td>10</td>
</tr>
<tr>
<td>Decrease</td>
<td>20</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>10</td>
<td>2,00</td>
<td>30</td>
</tr>
<tr>
<td>Resource seeking</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>0,00</td>
<td>5</td>
</tr>
<tr>
<td>Market seeking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10</td>
</tr>
</tbody>
</table>

**LEGEND:**
- Significantly changed input
- No changes to the input
- Overall weight : 10,0<
- Overall weight : 5,0-10,0
- Overall weight : 0-5,0
- Overall weight : 0

- For the three decision makers that took part in both rounds of tests, the outcome of the second test was significantly enriched and more satisfying for the users (see Table 5.8). It was also more aligned with the criteria used to make the decision. The stated weights were comparable between those users, but still covered a rich pool of criteria. This was caused by adjusting the calculations done by the tool (see Chapter 4.1) and allowing the users to actually see all the criteria gathered within the program and include all of the once they found relevant.

<table>
<thead>
<tr>
<th>REASON</th>
<th>TEST ROUND</th>
<th>DM1</th>
<th>DM2</th>
<th>DM3</th>
<th>DM4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I II</td>
<td>I</td>
<td>II</td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>NUMBER OF CRITERIA</td>
<td></td>
<td>20</td>
<td>26</td>
<td>20</td>
<td>29</td>
</tr>
</tbody>
</table>

There are significant divergences between the criteria derived for all of the three stakeholders. This situation is caused by the changes in the weights distribution between the determinants (see Table D.2, D.3 and D.4. in Appendix D) and providing an access to all of the available criteria. All of the three users were more satisfied with the outcome from the test of the second version of the tool.

- The information gathered from DM6, who was not involved in the Pilot Study substantially deviates from the input of rest of users. While working with the tool, he was not considering any specific case, but following his own knowledge, he filled in data as if he was to be affected by the possible relocation. The weight distribution among determinants was very detailed and among many topics.

-
This resulted in a long list of low weighted criteria. Such approach has less impact on the combined scores in comparison to a more focused attitude. However, if a number of stakeholders repeat this kind of behaviour, it might significantly enrich the thinking process of the decision group.

When looking at the report created from the tool outcome, the decision makers that were part of the integration team expressed satisfaction with the fact that the criteria, which were rated as the most relevant have been addressed in the process. At the same time, the real estate representative realised that input from DM5 suggests that there is a number of factors that were not taken into consideration. He agreed that a more diverse approach to the LDM process should have been taken, as he assumes that including more stakeholders directly affected by the decision would have had a meaningful impact. This could result in a different recommendation after a reassessment of alternatives.

During the interviews, the tool was tested for its functionality and possible use in practice. All of the stakeholders accepted the outcome. However, it was pointed out that including a more diverse group related to the Study Case would be profitable. Nevertheless, an important notion is that the outcome triggered a discussion on the effects of considering different variables, increased understanding of the real needs and caused questioning the decision rationale applied up to this point. The evaluation of the pilot study can be found in the next chapter.
6 PILOT STUDY EVALUATION:
UTILITY OF THE TOOL
The following chapter presents the evaluation process of the tool conducted with the pilot study. It brings an answer to the question whether the tool was evaluated positively if it brings added value to the office location decision-making processes and if it can be used in practice. Therefore with this chapter the research sub-question: How would such tool be perceived in practice? is answered.

The information was gathered individually from each user. The short questions about the experience were asked after each interaction and a full evaluation interview was conducted only after the testing of the second version of the tool. In general, the tool was received with a positive attitude as it provided an insight into the interests and needs of stakeholders. It made it possible to reconsider the current decision-making process and question the recommendation given for the location in the current decision-making process. It provided a ground for a discussion by bringing transparency and theoretical support into the highly emotional process. Such tool can improve the decision-making process and can lead to achieving a truly optimal solution.

Table 6.1 The evaluation checklist for computer systems based on de Visser, (2016; Joldersma and Roelofs, 2004; and Riedel et al., 2011)

<table>
<thead>
<tr>
<th>Lp.</th>
<th>Characteristic (Riedel et al., 2011)</th>
<th>Evaluation category (Joldersma and Roelofs, 2004)</th>
<th>Resulting effect (Riedel et al., 2011)</th>
<th>Concerning the Tool (T)/Output (O)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Participation and involvement of users</td>
<td>Experience (Ownership, Facilitated communication between people, Greater understanding of other people’s views and perspectives)</td>
<td>System acceptance</td>
<td>T</td>
</tr>
<tr>
<td>2</td>
<td>Perceived control</td>
<td>Attractiveness (Acceptability of the model, Attitude of the participants)</td>
<td>System acceptance</td>
<td>T/O</td>
</tr>
<tr>
<td>3</td>
<td>Familiarise with the backside of the system</td>
<td>Experience (Provision of a structure for managing interventions, Supported steering of the thinking process, Satisfaction with components)</td>
<td>Trust in the system</td>
<td>T/O</td>
</tr>
<tr>
<td>4</td>
<td>Complexity</td>
<td>Attractiveness (Feeling comfortable about using.)</td>
<td>System acceptance</td>
<td>T</td>
</tr>
<tr>
<td>5</td>
<td>Perceived usefulness</td>
<td>Attractiveness (Quality of the problem solving, Willingness to use again) Effectiveness (Facilitated speed of work, The contribution of the method to the outcomes, Likelihood of acceptance of the results)</td>
<td>System acceptance</td>
<td>T/O</td>
</tr>
<tr>
<td>6</td>
<td>Purpose</td>
<td>Attractiveness (Satisfaction, Willingness to use again, Impact of intervention, Acceptance of the results)</td>
<td>Trust in the system</td>
<td>O</td>
</tr>
<tr>
<td>7</td>
<td>Perceived ease of use</td>
<td>Attractiveness (Liking, Feeling comfortable about using )</td>
<td>System acceptance</td>
<td>T</td>
</tr>
<tr>
<td>8</td>
<td>Performance reliability</td>
<td>Effectiveness (Facilitated speed of work, Supported steering of the thinking process, Number of ideas, Quality and quantity of ideas in a certain time)</td>
<td>Trust in the system</td>
<td>O</td>
</tr>
<tr>
<td>9</td>
<td>Justification of outcome</td>
<td>Attractiveness (Confidence in performing a task, Impact of intervention) Effectiveness (Supported steering of the thinking process, Greater understanding of other people’s views and perspectives, Number of ideas)</td>
<td>Trust in the system</td>
<td>O</td>
</tr>
</tbody>
</table>
6.1 EVALUATING THE TOOL FRAMEWORK AND OUTCOME

In the chapter below, the evaluation of the tool is presented. It is structured by following several topics displayed in the Table 6.1. First the characteristic defined by Riedel et al. (2011) are addressed. Each of the listed characteristics will be addressed and linked to the evaluation elements and resulting effects. Secondly, the experience, attractiveness and effectiveness are discussed. In the end the acceptance and trust level towards the tool is presented.

The evaluation is based on the interviews with the users, who took part in test. The interview protocol can be found in Appendix B. There were five main questions that were covering all the evaluation aspects. Four of the questions were open ended and allowed the interviewees to elaborate on the topic. Additionally, a number of follow-up questions were prepared to ensure that all the relevant information is stated. The fifth question was formed to assess several characteristics through likelihood of the tool recommendation. The question was formed with the use of the Likert scale, as it was assumed that using the widely applied in various questionnaires approach will make a good starting point for further deliberation. Using this kind of ordinal scale is not a good way to measure the complex preferences, and indeed, although all the interviewees used the same number of ‘10’ to indicate that they would recommend, a further deliberation proved that it was not used correctly. For this reason, the summary of the tool evaluation to not refer to the ordinate scale, but it reflects on the explanations and follow-up discussions triggered by the fifth question.

6.1.1 Evaluation outcome

Generally, the users claimed to feel involved in the tool development. Moreover, they indicated getting a chance to be involved in the DM process by providing the information with the help of a tool. Due to the fact that their own perceptions and goals are taken into consideration, they were eager to accept the outcomes which reflect their ideas significantly better than before.

‘A big advantage of the tool is that you can work with people from various backgrounds and bring an understanding of the process for them’

When it comes to the perceived control the stakeholders were certainly content with the power they got over the input. They had a positive feeling about the possibility to moderate and adjust their input. They have seen and understood how their decisions impact the final criteria list. This was closely related to the level of involvement, as the more engaged decision makers (who decided to ‘play with the tool’) noticed and really understood how they can vary the output.

There was enough control over the input, giving a feeling of ownership over the outcome, as one of the interviewees stated:

‘I got enough control to properly express my needs’

However, it had also another side as two of the decision makers suggested that there might be even too much control given making it very manipulative and complexed.

Thanks to the given introduction to the tool and the written instructions and manuals included in the tool, the users claimed that they gained sufficient understanding of the backside of the model and its principles. It was however indicated several times that the presence of systems engineer and presentation provided by him is crucial to trust the model and its outcomes. Only in this way a real understanding of the system can be brought and ensure the provision of proper information. Interestingly, none of the interviewees asked about the detail explanation of calculations or operations performed by the tool. The users were willing to trust the tool even without that knowledge.

