

Graduation Plan

Master of Science Architecture, Urbanism & Building Sciences



Graduation Plan: All tracks

The graduation plan consists of at least the following data/segments:

Personal information	
Name	Hylke de Visser
Student number	4009266
Telephone number	+316 21 62 21 64
Private e-mail address	Hylkedevisser@gmail.com

Studio	
Name / Theme	Real Estate Management
Teachers / tutors	Monique Arkesteijn, Ruud Binnekamp
Argumentation of choice of the studio	<p>A few years ago I was the chairman of an international student association (STeLA) that provides trainings and workshops in team dynamics and personal development on a cross-cultural scale. It is especially focussed on technical students from all around the world. During this year I have experienced decision-making processes with many people involved that all had other preferences on different criteria. This was the period that I developed a curiosity in complex decision-making processes. When I tried to formalise this curiosity, I came across literature on Multi Criterion Decision Analysis (MCDA) and started to grasp the complexity of such matters.</p> <p>Drawing the parallel from this curiosity to the built environment brought me to the subject of real estate management (REM). More specifically, the troubles that real estate managers experience in weighing different criteria and preferences in strategic portfolio design. In the field of corporate real estate management (CREM), some successful experiments are performed. In these experiments, computer models are used to support the decision makers in designing a portfolio based on their preferences.</p> <p>My background in STeLA provided me with some experience in systems thinking and system dynamic modelling, which I find interesting ways to model the real world. I am particularly interested in how to employ the leverage of such models to achieve better results in decision-making.</p> <p>The topic of this research finds itself particularly close to the questions real estate managers struggle with. Therefore, it is quite practically oriented. For me, this is an important aspect in my motivation and the intrinsic value of the research subject to me.</p>

Graduation project

Title of the graduation project	Testing the improved PAS methodology: implementation of a search algorithm
Goal	
Location:	A real estate portfolio somewhere in the world
The posed problem,	<p>Corporate real estate management is the management of the real estate portfolio of mostly large multinational companies. This is not their core business, however it is needed to achieve the business goals. In order to do so, the static real estate has to be aligned with the dynamic business environment. The alignment of the two strategies has been a long-standing issue (Heywood, Kenley, & Waddell, 2009, pp. 5-7), the importance of this alignment lies in the added value the real estate could provide to the performance of an organisation (Den Heijer, 2011, p. 91). Achieving this alignment requires a structured approach that measures the state of alignment in order to be able to take better decisions. A review of the models that have been developed so far shows that no such model exists yet (Arkesteijn & Binnekamp, 2013, p. 94; Arkesteijn, Valks, Binnekamp, Barendse, & De Jonge, 2015, p. 103). Therefore Arkesteijn et al. (2015) propose the preference-based accommodation strategy (PAS) procedure.</p> <p>In this procedure, the stakeholders define a set of decision variables and their preferences. In an iterative self-design process, the stakeholders then manually design portfolio alternatives, while optimising the overall preference rating. The alternative with the highest preference rating is selected (Arkesteijn et al., 2015, p. 104). In order to solve more complex decision making processes, a search algorithm is required that searches for a maximum overall preference rating (Arkesteijn & Binnekamp, 2013, p. 98).</p>
research questions and	<p>The main research question that is covered in this research is: <i>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?</i></p> <p>The question comprises of three parts that constitute the core of this research and are used to structure it. Part one concerns the improved PAS, the second part the reflection of the stakeholders' preferences in the outcome of the PAS and third, the insights of a test and evaluation in practice. The three elements result in the following three sub-questions.</p> <p>1.1.1. Sub-questions</p> <ol style="list-style-type: none"> 1. <i>How could the search algorithm be implemented PAS?</i> 2. <i>Does the outcome of the algorithm reflect the stakeholders' preferences?</i> 3. <i>What is the judgement of the improved PAS by the</i>

