

Personal reflection

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Notes: the aim of this document is to provide a final reflection on why a certain approach was chosen and how this planned approach from the research proposal fits in the working methods of the research lab and to what extent it worked out in acquiring the results and answering the research questions.

What did I plan to do and why?

This research project started with the following main research question: *How could an improved PAS be developed in such a way that the outcome of the algorithm closely reflects the stakeholders' preferences and what insights do a test and evaluation in practice provide?*

This question was based on a thorough literature study into the development of the PAS in order to identify its current state and thereby the recommended next step. It appeared that in the previous pilots, a search algorithm to optimise the outcome was not yet available, therefore the objective of this research and design project was to bring the research into of the PAS procedure a step further. This was done by testing and evaluating a model of this procedure that uses a search algorithm that helps to find an optimum solution in complex decision-making processes. From this objective, it follows that a working mathematical model of the PAS procedure had to be built, tested and evaluated in an actual decision-making process.

The main question was split into three elements that were answered separately, which resulted in a complete answer to the main question by the end of the research project. The three elements are the following:

1. *What is theoretically the best way to implement the search algorithm in the PAS?*
2. *Does the outcome of the algorithm reflect the stakeholders' preferences?*
3. *What is the judgement of the improved PAS by the stakeholders in practice, and what implications does this have?*

The main question predominantly represents a design problem that requires some sort of artefact to arrive at a solution. So in order to answer the main question, a design approach was followed, combined with empirical elements. The approach that was employed in this research, and that is commonly used to answer such research questions in general, is summarised in figure 1.

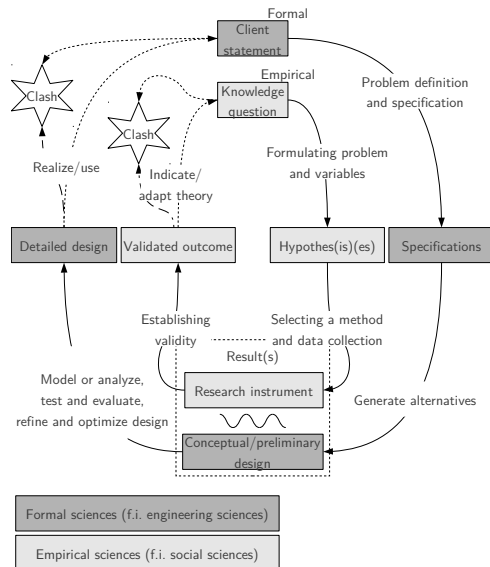


Figure 1 - The formal and empirical process combined (Barendse, 2012 #22@6).

This design process is typically an iterative process. As such, the formal cycle in figure 1 resembles the entire research and design project as well as the more specific design process of a mathematical model as part of the implementation of the PAS procedure. This model design process takes place in step three. In this step, a separate formal cycle was implemented to guide the iterative model design. This is discussed in detail in chapter 2 of the final report.

The first and third sub-question were answered in the empirical cycle, respectively based on a literature study and on the evaluation results of a pilot study with the PAS. The second sub-question was answered based on the model that has been built. In order to answer the main question, the entire cycle in figure 1 was completed. This provided the answers to the sub-questions that are combined into an answer to the main question, which is essentially based on the model that was built and tested in the pilot study.

In addition to the project objective and research questions, a set of personal targets has been established.

Where do I stand and how did I get there?

In the process of this research and design project, roughly five steps can be discerned, which are discussed individually in chapter two of the report. Currently the project finds itself at the end of the cycle where the model has been built, tested and evaluated; the main research question has been answered and recommendations have been made.

The first literature results are part of the problem definition and provide an overview of the development of a procedure that is now called the PAS procedure. This started with the detection of a problem in the alignment of real estate and business strategies, for which no appropriate models seem to be available. Based on the PFM tool, an evaluation model that uses a correct way to measure stakeholder preferences, a first design procedure was developed. This first design decision-making tool, using correct preference measurement, was called the PBD procedure. This procedure was further developed into the forebear of the PAS, the PBPD procedure, which was later on referred

to as the PAS procedure. The first pilot studies with these procedures show that stakeholders are able to work with it. Also an important aspect of the procedure, correct preference measurement, has been studied and is explained in a chapter in such a way that it can be used by other students to gain a basic understanding of this matter.

The first sub-question is answered based on a literature study into the determinants for successful implementation of decision support systems (DSS's). The main results of this study are presented in chapter 7 of the report, which concludes that user involvement is a critical element in the process; therefore the algorithm should be implemented in addition to the self-design of portfolio alternatives. Also the literature study provided a checklist that can be used to prepare the process of development and implementation of a DSS and in order to evaluate both the process and the system itself afterwards.

An early experiment on modelling a PAS problem in Matlab provided some additional practical lessons that have been translated to requirements for the final model. In the first place, the output of the model should be presented in relation to a visual representation of the portfolio that is being designed. Secondly, the interface for designing alternative portfolios should provide an interactive input screen. This screen should enable the stakeholder to easily design portfolio alternatives and provide direct visual feedback of the resulting portfolio and overall preference rating.