In terms of the complexity of the tool, the outcome of the evaluation varied among stakeholders. All of the users agreed that the level of complexity is high, relating to the complexity of location decision-making process. With the first version of the tool, some of the users doubted if the derived list presents really the most relevant criteria. The changes applied to the second tool version triggered with two-sided reaction. On one hand, the decision makers cherished getting the insight into the full range of criteria; on the other hand, they started to think that it might be too much information to handle.
'Proposing the support is for me connected with making thing easier to understand. With your tool you let the decision maker deep-dive in the problem. For me, this is not really making things easier. This might lead to missing the objective of "supporting". On the other hand, you provide a deeper understanding and help to underpin the needs and 'the gut feel'.

What is more, adding the possibility to state the preference values and the detailed specification was left out by the stakeholders, as they indicated that this level of detail is beyond their knowledge and scope.

The level of complexity increases the amount of time required for the interaction with the tool. As stated by the stakeholders, it would not be possible to involve all the relevant, highly ranked stakeholders as their schedules are very tight. Such people are unable to spend an hour or two to learn how to use the tool, understand the principles and have the time to provide the right information. Even including a manual, description would not be sufficient. In order to involve them, guidance from an expert is needed:

'Of course, it depends on the time available. In big companies everybody is busy and if you ask the manager to fill it in, he cannot sit with the tool for 2-3 hours. He just will not do it. But with the guidance, it would not take so long.'

When asked about the perceived usefulness, the stakeholders unanimously agreed that the tool is very useful. According to the interviewees, it has a potential to significantly improve the current decision-making process by mitigating the tension and clashes between people, and limit the number of emotional biases. In addition, as cited above, it can enrich the viewpoint of decision makers and give more structure to the entire LDM process, which usually is very chaotic.

DM1 and DM5 claimed that they would like to see the implementation of this tool within the company. They were even willing to adapt it to use in decision making for other projects, concerning not only the location problem. On the other hand, the DM2 and DM3 could not envision applying the tool within the company itself but would like to see it brought by the consulting companies.

'I can see it in a real estate company, consultant or advisor. They can have it in their offer, come to a corporate company and say to the client: we can help you underpin your priorities in location decision making, summarise it and derive a report with a recommendation on which decision should be made. That can be very helpful. If we look at having it in corporate companies- I am not so sure'

As a result of the introduction provided before each of the interviews, the stakeholders claimed to understand the underlying purpose of building and using the tool. They agreed that it certainly helps in reflecting the usually unstated needs of stakeholders, which leads to making better decisions and increases the overall understanding and satisfaction level among them.

The ease of use of the developed expert tool was another characteristic that divided the users. The general feedback was positive. However, in relation to the complexity of the tool, the interviewees indicated that the number of steps to be taken and the number of variables to look at might bring confusion to the users. Although they agreed that with the explanation windows, one is able to use the tool on his own, it is becoming too time-consuming. They expect that a user could get ‘bored’ and ‘give up’ before finishing providing the input. It was mentioned several times that while working with the support of a system engineer, the tool can be filled in much faster, as he (being an expert) can quickly guide the user through the steps and help when the user struggles with understanding what is asked from him, without reading a long explanation. Despite this comment, the interviewees pointed out that the longer you interact with the tool, the easier it gets. Thus a learning process is needed before leaving the decision maker can work with the tool on his own without hesitation.

'You have to get used to it. There are a lot of items to choose from and in order to give good input, you need a lot of time. But with the guidance, you can do it very quickly'

'When you start working with the tool it seems difficult, but the more you fill in, the easier it gets'

When it comes to the user interface for the input, it was found to be attractive and the process of using the tool (filling the data in) is rather easy.
The decision makers assessed the performance as reliable and satisfying. They were not sure what they should expect from the tool in the beginning, but they all agreed that it provided insight into the part of the problem that was not taken into consideration before. The outcome enriched their thinking and the derived personalised list of criteria brought satisfaction. Especially, the feeling of empowerment was what the stakeholders sought.

“You have the ability to express of what you find important and the tool incorporates it to this wider pool, where your idea, your voice is being heard. In a normal discussion, it would not be possible for everyone. It is empowering.”

The possibility to get an overview of how much weight is still to be distributed was also highly valued. Additionally, the windows with description were appreciated. The decision maker, who decided to look at or even fill in some of the constraints, were found of the possibility to add personalised comments and details. These elements increased the overall system acceptance.

The overall justification of the tool outcome was sufficient for the stakeholders. The ones that decided to vary their input, ‘play with it’ and see how the final list changes understood the way in which it is received better than the ones who decided to keep the outcome they derived in the beginning. The justification of outcome was however questioned one point. It was mentioned several times that with the current version of the tool, only a quick overview of the outcomes is possible, which might not be sufficient. In order to get a more detailed outcome, the reporting possibilities have to be improved. The currently available display of this information is not attractive according to the stakeholders. The report that was created separately, basing on the tool output, allowed comparison of the general outcome with the input provided by each of the stakeholders and was highly valued. Again, the importance of the system engineer that would prepare such report was pointed out to be crucial.

6.1.2 Experience, attractiveness and effectiveness

As introduced in Chapter 3.5, the expert tool can be evaluated by taking into consideration the user experience with the tool, its attractiveness and the effectiveness, basing on the perception of the users and systems engineer. The Table 6.1. shows that each of the elements is linked to characteristics defined by Riedel et al. (2011) and the conclusions can be drawn from the analysis presented above.

To begin with, it was noticed that at the very beginning of the test, the interviewees were eager to state only the criteria that come to their mind immediately. They were asking where they can find ‘their’ criteria in order to include them. As soon as they understood that they should follow the indicated steps, the decision makers started to put more consideration to the underlying reasons for the process. They took a real advantage of the available pool of criteria and gave more thought to their real needs. This observation allows drawing a conclusion that the tool enriches the thinking process of the users and thus is in fact effective.

“It really makes you consider even more where your main focus point is placed. But it also makes you think about the weights distribution within the criteria themes. It makes you question WHERE you put points and WHY. You reflect on your choice.”

It was challenging to find people within the company who were able to dedicate some time to work with the tool. For this reason, the diversity of the decision makers was rather poor and the real added value of the tool could not have been fully tested. Nevertheless, it gave an insight into how disparate and diverse the needs of stakeholders within one company can really be.

In addition, the interviewed employees were doubtful about the level of complexity of the tool, questioning the overall attractiveness. From the system engineering perspective, the tool could not have been less complex. The underlying idea of this kind of program is to provide to the user an access to the knowledge of experts in the field. Limiting this access would contradict the main principle of the program. The recurring suggestion that the presence of the system engineer is necessary to properly use the tool seemed to be accurate. Especially, when the hectic character of the corporate world is taken into consideration.

Nevertheless, a rather positive evaluation of the experience can be deducted from it. The level of participation and involvement was high, making the users eager to work with it in the future. When asked if
they would recommend the tool to other professionals, all of the interviewees claimed that they would do so. Of course, they pointed out that a number of improvements would have to be done, but the tool has a lot of potentials and is definitely useful. The clear structure, a step-by-step approach to gathering the input and the steering through the process was convincing and appealing to the decision makers. The component that failed the testing was definitely the reporting part.

A mixed assessment was given to the attractiveness. The level of perceived control was sufficient and the stakeholders claimed that the idea for the tool and its purpose make the tool very attractive. It was mentioned that the tool helps in empowering the stakeholders and provide a possibility for a good representation of the criteria that should be underpinned in the location decision making. This allows an easy assessment of the available alternatives, explaining and substantiating the reasoning behind the taken decision. In general, the users were willing to use the tool again.

The attractiveness was questioned on the ground of the ease of use and complexity, lowering the feeling of being comfortable with using. Additionally, although there was a general acceptance of the outcome, the reporting quality has to be improved.

The users had a very good perception of the effectiveness of the tool. The majority of stakeholders were eager to work with it and test its possibilities. The stakeholders agreed that gathering the input from employees with the tool can contribute to achieving better outcomes of the decision-making process. It can enrich the knowledge of people and help in justifying the final decision.

'It gives you such a broad criteria pool from all points of view, that even if you are not familiar with the real estate topics, you can understand what is asked from you and indicate which criteria you consider as important.'

'It could be very useful. The decision making has proven to be a complicated process, lots of meetings that led to no answer because several criteria were brought all the time and there was no particular focus, all criteria were treated as the same importance. Bringing focus would make the process easier.'

6.1.3 Acceptance and trust

The Table 6.1., presented at the beginning of this chapter, indicates also the way in which the mentioned characteristics influence the acceptance of the system and trust in the system itself and its outcome. Basing on the previously presented analysis, it can be concluded that the stakeholders showed a great trust in the system but their acceptance of it is still to be improved.

The users’ trust in the tool was mainly built upon the positive experience and understanding of the structure. What is more, the purpose was clear for everyone and they were willing to use the tool again. The stakeholders trusted the received outcome and the possibilities it provides. They were clearly willing to further recommend it.

'It would absolutely recommend using it in the decision-making process. It could be very beneficial.'

'It would recommend the tool to be used in the processes.'

As mentioned, the acceptance of the system was less positive. On one hand the experience was highly valued and the general idea was greeted with support. In addition, there was trust in and acceptance of the outcome. The logic of tool is understandable.

The main reason for questioning the overall acceptance kind of was again the complexity. One of the stakeholders claimed that the tool was ‘too scientific’ and including too many factors, given to the user at once. This might cause getting lost in the process. In addition, the number of possibilities to vary the input was found confusing and ‘more scientific than the art of decision making in practice really is’. The same person indicated that in the current version it can be used for an analytical reason but not for the process in the company.
In current version the tool is too scientific and too artificial if you start playing with the stakeholder’s weights. It is, however, a good analytical tool. It would just not be very useful, ‘over-scienced’

Moreover, the acceptance level was reduced by the way the output is currently presented within the tool. With the current version, the useful reporting can be done only by a coordinator who is familiar with the tool.

There is still a lot of hope and expectations connected with the tool.

‘I would definitely use it again. Of course, if you start using it, some changes to the interface would have to be made’
6.2 REFLECTION ON THE RESULTS

In this chapter, the reflection on the results from the tool development and testing will be presented. As mentioned in Chapter 3.5, the expert system is based on the simple idea that expert knowledge is transferred from a human to a computer. With this research, an attempt to capture a vast body of task-specific knowledge on the location decision criteria was gathered in a program which was then made available for and tested by practitioners.

6.2.1 Tool complexity

The main idea was to provide support and explain provide a logical reasoning for the emotional process. With the tool, the expert knowledge was supposed to be represented in a common and easy way in order to facilitate location decision-making activities. It was done by giving an expert-level knowledge identified in the literature to the user of the system, who is not so familiar with the problem complexity. The developed tool containing all the identified necessary information was created in such a way to improve the productivity in the decision making by preparing the structured knowledge base and shorten the time-intensive task.

The outcome of the evaluation clearly shows that the complexity level of the tested version of the tool is too high. The first version of the tool was limiting the number of variables that are accessible to the user. The decision to give an access to only 20 criteria (considered as the most relevant basing on the input) was taken in the very beginning to actually prevent the decision maker from getting lost in the amount of information. However, after the first testing, it became clear that although the users considered they derived ‘top 20’ as accurate, they had doubts whether all of their needs are really reflected. This was especially visible when they decided to ignore one criterion and saw that another relevant was appearing.

For the second version, the idea had to be reconsidered. Therefore, basing on the expert system definition, an access to all of the identified expert knowledge was given. The stakeholders were still guided to where their focus should really lie, as the program assigned prelaminar weights to some of the criteria (basing on the links between determinants marked as relevant and those criteria). This was done as a response to the first testing and aligning with the main principle of the expert tool.

With the tests of the second version, majority of interviewees noticed the risen level of complexity. It is, however, important to point out that after seeing the number of variables they were able to consider, there was a general tendency to narrow down the focus by on their own and clearly indicate only the real needs. While working with the tool, they started to give more thought to the ‘why’ question.

It seemed that after getting more control when specifying the criteria, the weight distribution became a problem. Not everyone understood how it really works and required a deeper explanation which clarified the rules. There is, of course, the possibility to read the explanation but in order to really get the detailed information and full clarity, additional time is needed, which is not available in the multinational organisation. Nevertheless, the users who could devote some more time to the tool indicated that they are able to develop a proper comprehension on their own. As one of them stated:

‘The assigning of weights to criteria is pretty tricky. You really have to consider how you distribute it. (…) It forces you to really think about your input.’

As mentioned before, the decision makers agreed that the tool reflects the character of the problem. When asked if there is anything missing in the tool, one of them said:

‘Nothing seems to be lacking but maybe it is just too much’

There was a recurring suggestion that the presence of the system engineer is necessary to properly use the tool. This seemed to be an accurate suggestion, taken into consideration the hectic character of the corporate world. Moreover, although it took some time to understand the principles of the tool, the users claimed that the longer they work with the tool, the easier and clearer it gets.

After getting full feedback from the testing, some small changes to the user interface. They were aimed at reducing the complexity with the visual effects. It was applied to the windows displaying the criteria list within the category (see Figure 4.15.). If any of the criteria got 0 points assigned by the tool it was displayed
in a grey colour, clearly distinguishing it from the criteria that should be given some attention. The criterion is still readable and it is still possible to assign weight to it, which would result in changing the text colour to black again. More recommendations on the improvements to the tool, which were not applied, can be found in Chapter 6.3.

### 6.2.2 Using the tool in perspective of the current decision-making process

With the case study, the application of the tool in the making process and its practicality were tested. In comparison to the current decision-making process, the use of the tool was considered to add value. The company made an attempt to change their approach with the Pilot Case, trying to increase the level of involvement and transparency. The formation of the team was driven not only by the problem of establishing a new location but mainly to work on the integration of various elements of the business. In the end, the attempt failed as there was not enough communication and transparency between team members.

In TNT and FedEx, due to the character of the company main business, there is an in-house group of people who always work on establishing the location factors. Currently, they are mainly cost driven and lead by the ad-hoc decisions, because of lack of clear organisational structure caused by the integration. There are a number of people trying to bring structure but for now, it is still clearly missing. The tool allows the stakeholders to bring more theoretical-driven reasoning to the process.

Although the tool was tested after the final recommendation was presented to the company decision board, some crucial elements can be pointed out. First of all, the users agreed that the tool made them look at the problem from the more broad perspective, deep-dive into it and really reconsider the prevailing reasons. Despite the complexity, they appreciated getting a structured insight.

> ‘The tool idea is very simple and at the same time, it surprisingly gives you so much insight into the complexity of the problem. That is what I really like.’

Moreover, the goal that was not achieved by the team could be reached with the help of the tool. The empowerment of stakeholders and a common approach was clearly missing. Using the tool brought a feeling of inclusiveness and would help in explaining the reasoning behind the final recommendation, which would follow the guidelines given by the stakeholders themselves. The users appreciated not only possibility of expressing their needs but also an easy way to gather input from various sides, as one of interviewees stated:

> ‘My point of view was reflected very well, of course. But for me, the combination of outcome from all stakeholders is most interesting.’

The tool can open the fixed mindset of the stakeholders, encouraging them to consider more criteria than they would normally do. In addition, it was agreed that if the final recommendation given for a new location in the Pilot City would be tested against the whole range of criteria provided by the team, it would have ensured more involvement and acceptance from the team members’ side. This element was reflected when significant differences appeared between what was stated by integration team members and the person working in the Pilot City, showing a significantly different point of view. Despite broadening the criteria list, with the help of a tool, the elements that were considered as most relevant by the experts from the real estate team, were still listed with the top scores. This overlap increased the level of tool acceptance.

In the end, the possession on the land was the deciding factor in the Pilot Case. As one of the team members pointed out, the case was not a ‘greenfield study’ and had to be approached differently than assumed with the tool. There was already a company presence in the area and it had an ownership over the land, giving advantage to one of the alternatives. In this kind of case, it is agreed that the tool could be more of a supportive element for the entire process, helping in shaping an advice, but would never be able to fully cover all the factors as there were many case-specific issues that needed to be taken into consideration.
6.2.3 The added value of criteria establishment

Having all the testing and evaluation done, an attempt to quantify the added value of establishing the list of ranked criteria can be done.

The main added value is definitely broadening the viewpoint of the stakeholders and engaging them in the process, increasing their feeling of empowerment and transparency. The impact of this element might not be quantifiable at the moment but an overall effect noticed in the behaviour and level of satisfaction of stakeholders could be observed.

In general, the idea behind the tool was highly valued. The interviewees agreed that they have never worked with such a tool before and they definitely see the possibilities of its application and the positive impact it can bring. The main failure of the Pilot Case was losing the involvement of stakeholders, who after feeling that their needs are not addressed, were discouraged for further cooperation. The final recommendation was received by them, but the full acceptance and understanding of its motivation were missing. The users claimed that working with the tool and following the reasoning from the ranked criteria to substantiate the location decision would limit that significantly.

Although the acceptance of the final decision would be improved, in the end, one has to be aware the people will always disagree up to a certain level since their personal demands will not be completely satisfied. The advantage brought by the tool is providing structure to the factors (reflecting on their importance) and more detailed overview of demand that leads to making a better decision or recommendation.

Additionally, it was proven that the tool can help in defining the most relevant criteria in a faster way, serving also as a checklist for professionals. It was named ‘a perfect tool to start with’ when multiple people are involved.

Despite this positive first evaluation, the actual practicality level of establishing such list with the developed tool was challenged during the interviews.

First of all, the complexity level was mentioned several times. It would force the decision makers to be guided by a process coordinator, as the tool could not be given to the stakeholders directly. In addition, a general introduction, where the tool purpose and principles are to be explained would have to be given to the decision-making group.

Furthermore, after the list is derived it has to be re-evaluated due to the limitation of information available on the market. As one of the interviewees mentioned, in order to evaluate the design or alternatives on basis of certain criteria, you have to be able to get the relevant information from the market. This is not always possible or poses a lot of costs for the companies to do the proper market research. As the tool was developed on the basis of scientific literature, it was concluded that all the listed criteria are already used by the practitioners and available on the market. Nevertheless, the user doubted in the amount of added value if the resources required to get the proper information exceed the number of profits it will provide. The re-evaluation could be done with help of brokers or consultants who can define the scope of work they are able to perform to get the information.

Another point is that a company with a mature real estate department will not use the tool. The stakeholders claimed that a company might have an in-house real estate department that can provide sufficient amount of expertise. However, with this comment, the stakeholder forgot the principle of the tool - that it supports the decision makers that are not experts in the field and by using the tool they can bring more feeling of inclusion.