The final model that was built, meets almost all the requirements that were formulated based on the case and the experiment. Only the visual representation of the portfolio alternatives in a map was not possible. However, it was possible to implement some additional features that improved the design process, e.g. saving and recalling alternatives and visual feedback on the design constraints.

The outcomes of the pilot study in terms of location ranking and optimum portfolio design provided a positive answer to the second sub-question. The final ranking from the PAS that was confirmed in Tetra, prompted the location selected by LOB 1 from place 17 to 4. In addition to this, the portfolio alternative with the highest preference rating found by the stakeholders and checked in Tetra, provided an improvement in alignment of 5% over the current portfolio. Also after the pilot study it turned out that it was possible to generate all feasible alternatives with a brute force function. The best solution results in an improvement in the alignment rating of 7%. Moreover, the users indicated that they think the ranking closely reflects their preferences and that they accept the optimum portfolio alternative from the brute force function as the final outcome of the pilot study. This confirms that the model closely reflects their preferences.

The third sub-question was answered based on the evaluation results from the pilot study. The users were very positive about the pilot study process and the results. Especially they liked their involvement in the iterative model development process and were very enthusiastic about the intuitive design interface and the feedback it provided. The process made them accept the model and trust it and its outcomes. They even indicated that they would like the model in their daily process and are willing to implement its output without many more development iterations. Only to improve the representation of their preferences in the optimum portfolio design, they think some criteria should be added. The conclusions from the evaluation are that the PAS should be applied in the future as in this pilot study. User involvement in the process and explanation of the PAS principles and the model are important aspects.

Recommendations are made to apply the improved PAS in its current form and also test it in more complex cases, while explaining the principles based on a simple model. Moreover, since the brute force function provides the added value that it finds the global optimum, the complexity of cases up to which this tool can be used should be researched.

Further research might also focus on developing a standalone application with the algorithm implemented, while looking for a more visual representation of the output.

Reflection on how I got here

The approach that is described by the model in figure 1 helped me quite well to structure the process. By performing both cycles, all sub-questions could be answered. The knowledge behind the final answer to the first sub-question provided important input to start the pilot study. The checklist that is part of the conclusion of the literature study provided a useful set of elements that are explicitly implemented in the pilot study.

The evaluation of the pilot study, confirmed that the implementation of the algorithm in addition to the self-design process pays-off as shown by the users' enthusiasm. I think that the use of this checklist in the preparation helped to achieve the desired result. The stakeholders accept the model and trust its outcomes and even indicated that they would like to use the current model in their daily decision-making process. Moreover, since the evaluation interviews were based on the checklist, the elements were explicitly evaluated including the resulting acceptance and trust. The connection with the evaluation structure of experience, attractiveness and effectiveness made it possible to evaluate these elements at the same time.

The design approach used in the modelling process also proved to be useful. In order to arrive at a proof of concept for the modelling of a PAS problem in Matlab, a simple case was used to construct an initial model. The process of constructing this model resulted in some valuable conclusions regarding the modelling of the case in the pilot study, and proved that modelling such a case in Matlab is feasible for me. Moreover, it provided me with a basic proficiency in Matlab modelling. The same process was used in the actual case, by first establishing the model structure in a basic model after which I expanded it to the full model.

Overall, the operations research approach that is used in this project is quite a common practice in the department of Management in the Built Environment, because in this field many complex, non-linear problems occur. Also problem-structuring procedures like the PAS are not unknown in the department. In practice however, it seems like people in practice do not know how to cope with such strict step-by-step procedure.

However, during the first meetings, it appeared to me that people are open to it, but do not see the necessity of the strict steps and try to find a more efficient way at any time. This might be induced by the fact that they work under quite some time pressure. So even if they were enthusiastic to participate, they could do this to the fullest since other tasks had a higher priority. This raised the question whether the procedure is maybe too strict for practice. The representative of LOB 1, for instance, had only one hour for the PFM interview, so a work around had to be found. In the end Katie Davenport established the rest of the preference functions and the representative checked them and assigned weights. This raised the question for the future; how much time can the researcher or problem owner ask from the people for such a project.

During this four-month project, Katie Davenport and Carol Leipner-Srebnick dedicated at least 1-2 hours a week to meetings with me to understand what I was working on and to provide me with the required information. Also the two workshops and evaluation interviews took about 4 hours each. This implies that from the perspective of the advanced planning (AP) team, there was some time available for this pilot study. During this period the LOB was in the final phase of the financial year, therefore the representative was very busy. From what I understood from Katie Davenport is that she spent much more time in the original study over a period of multiple weeks, in which also the LOB representative was closely involved. In conclusion, the above can be interpreted as follows: from the business user there is quite some time available for a location study they directly benefit from, provided that this process takes place in a more quiet period

during the year. Also, such a process has a higher priority within the AP team than a pilot study. However, apparently the AP team realises that research and development activities into new tools for their pilot studies might improve the results and save time in the future. Contrary to the LOB that does not directly perceive the benefits they could have from this. This besides that the pilot took place in a rather busy period for them. So once the PAS procedure has proven itself as being an improvement over the current process, there is a good chance that it will be used in practice. However, the first time use with a new LOB will take more time, so it should be clarified to the LOB that eventually they will benefit from this in terms of a higher efficiency in future location studies.