With the second version of the tool, the users were provided with a quick overview of the 50 most relevant criteria. The choice of number 50 was done after observing that none of the stakeholders spread his weight among more than that number. Some of the interviewees claimed to be overloaded with the amount of information. For this reason, to really make use of the outcome, there has to be a common agreement within the decision group on how many criteria they want to use, or they can choose to ‘put a line’ and ignore criteria which got less than a certain amount of points. This action would not harm the output but underpin the priorities even more. The list could be expanded or shrunken depending on the company needs.
The last point relates to the fact, that there is a lot of potential added value in the overall data gathered from decision-makers. It provides an overview and comparison of the determinants and statements from different parts of the company. It could help in understanding the differences and information gaps encountered by some of the stakeholders. This was the part of the report that the real estate representative was really interested in. It allowed him to assess the recommendation that was given and address the reasons for the limited acceptance of it.
6.3 DEVELOPMENT POSSIBILITIES

The conducted tests and evaluation interviews provided a variety of discussions concerning further development and improvements that could be applied to the tool. This chapter presents implications derived from these discussions.

Since the general idea behind the tool has been evaluated positively and the ensured the overall acceptance and trust, the main requirements for use of the system behind the tool and its outcomes have been met. No major structural implications for the further development of the tool background structure are needed. However, the shell of the built expert system, the tool (the computer program), has a lot of room for improvement.

The most important element that has to be addressed is the tool complexity. The initial idea for the tool was to build it in such a way to allow the stakeholders to work with the tool on their own. The user interface and the information windows were supposed to be sufficient to allow an individual interaction. The current version of the tool failed to provide this possibility. Its complexity reflects very well the complexity of the LDM process. Although with all the explanations and manuals, the users claimed that they would be able to work with it (which was even proven with one of the tests), there is a serious risk that the stakeholders would not devote enough time to provide the information properly. From the conducted interviews and analysis of the tool, it was concluded that there are two possible development options.

1. In order to allow the user working with the tool individually, the shell has to be simplified. It was suggested that the number of steps to be taken could be reduced. Moreover, the tool could already ignore and hide from the user the criteria, which are not relevant to the case, as it was done with the first version of the tool. These changes could be done by turning the tool into a simple application with a user-friendly interface, possible to use on mobile devices.

This option, however, poses a significant risk. With the simplification of the tool, there is a risk of missing the richness of knowledge and objective of enriching the decision makers’ point of view. Additionally, when limiting the criteria list, again the situation encountered with the first version of the tool would appear when the stakeholders were doubtful whether some of the excluded criteria would turn out to be relevant.

2. The second option would be to accept the fact that the tool requires the presence of a system engineer. This would allow resigning from the explanation windows and work on adjustments of the interface for supporting the system engineer, like for example providing an easier access to the specification window. Simplification of the shell would not be necessary anymore.

No matter which of the above-mentioned directions would be chosen, the substantial improvements to the user interface should have been applied. In addition, the reporting format should be clarified and allow automatic display of results in an attractive way, showing the key points. Another option could be to structure the output in such a way, that the user is able to see the criteria in relation to the determinants that were pointed out as relevant. This would allow understanding of the criterion origins. Additionally, it could be expanded by providing a quick overview of major differences between stakeholders, as that was named to be an interesting outcome part.

The desired improvement would be also to allow the stakeholders to define how many criteria they want to see in an output- defined either by a specific number or by a constraint coming from weight distribution.

Furthermore, despite the fact that the tool includes a possibility to specify the character of the location seeking in order to better assign the weights and tailor the criteria for the user, this element could be developed in a more detailed way. It could be working with practitioners as not enough knowledge was found in the literature.
6.4 CONCLUSIONS

With this chapter of the research, a closer look at the evaluation of the tool with the pilot study evaluation and utility of the tool was presented. It gave a lot of insight required to answer the main research question and challenges the outcome of this research.

The importance of various characteristics of the tested tool and its user was introduced in Chapter 3.5. All the elements listed in Table 6.1. are crucial in creating an acceptance and trust in the system. The conclusion drawn from this chapter is that the developed tool was evaluated positively and could improve the (re)location decision making in large multinational companies.

There were several elements that the stakeholders were especially positive about. One of them is the fact that the model was forcing them to think deeply about the reasons for certain choices and get more insight into the decision variables. It was said to be very useful and enriching the location decision-making process by empowering the stakeholders. It improves the participation and transparency level, broadening the list of factors that are taken into consideration while making a choice. The tool also indicates the differences in needs and understanding of the ongoing process, bringing a full overview of viewpoints. Moreover, the interviewees liked the way in which the tool allows underpinning the overall priorities. All these elements improve the level of acceptance of the final decision by the impacted employees.

The decision makers were impressed and satisfied with the idea of bringing the scientific knowledge to the practice. All of the interviewees had a different background, despite which they were capable of using the tool. This indicated that it is universal enough to be used by various kinds of stakeholders. However, some significant improvements can be done.

The biggest obstacle mentioned by the users was the level of complexity and the amount of time required to work with the tool. It was “too complex to fill it in on your own” and with ‘too many criteria’ to cover in a short time. The stakeholders suggested that a guidance of a system engineer is needed to shorten the task. For this reason, the idea of changing the tool designated owner was born. If there is a need for such a tool in the decision-making process and guidance is necessary to ensure the proper use, the program could be held within a real estate company or a consulting group, supporting large multinational companies. Another solution would be to move the developed expert system into new shell-application software, simplifying the use.

In addition, the current version of the tool requires adjustments that would make it more user-friendly, making it easier to read the outcomes and adjust the results to the specific case. The reporting part also needs to be given more attention.

All in all, the idea of the tool was highly valued but significant work to its implementation of the program is needed. The use of the tool is seen as adding value. There was a general willingness to work with the tool on other projects as long as some improvements to the shell of the expert system are done. Despite the fact that the pilot study was rather limited and the decision concerning the Pilot City was taken, the real estate representative wanted to implement the tool used for making the decisions in other locations that are still waiting for the integration.
7 FINAL CONCLUSIONS
In the following chapter, the final conclusions from this hybrid research and design project are presented. The structure of this chapter is based on the structure of the report and provides the answer to the main research question and its sub-questions. Since the sub-questions provide a background for formulating the answer to the main question, they will be addressed in the first place. After the final conclusions, the limitations constraining the research are given. This part is closed by the presentation of the recommendations for further research and development of the tool.
7.1 ANSWERING THE RESEARCH QUESTIONS

To begin with, the research question, introduced in the Chapter 2.1., have to be refreshed. The main question that is posed in this research is:

*How can an expert tool improve the (re)location decision making in large multinational companies?*

It was established as a follow-up of the literature study conducted to define the problem recognised in the practice that is still to be solved. The issue relates to three elements: the process of (re)location decision, an expert tool, and the improvement of decision making in large multinational companies. The recognised challenge is to ensure that the most value is added to the organisation with the location decision. To achieve that, a more informed process is needed since the awareness of proper location criteria and its’ relative importance is lacking in the majority of cases.

To come up with a proper and thorough answer, the sub-questions were defined to support the research:

1. **What is the current body of knowledge on the (re)location decision making (LDM) and expert tools connected to it?**
   a. What frameworks and models are used in LDM?
   b. What are the criteria and objectives used in LDM processes?
   c. What can be improved in location decision making according to various authors?
2. **How to develop a successful expert tool?**
   a. How would such tool be perceived in practice?
3. **How can the expert tool be linked with decision supportive models?**

7.1.1 Addressing the sub-questions

The research sub-questions help in creating a theoretical background for the research and the answer for them need to be established on a theoretical level. This allows gaining insight into the critical elements of this research, incorporated in the main question. Below, the answers to the sub-questions are given:

- **What is the current body of knowledge on the (re)location decision making (LDM) and expert tools connected to it?**
  - What frameworks and models are used in LDM?

With the third part of the research, a long and in-depth literature study analysis is presented. The location decisions are part of the corporate real estate strategy of a company. The literature recognised three main aspects that have to be considered: the real estate portfolio characteristics; the organisational characteristics and the corporate business strategy.

Firstly, a closer look at the existing location and re-location theories is done. These theories focus on the optimal location choice and currently, the main categories are recognised: the neo-classical, the behavioural, and the institutional. Nowadays the majority of the firms’ relocation studies are based on behavioural principles, helping in understanding the actual behaviour and firms’ decision-making processes that may lead to relocation. The decision for optimising portfolio is always company-specific.

The (re)location decision-making process can be broken down into the three stages of activity: trigger, analysis, and outcome. The trigger stage refers to the stimuli or catalyst, which provokes the initiation of the process and is concluded by the start of contemplating relocation. The outcome of the first stage is a list of the criteria, basing on which the decision analysis is possible. In the analysis the influence of people and factors on process becomes central, influencing the final outcome of the decision-making process. Finally, in the outcome stage, the decision is made and process concluded.

The location decision-making process is a very complex matter. Using a simplified framework allows identification of elements which can be improved to enhance the decision-making outcome.

No matter to which framework one refers, the first steps require a vast amount of knowledge and information. Addressing the accurate criteria impacts the entire process. It is crucial to make sure that the
list of criteria is complete and reflects all the business functions’ requirements, thus all the relevant stakeholders are able to express their needs.

- What are the criteria and objectives used in LDM processes?

In reality, every company follows its own process of making location decisions. It is driven by a unique set of requirements and/or preferences, reflecting the company needs. Nevertheless, some common grounds can be noticed.

Looking closer into the organisational structure, one can say that each of the company department has its’ own characteristics and relies on different location capabilities. Being aware of the relative importance of those capabilities for each of its’ business function is crucial to facilitate the location decision making in the most reliable way. The analysis of potential locations should be based on function, which allows companies to optimise each of it in a unique locational decision. Taking into consideration various priorities which are already embedded in the firm helps to avoid trade-offs.

Moreover, the decision of where to locate is mainly dependent on the company’s driving forces. It has to consider what the core purpose of the company is and what it strives for. These elements can be reflected in location characteristics.

Various authors point out that analysis of factors affecting the company and criteria based on them is crucial in the first stages of location decision making. The more in-depth and thought-through the analysis is, the easier, faster and more accurate the up-coming decision-making stages are.

Criteria stand for ‘means or standard of judging’ and enable judging choice or course of actions to be taken. In general, each company has its’ own unique set of demands for a location, which are the result of combined driving forces and firms’ strategy. Despite the fact that each company has unique demands, it is possible to find some basics for corporate companies’ real estate decisions, which are reoccurring both in the literature and practise.

The literature study provided a clear indication that while considering the location criteria, one should first look at the reasons (triggers) of the (re)location decision and the objectives (requirements and goals) to be met with the choice of the new location. A third crucial element derived from the literature analysis is categorisation of the criteria into themes.

The reasons to look for a new location (reoccurring in literature) are strategic asset seeking, resource seeking, efficiency seeking, market seeking, growth, decrease, being unhappy with the current asset, cost reduction, and merger/ acquisition/ takeover.

The objectives can be captured with the following list: minimizing the number of located facilities, minimizing average time/ distance travelled (with client focus or employee focus), increase employee satisfaction (by attracting new talents, retaining talents, promote hr objectives, maximizing service (increasing flexibility, promote marketing message, promote sales and selling, facilitate and control production, operations, service delivery, facilitate knowledge work, capture real estate value creation of the business), minimizing cost (through minimizing fixed cost, minimizing toc, minimizing the total setup cost), and minimizing the longest distance from the existing facilities.

The most important element is, of course, a thorough list of location criteria that cover all the identified aspects of location, allowing analysis and assessment of alternatives. Basing on the literature, these criteria are listed under thirteen themes (criteria categories): costs, labour characteristics, infrastructure, proximity to suppliers, proximity to markets/customers, proximity to parent company’s facilities, proximity to competition, quality of life, legal and regulatory framework, economic factors, government and political factors, social and cultural factors, and characteristics of a specific location.

- What can be improved in location decision making according to various authors?

The location decision-making is a very complex problem and it is impossible to cover all the relevant issues and influential factors by looking only on part of the organisation. Including all the relevant stakeholders and proper management of the multiple and potentially divergent agents is crucial. This requires the use of various management supporting tools to align functional objectives and satisfy the stakeholders. All the desires, needs and wants of relevant users have to be brought up and consensus among them should be
established. When more stakeholders are involved in the decision-making, a better quality data can be derived, leading to better tailored LDM outcome. The input gathered for the process has been very well structured, thought-through and presented to the end-user.

When many stakeholders are involved in the process the behavioural factors are taken into consideration. The statement provided by the decision makers can be based on the limited or biased information. The decision makers rely on their own ideas about the choice options and their characteristics. They determine own criteria that define choices which are or could be satisfactory according to their knowledge.

Additionally, the transparency level has to be addressed. To achieve strategic CREM gains a transparency between stakeholders is needed, as it allows achieving specific and customised solutions, required by all organisation parts for operational reasons. The effective communication is one of the crucial aspects of CRE alignment. Higher transparency could provide fairness to stakeholders and ensure more equal treatment in the process. In decision-making models, the input can reflect each decision maker’s interests.

Thus, the stakeholder engagement, their level of knowledge and transparency towards them is a point where there is always a room for improvement.

- How to develop a successful expert tool?

Expert systems can be defined as computer programs that cope with and work on the bases of knowledge of some specialist subject. It has an ability to solve problems or provide an advice. They are also known as “knowledge-based-systems” or “rule-based-systems”. The expert systems can make any decision support system more flexible and powerful aid by simplifying the use of it. Additionally, they help in monitoring the decision processes, analysis of the content, and direct the stakeholders to the desired goal.

An expert system tool (shell) gathers the elements of an expert system, improving the productivity, preparing the knowledge base for the processes and concentrate on gathering and structuring the knowledge.

There are many research papers focused on validation and verification of expert systems. One of the proposed frameworks includes logical, laboratory, and field testing of the program. The logical methods cover checks for completeness and other problems such as unobtainable data items, unsatisfying rule conditions, data type clashes or missing goals. Subsequently, the system can be tested empirically which involves running a prototype system on a number of selected test cases to check output accuracy, assessing the results and the level of user acceptance. Only then extensive field tests are applied.

The success of the tool development can be defined by the outcome of its evaluation, looking at the interaction between humans and the program. To do this, several aspects have to be addressed. According to the literature, a certain level of system acceptance, trust in the system and satisfaction based on effectiveness and attractiveness need to be reached. Those elements are interlinked and connected to different characteristics. These characteristics are closely correlated.

User participation and involvement is crucial in gaining the acceptance of the system and influences the overall experience. Perceived control and complexity affect also the attractiveness and system acceptance. The higher the complexity, the less comfortable the user might feel when using the tool. On the other hand, if there are more involvement and participation might improve the tool by adding more variables and increase complexity. In addition, the perceived usefulness and ease of use (relating back to the complexity) impact the system acceptance.

Trust in the system is assessed by addressing both the system usage, the characteristics of both the model and the user. By looking at the feeling of being familiar with backside of the system (addressed through the experience), the performance reliability (if the user goals were achieved), the model purpose (aligning with the intended goals) and justification of outcome (understanding of how the outcome was derived), one can assess the level of trust. The trust is applicable both to the tool (model) and its outcome. This judgement, however, can be influenced by the abilities of the user an understanding of the model is crucial.

Basing on this, a checklist can be created. This checklist needs to be addressed in the expert tool testing and interviews conducted with users. It can also provide some suggestions for improvement coming directly from the users.
How would such tool be perceived in practice?

During the testing and interviews, the tool's functionality and possible use in practice were challenged. All of the stakeholders accepted the outcome received for the purpose of this research. The tool is seen as an element adding value to the location decision-making process. The idea for the program and its principles of use were highly valued by the users. However, a significant amount of work needs to be applied to the program. The users claimed that they are willing to work with the tool on other projects.

With the interviews, the tool was said to be very useful and enriching the location decision-making process. The interviewees appreciated that the tool allows underpinning their priorities and improve the level of acceptance of final decision within the company. It is considered to be effective, helping stakeholders in working with complex cases.

Although the interviewees had different backgrounds, all of them were capable of using the tool. This suggests that the tool can be used by various kinds of stakeholders, due to its universal character.

Nevertheless, significant improvements have to be applied. The pitfall mentioned by users was the level of complexity and the time-consuming first interaction. In addition, the current version of the tool is said not to be user-friendly enough. Working on the graphical interface and visual attractiveness would make it easier to read and adjust to a specific case. The reporting part also needs to be given more attention, as a visual representation of the outcome is crucial for acceptance.

During the conducted tests a suggestion was given that the program could be held within a real estate company or a consulting group, supporting large multinational companies.

- How can the expert tool be linked with decision supportive models?

The location decisions in the CRE processes require looking into multiple objectives, which are often conflicting. In practice, Multi-Criteria Decision Analysis tools are used, allowing considering multiple criteria to help users explore decisions that matter. They help in processing a number of alternatives and assessing them against the defined criteria set to choose the best alternative. In real estate management field, several MCDM models exist.

The Preference-based Accommodation Strategy (PAS) design approach was developed as a design methodology that aims to solve strategic portfolio design/decision-making problems. It is based on preference function modelling (PFM), serving multiple stakeholders in creating portfolio strategy. It supports more collective thinking and reasoning, allowing the identification and assessment of alternatives in order to select the best one.

The literature provides information that the majority of expert systems are stand-alone, independent systems. Some researchers work on developing them further and integrate expert systems with DSSs. It can result in major opportunities and benefits, especially when more than the user is involved. By taking advantage of the heuristic expertise from ES technology and combining it with decision-making support for groups the overall system can be significantly enhanced (in for example database management, model base management, user interface or system development). An ES can turn a DSS into a more flexible and powerful aid, facilitating the use, monitoring a decision process, analysis of the content, and directing the stakeholders in the direction of the desired goal. The expert tool is able to comply with different types of DSSs by for example providing the relevant data sets gathered from the stakeholders.

7.1.2 Answering the main research question

In order to answer main research question covered with this report:

How can an expert tool improve the (re)location decision making in large multinational companies?

Considering the outcome of testing and interviews, using the expert tool is an effective way to improve the (re)location decision-making process in large multinational companies, where multiple stakeholders are
involved, by increasing level of transparency among decision makers, broadening the knowledge of the topic, limiting the information inequalities and biases, and raising the acceptance of final decision.