This is confirmed by the reaction of the users on the first physical result of the process, in the form of the initial GUI. They became more and more enthusiastic. Also the workshops were perceived as very useful and in the evaluation the users indicated that the PAS provides an improvement over their current system, provided that a user-friendly application becomes available in the future.

It was unfortunate that the algorithm was not ready on time. However, I see this as a force majeure that was overcome by discussing and evaluating these results with the users after the pilot study. The results from the brute force function that was used instead of the algorithm provided an improvement of the preference rating over the alternative found by the stakeholders themselves. Moreover, it found the global optimum that was accepted by the stakeholders as the final outcome of the pilot study.

The theme of this research and design project is closely related to the research conducted in the CREM graduation lab. Moreover it builds upon the current PhD research by Monique Arkesteijn and a former PhD project by Ruud Binnekamp. Both are part of the research into the PAS procedure. In order to bring this research a step further by means of the test and evaluation of an improved PAS, including the search algorithm, a case was required that incorporates sufficient complexity. This complexity can be described in terms of stakeholders involved, the number and nature of criteria and the type of objects and their characteristics. The ideal case for this project would have comprised of 4-5 stakeholders with each 4-6 criteria that are conflicting to some extent, together with a set of 10-20 objects with about 10 characteristics. Because the previous pilots have been held at public institutions, the ideal case should be at the real estate department of a large multinational company.

The search for a case at a company started half-way December by sending out the first letter to Shell. Because I contacted them based on personal contacts, it was not preferable to send out multiple letters at once. Only after Shell indicated that they were very interested but expected to lack time for such a project, I contacted more companies. Therefore, the current case was confirmed only in the beginning of March. This meant quite a delay with regards to my planning. Something I think I compensated by the fact that I wrote a large part of my final report prior to P3 and could work on the pilot study and report on the results full time until P4, instead of gaining practical experience next to it.

In the process of finding a case, Oracle indicated that they were willing to take up the project. They had a case that seemed suitable at first sight, but later on it appeared that it did not exactly meet the requirements of the ideal case. There appeared to be only one stakeholder and the design aspect in the case seemed not to deliver the preferred complexity. Unilever also wanted to work on the project, but required me to come to London without providing additional financial support. This made me realise that the ideal case, in a company that makes time to facilitate such a project, does not exist. At least not now, at the companies within reach. Initially, the process I went through with Oracle, made me worry about at what point the case would not suffice anymore to find meaningful results. A discussion about this made me realise that I worked on it and

thought about it all the time at the level of adding a novelty to the research into the PAS, instead of proving a concept within my MSc graduation project.

Looking at the effects of the current case on the meaning of the results, the following observations are made. The case does not have all the characteristics of the ideal case, but still matches the number of criteria and objects. Also the pilot study took place at a large multinational company. This means that even when it turned out that the users found the same optimum alternative as the algorithm, this comparison could still be made and be evaluated. Also it could be that the relatively low complexity of the case resulted in a better understanding of the model by the users and therefore a more positive evaluation. However, this does not make the evaluation results less valuable in the PAS research context, as it provides important insights into the implementation of the algorithm and the model development process. Especially valuable was that it provided the perspective of a private party on the process and model, which is important for a tool that should improve decision-making in CREM practice. From this perspective it was even more positive that the users indicated that they would like to use the current tool in their actual decision-making process. Moreover, the fact that it was the first time that the users were confronted with the outcomes of the brute force function as equivalent of the algorithm and that this was evaluated in a pilot study are some important novelties to the research into the PAS. Also a novelty was that the model and design interface have been written in Matlab,

The first study target, planning my activities in a structured way improving my time estimates, worked out quite well. The detailed planning for the pilot study process gave me some confidence in the viability to finish the tests and write the P4 report on time. I detailed it after the second workshop into a daily planning with the chapters I had to deliver for my P4 report. This turned out to be quite a good planning as I could stick to it most of the time. Also the daily task planning I made every day helped me to prioritise tasks. However, I experienced that often it was difficult to stick to the time estimates that I made, although I made progress.

The second target, modelling a real life situation, was a continuous process during the pilot study. I made a lot of progress in understanding the principles during my modelling experiment and developing the final model. I think this experience increased my analytical skills. The study target to make an academic contribution is embedded in the theme of this research project, and really helped me to motivate for the project until the end.

The final target, to improve my writing productivity, initially really helped me to produce the chapters for my P2 report. However, after this report it somewhat lost my attention. This slowly increased my frustration on my writing productivity until I realised at some point that I forgot to apply my intended structure in writing, i.e. first setting out the structure of a chapter, then writing a writers version of just quick sentences and only then a readers version. When I started to use this again, especially in writing the last parts for my P3 and P4 report, it spurred my productivity and therefore my satisfaction. Initially I regularly fell back into my pitfall of writing too neatly in my writers version. However, when I applied the structure more explicitly I by writing a chapter in just quick sentences, I almost never made a fall-back anymore. Also I really experienced how much better I could get my thoughts on paper.