Basing on the literature study and the conducted pilot study the answer is elaborated below. The first process of developing the tool is addressed followed by analysis of the product of the research- the expert tool, outlining how it was received and what are its application possibilities.

First of all, it is worth looking at how the tool was created and how the potential added value was defined. With this research and design project, a prototype of an expert tool was developed. It gathers the state-of-art knowledge on the location decision-making determinants and criteria found during the literature research. The framework for the development and successful implementation of the tool was covered with help of the research sub-questions. The comprehensive literature review indicated that there is still a lot of room for improvement in the location decision-making processes. Especially awareness of real demand coming from various parts of the company is very often missing. A lot of requirements that could be addressed by the location criteria are not taken into consideration, lowering the potential added value created by a properly chosen real estate decisions and causing adverse effects of relocation.

The tool was built in an iterative process, in which the stakeholders working on the pilot study were involved. They provided the necessary feedback and critical point of view. The users were introduced to the research problem and objective before the testing and interviews. This ensured a proper understanding of how their input affects the outcome, and what is the goal. Thanks to this they were able to properly evaluate the tool and its output, helping in improving the program. They worked with an expert shell that tried to properly capture the expert knowledge on the location criteria. At the same time, they were reflecting on the current location decision-making process, their involvement and room for potential improvement. The testing process was beneficial not only for the research but, as stated by the interviewers, also for them, broadening their point of view.

Secondly, a closer look to at the tool itself is given. It is a product of the research and was built with help of the Microsoft Excel and Visual Basic for Applications to create a graphical user interface for the expert shell. The results of the pilot study showed that using an expert tool in the (re)location decision making in large multinational companies can significantly improve the process according to the users. It was evaluated rather positively and the tool was accepted by the practitioners. They indicated that they would be willing to work with the tool in future as long as some improvements to the program are applied. The biggest obstacle mentioned by the interviewees was the level of complexity, which makes the use of it a very time-consuming task. For this reason, they would rather see the toll to be owned and brought as a support to the company by a consultant or a real estate company that would also ensure a system engineer who would guide the user through the program. For this reason, the idea of changing potential target owner of the tool was brought up.

Nevertheless, an important notion is that the outcome of the program triggered a discussion on the effects of including different criteria and approach to their establishment. Additionally, it increased understanding of the real needs and caused questioning the decision rationale applied up to this point. It also gives a feeling of empowering to the stakeholders, improving the participation and transparency level. It also indicates the differences in needs and understanding of the ongoing process, bringing a full overview of views points.

The significance notion for the findings in this pilot study is that the graduation company (FedEx/ TNT) is a very large and globally operating company. They have an in-house real estate team that includes a number of experts. Nevertheless, the stakeholders still noticed the improvement potential brought by the tool and were willing to implement it in their projects.
7.2 LIMITATIONS TO THE RESEARCH

When presenting the conclusions, some limitations concerning the research process and professional application have to be brought up.

7.2.1 Research limitations

The development of the tool was part of a graduation process. A comprehensive literature research and a proper development framework had to be established before the tool could have been built. In addition, it required getting familiar with the program and coding principles. All of these elements resulted in postponing the testing period to the month of March 2018, when the recommendation location decision in the company has already been formed. As a result, the outcome of tool testing was not taken into consideration in the case study but only used as an additional assessment.

What is more, as the testing was not part of the official decision-making process in the company, it was challenging to reach out to the involved stakeholders. Because of this, the group of interviewees was still quite limited. Including the input from directly affected employees could have given a broader overview of tool possibilities and expose the real differences in priorities of decision makers. More diverse user group would have been beneficial both for the study and for the company (which was even pointed out by the interviewees).

Due to the fixed terms of graduation process and time required for a conducting a proper interview, no field testing outside of TNT was done. Although it was possible to evaluate the tool and derive conclusions from the outcome of the pilot study, presenting its possibilities to decision makers from different multinational companies would have been beneficial.

Another point is that despite the fact that the tool had a built-in function to provide an input for design and evaluation of the alternatives (on chosen criteria) with the PAS methodology, this feature was never tested. This was due to the limited time for interviews that was offered by the decision-makers and hesitant approach to conducting a workshop when a decision has been already taken.

7.2.2 Application limitations

First of all, as mentioned in the analysis of the added value of the tool the availability of data turned out to be a concern for the interviewees. This is a common problem that is to be expected when using various tools for decision-making. Although the tool is able to equip the stakeholders with a tailored list of criteria, the actual usefulness of it might be limited. The company might have to use significant resources to obtain the information for the suggested criteria. What is more, this kind of data might not be readily available in the market and can be very case-specific. The company would be forced to trust brokers and market researchers on the provision of high quality of data. Professional application is therefore limited to the ability to obtain proper information.

Secondly, although the attempt to capture all the criteria recognised in the literature was made, it might occur that a number of interests stated by the stakeholders can be so specific for a part of the real estate, that the tool was unable to capture it.

Additionally, the implemented list of determinants might not be able to actually capture the real reasons and objectives for seeking the new location. Despite the fact that it was accepted in its current form by the interviewees, it might not be suitable for all the cases. In this situation, the user would have to try to ‘fit in’ with his determinants in the current version and adjust the criteria weights accordingly in the further steps.

Another limitation to practical implementation is the problem of assigning the weights to the stakeholders. In order to do that, the process coordinator has to be able to really substantiate the weights distribution. Otherwise, it might lead to losing the trust of the decision makers side, who might feel unfairly treated.

When it comes to the transparency, as it was mentioned in the Chapter 3.1., transparency might be a secondary value in certain cases and more manipulation possibilities might be needed. The more transparent is the process, the less room for manipulation it leaves. It might not be a favourable situation
for some corporate companies, where following the business priorities is more important than full operational transparency, which is increased with the tool.

The last point relates to the fact that the tool in its current version is not able to replace a professional that has an in-depth knowledge of the company. A mentioned in the interviews, it is a great tool to start the process with and indicate the main priorities or even help in gathering all the needed specifications further in the process but it is impossible to rely on the knowledge derived from tool only- it is a supportive program, able to improve the current process.
7.3 RECOMMENDATIONS FOR FURTHER RESEARCH

The conducted research and design project resulted in the deployment of an expert tool. With the prototype of the program, a first pilot study was conducted. There is a lot of room for improvement concerning the tool that was already brought up in this report. Below, a number of further recommendations are presented.

1. Tool for design purposes.
The tool was tested with a pilot study where criteria were derived in order to assess the available alternatives. It might be beneficial to test the use of the tool for creating a set of criteria for the design purposes. With the tool one is able to define priorities that could help with creating an optimised real estate portfolio for a company with the use of a proper design method. For this reason, a before mentioned PAS could be used. In such test also the built-in option concerning the preferences could be tested.

2. Testing the tool in the on-going process.
The tool should be tested with another, on-going pilot studies in order to validate the presented conclusions. The conducted testing was unable to fully explore the program possibilities as the outcomes were not applied to the actual location decision making.

3. New target owner.
As brought up in the conclusions- it is highly recommended to test the practical application of the tool with a consultancy company. It would ensure that the tool has a knowledgeable system engineer and bring it to the wider audience.

4. Wide accessibility and dynamic character.
At the beginning of the research, when the idea of the tool was established, the final outcome was envisioned as a dynamic program that could be enriched with the growing knowledge. Turning the expert tool into an application adaptable to changing the environment and available to companies would bring a lot of benefits. First of all, the tool would be tested on a large scale, providing the feedback for further improvements. Secondly, it would be fed with the information that was not taken into consideration at the moment of building the prototype, allowing it to actually capture the state-of-art knowledge.

5. Visual support of the tool.
The expert system could be transported into another shell, improving the user interface and visual representation, making it more user-friendly. That point was addressed in many interviews and is a major point of criticism that could be mitigated with help of a knowledgeable program developer.
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APPENDICES
9.1 Appendix A

The Literature Study Outcome Structures

This appendix shows the models that were created basing on the literature study.
Figure A.1 A model reflecting the identified links between the location determinants and criteria in the article written by Dunning (1998).
Figure A.2 A model reflecting the identified links between the location determinants and criteria in the article written by Ciaramella and Dettwiler (2011).
Figure A.3 A model reflecting the identified links between the location determinants and criteria in the article written by Mazzarol and Choo (2003).
Figure A.3 A model reflecting the identified links between the location determinants and criteria in the article written by Mazzarol and Choo (2003).
Figure A.4 A model reflecting the identified links between the location determinants and criteria in the article written by Brouwer et al. (2004).
Figure A.5 A model reflecting the identified links between the location determinants and criteria in the article written by Rymarzak and Siemińska (2012).
Figure A.5 A model reflecting the identified links between the location determinants and criteria in the article written by Rymarzak and Siemińska (2012).
Figure A.6 A model reflecting the identified links between the location determinants and criteria in the article written Farahani et al. (2009).
Figure A.6 A model reflecting the identified links between the location determinants and criteria in the article written Farahani et al. (2009).
Figure A.7 A model reflecting the identified links between the location determinants and criteria in the article written by Nourse and Roulac (1995).
Figure A.8 A model reflecting the identified links between the location determinants and criteria in the article written by Rothe et al. (2015).
Figure A.9 A model reflecting the identified links between the location determinants and criteria in the article written by Van Dijk and Pellenbarg (2000).
Figure A.10 A model reflecting the identified links between the location determinants and criteria in the article written by MacCarthy and Atthirawong (2003).
Figure A.10 A model reflecting the identified links between the location determinants and criteria in the article written by MacCarthy and Atthirawong (2003).
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Figure A.10 A model reflecting the identified links between the location determinants and criteria in the article written by MacCarthy and Atthirawong (2003).
Figure A.11 A model reflecting the identified links between the location determinants and criteria in the article written by Kimelberg and Williams (2013).
Figure A.11 A model reflecting the identified links between the location determinants and criteria in the article written by Kimelberg and Williams (2013).
9.2 APPENDIX B

EVALUATION INTERVIEW PROTOCOL

After the testing, the tool development and possibilities was discussed individually with each stakeholder. In this appendix, the protocol used for these interviews is showed.

In the Table B.1. the checklist developed in Chapter 3.5. is used. The interviews were held in English. For the evaluation, the evaluation protocols of de Visser (2016) and Meijler (2017) are used as a basis.

Table B.1. The evaluation checklist for computer systems based on de Visser, (2016; Joldersma and Roelofs, 2004; and Riedel et al., 2011)

<table>
<thead>
<tr>
<th>Lp.</th>
<th>Characteristic</th>
<th>Evaluation category (Joldersma and Roelofs, 2004)</th>
<th>Resulting effect (Riedel et al., 2011)</th>
<th>Tool / Output</th>
<th>Question number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Participation and involvement of users (Riedel et al., 2011)</td>
<td>Experience (Ownership, Facilitated communication between people, Greater understanding of other people’s views and perspectives)</td>
<td>System acceptance</td>
<td>T</td>
<td>1.5</td>
</tr>
<tr>
<td>2</td>
<td>Perceived control (Riedel et al., 2011)</td>
<td>Attractiveness (Acceptability of the model, Attitude of the participants)</td>
<td>System acceptance</td>
<td>T/ O</td>
<td>1.4</td>
</tr>
<tr>
<td>3</td>
<td>Familiarise with the backside of the system (Riedel et al., 2011)</td>
<td>Experience (Provision of a structure for managing interventions, Supported steering of thinking process, Satisfaction with components)</td>
<td>Trust in the system</td>
<td>T/ O</td>
<td>2, 3, 4</td>
</tr>
<tr>
<td>4</td>
<td>Complexity (Riedel et al., 2011)</td>
<td>Attractiveness (Feeling comfortable about using)</td>
<td>System acceptance</td>
<td>T</td>
<td>2, 3, 4</td>
</tr>
<tr>
<td>5</td>
<td>Perceived usefulness (Riedel et al., 2011)</td>
<td>Attractiveness (Quality of the problem solving, Willingness to use again) Effectiveness (Facilitated speed of work, The contribution of the method to the outcomes, Likelihood of acceptance of the results)</td>
<td>System acceptance</td>
<td>T/ O</td>
<td>1, 3, 5</td>
</tr>
<tr>
<td>6</td>
<td>Purpose (Riedel et al., 2011)</td>
<td>Attractiveness (Satisfaction, Willingness to use again, Impact of intervention, Acceptance of the results)</td>
<td>Trust in the system</td>
<td>O</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>7</td>
<td>Perceived ease of use (Riedel et al., 2011)</td>
<td>Attractiveness (Liking, Feeling comfortable about using)</td>
<td>System acceptance</td>
<td>T</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>Performance reliability (Riedel et al., 2011)</td>
<td>Effectiveness (Facilitated speed of work, Supported steering of the thinking process, Number of ideas, Quality and quantity of ideas in a certain time)</td>
<td>Trust in the system</td>
<td>O</td>
<td>1, 3</td>
</tr>
<tr>
<td>9</td>
<td>Justification of outcome (Riedel et al., 2011)</td>
<td>Attractiveness (Confidence in performing a task, Impact of intervention) Effectiveness (Supported steering of the thinking process, Greater understanding of other people’s views and perspectives, Number of ideas)</td>
<td>Trust in the system</td>
<td>O</td>
<td>1, 3, 2</td>
</tr>
</tbody>
</table>
Introduction

The interview will take up to 30 minutes. Do you agree for me to record this interview?

With this interview is would like you to evaluate the expert tool that you worked with. I would like to know how have you experienced this process of working with it and what you think of the tool itself. For this, I have some questions I would like you to answer.

<table>
<thead>
<tr>
<th>Main question</th>
<th>Follow-up questions</th>
</tr>
</thead>
</table>
| 1. Do you think that the outcome of the tool was useful? | a. Did it support or hamper the LDM process and its outcome?  
   i. Can you explain in which way was it supported/hampered?  
   b. Do you feel that it gave you more control over the DM process?  
   c. Did it help you to gain insight in the decision variables/enrich your thinking process?  
   d. What advantages do you think the tool provides in practice? |
| 2. Do you think the tool was easy to use? | a. What influenced that in this case?  
   b. Do you have any suggestions for improvement in this matter?  
   c. Did you understand in how the tool works? How does this influence your trust in the system? |
| 3. Did you accept the outcome of the system? What particular aspects helped you? | a. Was it influenced by the process of use?  
   b. Do you think that the tool appropriately addresses the complexity of the location-decision making process?  
   c. Do you think that there were enough criteria included in the tool? |
| 4. Do you think that you had enough control over the tool so that the outcome expressed your needs? | a. Was it adaptable enough?  
   b. Was it easy to use?  
   c. Did it meet your expectations?  
   i. Do you think your expectations were particularly high/low or the performance rather low/high? |
| 5. On a scale of 0 to 10, how likely are you to recommend using the tool to your friends or colleagues? (Where 0 is ‘Very unlikely’ and 10 is ‘Very likely’) | a. If you would be able to change one thing in the tool, what should it be?  
   b. Is there anything in particular that you liked about the tool?  
   c. Do you have any suggestions for improvements? |
9.3 APPENDIX C

REFLECTION

The following document aims to present the final reflection on the approach chosen for the research proposal. In addition, it will be outlined how it was planned and how it fits in the methods applied by the research laboratory, that this thesis was conducted in. It will be also indicated to which extent did it actually worked and if it supported obtaining the expected results, reaching the objectives and answering the research questions.

1.1. Product, process, planning: the reflection

From theory to practise in a smart way

I started thinking of how I would like my graduation project to look like in the summer of 2017. From the very beginning, I was sure that I would like to conduct my graduation in a close relation to the practice. I wanted to make sure that the outcome of my work could be useful and possibly utilised in the practice. In the fast running world, the professionals rarely look into the development of theoretical knowledge, ignoring the vast amount of data and useful information that was gathered through the years. I did not want my thesis to become just another report, which would never improve the changing environment.

Additionally, during the course of my studies, I found my own interest in the Corporate Real Estate Management area and wanted to work in close connection to this field. For this reason, I decided to work on my graduation project in the ‘Smart Real Estate Management’ laboratory, which allows working on problem solving with the use of the smart environment and focusing on end users. The idea was that it is possible to link the users of the real estate to the state-of-art knowledge with the help of smart tool in order to bring the most added value possible.

The ‘smart’ term is very broad and in my research, the ‘smart managing’ refers to the provision of the ‘smart tool’, a computer program improving human performance in the field of real estate management, by working with the date it gathered.

In the first part of the process, around the time of P1, I put a lot of focus into discovering and understanding the various frameworks and processes of location decision making in companies. I also looked at various decision supporting systems. Additionally, during the Operational Research Methods course at TU Delft, I made a first trial, a mock-up version of the tool, trying to visualise how the final product might look like.

As the research was progressing and I read more and more on the topic of location decision making it became the focus shifted a lot to business management field rather than purely real estate management. This is due to the fact that real estate strategies cannot be considered separately from the business strategies. Moreover, a lot of focus was given to existing theories, frameworks and views on how the decision making processes are conducted.

Before the P2, an insight into the expert tool systems and tools was gathered. The existing frameworks for development and requirements were addressed. However, the complete clarification of method and frameworks that were actually going to be used was done only after P2, which in a perspective of time can be seen as an unnecessary delay.

The theoretical base

The final outcome of my master thesis is not only a report but also a functioning expert tool. In order to build such a tool, a vast and through literature research had to be done in the beginning. Only then the product could have been built. The process of designing and building it was proceeded by several weeks of analysis of literature covering various topics connected not only to the processes related to the location decision making, but also creating the list of criteria and finding out what determines the use of them.
It gave insights in the state of art development on both corporate real estate management in the field of location decision making and its relation to the business. The focus was on identifying a thorough list of the location factors and criteria that created the ‘backbone’ structure of the tool.

Finding the proper literature was not hard, however in order to recognise the reoccurring patterns in the research papers and build a solid map of dependencies was not easy. It took a lot of time and was quite difficult, as already before the P2 I certainly got lost in the literature study, diving into wrong topics.

In the beginning of the literature study period, I failed in keeping a proper literature research structure grid that could help tracking and analysing the literature I had gathered and read. Although I have always immediately saved the papers in a proper folder structure, dividing them by the topic, I had difficulties in creating the links between the papers. Only after the P2, I started creating certain kind of ‘structures (‘maps’)’ for each article, which help in deriving core points from them. Later on, I was able to link the different structures to each other and build the tool backbone. However, I this could have been improved by maintaining a proper literature grid, which would make finding things easier from the very beginning. Unfortunately, this level was never reached, making the process more complex than in could (and should) have been.

The pilot study- working with the company

As soon as I knew in which direction the research could had and that I want to work with the practical world, I discussed the possibilities of finding the proper company for a pilot study with my supervisor. During the introduction to the laboratory, it was mentioned that it is possible to make a graduation internship in the FedEx/TNT, which are currently going through some substantial changes caused by a recent acquisition. I have been working at the real estate department in this company before, for a short three-month project. I contacted the potential company mentor to describe the idea for the research. It was perfectly aligned with the project and pilot case that the company was organising internally. The company was willing to cooperate in the graduation process.

I got involved in the pilot case very early, around November 2017, before my own theoretical framework, approach and methodology were defined. As a result, I took on various tasks within the company that were not always directly connected to my research, resulting in some distraction and delays in my own graduation process. However, I got some significant insights into the decision-making processes conducted within the company. It helped in clarifying research objectives and recognising gaps that I wanted to bridge with my final product.

Although in the very beginning it seemed that conducting the interviews in the company will be easy, it turned out to be to be the strikingly difficult. Many of the relevant stakeholders did not have time to take part in the testing and evaluation. Moreover, the theoretical level of the research was not fully accepted by the interviewees who called it ‘over scientific’ and ‘too academic’ for the practical world. Nevertheless, I managed to find some professionals who agreed to dedicate their time and provide a lot of valuable feedback.

Building the tool

Once the theoretical backbone structure was established, the recognised links were translated into simple numerical relations in Excel. It seems that Microsoft Excel is a very useful and quite intuitive tool for creation of simple prototypes of tools. I created sheets where the links were established, nevertheless, I knew that the tool has to be visually appealing to encourage the potential users to test it. Additionally, I wanted to make sure that the tool can be a used within the companies without a supervision of a system engineer. For this reason, I decided to use the Microsoft Visual Basics for Application.

The Microsoft VBA was suggested to me by one of my supervisors very early in the process (around October). I have never worked with the tool before and I had no programming skills, but I decided to postpone the building process until the proper theoretical framework is developed. Unfortunately, as mentioned before, the knowledge from literature was structured by me quite late in the process. I was forced to find out how to use the VBA and create the tool in a short period. I decided to watch a series of tutorials that I found online in the open sources and learn how to code in the program on my own. I was glad I had done this, as in my opinion, it allowed me to transfer and combine the gathered knowledge to create a new tool according to my own vision. I was able to reflect my own findings in the way I imagined it, as I created the tool structure from the scratch. I got a lot of valuable support from Rein de Graaf, who helped me in improving various elements of the tool.
Nevertheless, building the tool on my own was quite time-consuming and taking into consideration the delays I have caused to myself before, the first version of the program was ready to be tested only in March 2018.

Testing the tool
I wanted the tool to be tested on a real-life on-going case. However, due to the graduation schedule and my own process development, the decision-making process was almost over and the final recommendation was presented, waiting for approval from the management side. As soon as the first version of the expert tool was ready to be tested, I contacted a number of stakeholders involved in the pilot case in the FedEx/TNT to schedule the interviews. Scheduling the interviews was very challenging as in such a big, globally operating company the personal schedules of employees are very tight and they have to travel a lot.

Although the number of interviewees was lower than I hoped in the beginning, it seems that the iterative process worked really well from a research perspective. The model was adjusted after every test. The stakeholders that were involved had various backgrounds and not all of them deal with the location decision making on daily basis. Because of this, an introduction to the tool and the research was given to each of them.

The interviewees provided very rich feedback and were helpful and willing to cooperate. With the evaluation, it became clear that the stakeholders valued the idea behind the tool very much. They unanimously admitted that the tool has a great potential. However, the complexity of the tool limited significantly the acceptance level of the expert tool. The users indicated that such program can be used in the corporate world only if it is operated by a system engineer, which was contradictive to one of the ideas that I had about the tool.

In general, after testing the developed expert tool with the first pilot study, the research outcome can be considered successful. Clearly, there is a number of points of improvement that can be applied to the tool, however, it was considered as an added value by the stakeholders. It brought the knowledge gathered in the literature to the practice and proved that it can improve the location decision-making process. Personally, I am happy with the outcome of this pilot study.
1.2. Reflection of the research

Reaching the objectives and utilisation potential
The aim of my research was to develop an expert tool that would bring to the professional world the knowledge on the location decision-making criteria, gathered in the scientific world. This idea was formulated as a result of the recognition of the problem that the stakeholders do not always have a full overview of the location decision-making process complexity. As a result, they follow limited or biased information, which leads to making the decision basing on an incomplete set of requirements. Moreover, there is a lack of transparency in the majority of location decision-making processes conducted in the corporate companies, leaving a number of the stakeholders unsatisfied with choices done by the company.

As a result of this research, an expert tool was created next to the main report. The tool gathers the expert knowledge that was found in the literature research and makes it available to the stakeholders. Despite various points of criticism that were applied to the tool, the main research objective was met. The tool complied with the development framework and was evaluated as successful during the tests.

Nevertheless, there is still a lot of room for improvement. First of all, the tool was tested with only one pilot study, to test the full potential and usefulness, a number of follow-up studies should be conducted. In addition, the users indicated that they would like to see the tool within the ownership of a consultancy company. It was not tested yet if a consultancy company would see such a tool as useful for them.

The initial idea was to develop the tool in such a way that it can be used without guidance or supervision of the system engineer. Although it was proven with one of the tests that it is possible to use the tool individually, the interviewees claimed that the time required for the individual interaction is too long to apply it in real life.

Moreover, the tool was not tested with an on-going case, but rather to reflect on the decision that was taken and assessment of the approach that was chosen for the process. Working with an ongoing case would truly challenge the tool possibilities and utility.

In my opinion, the model requires significant improvements before it can present its full utilisation potential. The visual representation on output needs to be improved and the user interface simplified. On the other hand, the decisions makers claimed that already current version of the tool provides a lot of added value. It forces reflecting on the current processes and questioning the choices that were made basing on incomplete information. I was happy to hear that the users see a great potential in the tool and would like to see it further developed. I personally would like to work on the tool further, bringing it to more practical level, however, being aware of my own programming skills, I would need help from a professional program developer, who would be able to turn the established expert system into the perfectly working tool.

Position in the laboratory and scientific relevance
As mentioned at the beginning of the reflection, the research was conducted within the Smart Real Estate Management graduation laboratory. It is closely related to the field of the Corporate Real Estate Management and thus, directly related to the Real Estate Management course organised within the Management in the Built Environment program. The research addressed the problems recognised in the built environment and also closely related the to the issue of the facilitating the business operations with the real estate.

The state of art scientific knowledge gathered through the years and built by a number of researchers is given to the practitioners with a computer programme, making it easily accessible. In addition, with this research, I combined results from various studies and through recognition of reoccurring patterns I tried to interlink them. Basing on the ground established by others, I linked the location criteria with their determinants, which (to my best knowledge) has not been done before. Thus, this research also builds on the continuous improvement of matching the real estate with the real user needs.

Achievement of personal ambitions
Apart from the relevance of the research to the scientific world and adding value for the graduation company, I had a set of my personal ambitions that I wanted to achieve. In the beginning of the second year, when the graduation process started, I reflected on how I would like the graduation to proceed.
The first goal was to create a tool that would be useful in practice. As much as I enjoyed my study period, working in the field closely related to my studies was very eye-opening. I realised that the vast amount of knowledge and clever solutions that are presented to us at the university are barely recognised in practice. Even the professionals clearly indicate that ‘the real world’ has nothing to do with ‘academics’. I wanted to make an attempt to bridge that gap. Although, the current version of the tool is not what would be used in practice, I was very pleased by the achieved acceptance level and trust in the potential of the tool.

Secondly, I hoped to get more insight into the decision-making processes in the companies. In this case, both the in-depth literature research and graduation internship helped me in achieving this goal. I got a lot of insights in the process and was able to work with knowledgeable people, who contributed to my level of problem understanding.

Moreover, with the graduation internship, I gained a lot of practical experience in the field I was researching. I got a chance to work with fascinating people and was able to view the problems in the corporate real estate from various perspectives. I got involved in a fascinating project and got insights into aspects that go beyond the scope of my research. I sincerely recommend everyone to follow a graduation internship while working on their thesis, as the experience is invaluable.

Additionally, I hoped to finish the thesis in the time that was assigned for the research and graduate from the university within the two years. Despite the delays that I have faced in the first part of the process, I was able to work hard and make up for the lost time. I contributed a lot of time and worked long hours to meet the deadlines.
APPENDIX D

CONFIDENTIAL
DATA FROM THE PILOT STUDY
## 9.5 APPENDIX E

### THE CRITERIA LIST

In the table below, a list of themes and criteria categorised under them is presented. This list was used in the tool structure.

<table>
<thead>
<tr>
<th>THEME</th>
<th>CRITERION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs</td>
<td>1 Facilitating knowledge economy</td>
</tr>
<tr>
<td></td>
<td>2 Real estate/site search and acquisition costs</td>
</tr>
<tr>
<td></td>
<td>3 Relocation costs/ Cost of moving</td>
</tr>
<tr>
<td></td>
<td>4 Costs of hiring and training of new labour</td>
</tr>
<tr>
<td></td>
<td>5 The level of federal aid to local government</td>
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