	<i>stakeholders in practice, and what implications does this have?</i>
design assignment in which these result.	The aim of the research is to build, test and evaluate a mathematical model the improved PAS procedure in order to bring the research into this tool a step further and thereby to improve future decision-making processes. The final result will be generally applicable knowledge on the model development process and the pas procedure. Also part of model's core mathematical formulations and decision variables could be found to be generally applicable and could therefore easily be translated to a more general basic portfolio design model.
<p>[This should be formulated in such a way that the graduation project can answer these questions. The definition of the problem has to be significant to a clearly defined area of research and design.]</p>	
<p>Process</p>	
<p>Method description</p>	
<p>Research design</p> <p>The main question of this research comprises of a so-called design problem. It is aimed at making operation related improvements towards the future, i.e. an improvement in the PAS. In order to solve such problems in general, the design of an artefact is required to properly arrive at a solution (Barendse et al., 2012, p. 1). From the previous it follows that to provide an answer to the main question, a design process should be followed.</p> <p>A structure for such a process is shown in figure 3. It shows an iterative process towards the development of an artefact.</p>	

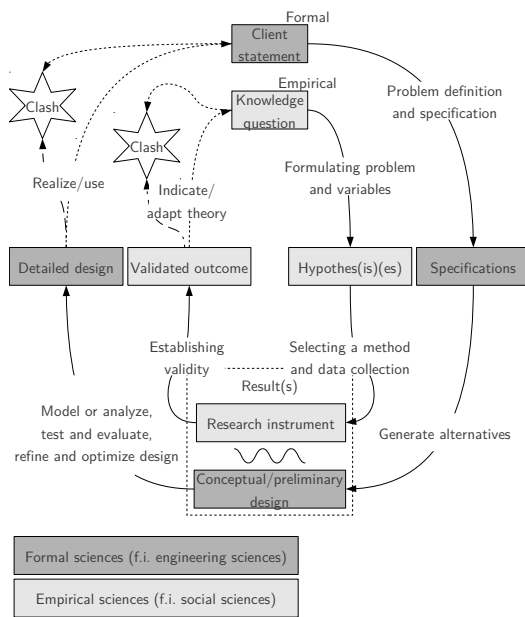


Figure 4 - The formal and empirical cycle combined (Barendse et al., 2012, p. 6).

The resulting model provides a good starting point to set out the structure and design of this research. The five steps are described below.

Step 1

In this step was used to define the problem based on an initial literature review and discussion with professionals in the research field. The PAS procedure as a solution to the problem of alignment of corporate and real estate strategies was identified together with the possible improvement of a search algorithm. From the problem statement, a main research question was derived, supported by several sub-questions. The first two sub-questions are answered in the formal cycle by building and evaluating a model of the improved PAS, applied to a practical case. The problem statement regarding this case, which is required to build a mathematical model, will be compiled when an internship position at a company is found. The first sub-question also has an empirical component, i.e. finding out what is theoretically the best way to implement such algorithms. This question will be answered in the empirical cycle together with the third sub-question. Both answers will be based on the evaluation of the PAS.

Step 2

In order to specify the problem statement, a literature study into the development of the PAS procedure so far was conducted. This yielded several specifications for the model design, regarding e.g. multi criteria decision analysis (MCDA) and correct preference measurement. In the empirical cycle, the first hypothesis is that the algorithm will yield a better result than the stakeholders are able to achieve through self-design. This hypothesis is mainly based on previous tests with the PAS and its predecessors. Related to the first sub-question, the second hypothesis that it would be best to implement the algorithm in addition to the self-design.

Step 3

Based on the specifications from the previous step, a first model of the PAS will be built in the formal cycle. In this process, the conclusions from the literature study into the first sub-question will be applied to the implementation of the algorithm.

This is also the step where the first feedback loop from the design process is applied. In a way, the entire formal cycle is run-through at least two times within the design

stage between step 3 and 4. This process of modelling a real life portfolio case is illustrated in figure 5. This starts with a client statement regarding the current alignment of the portfolio with the business (step 3.1). The stakeholders specify their wishes for the future state of the portfolio in terms of decision variables, preference ratings and design boundaries in step 3.2. These elements are based on the business strategy. Based on this, a first model is built that will be tested in a workshop where the stakeholders design portfolio alternatives themselves (step 3.3). This workshop is evaluated in an interview afterwards, comparing the model outcome with the knowledge of the process in real life, in order to improve the model's representation of reality (step 3.4). The clash comprises of confronting the modelling process with the expectations of the stakeholders in step 3.5. This is the start of the second iteration where the specifications of step 3.2 may have to be changed according to the evaluation models. This results in an adapted model of the PAS, which is evaluated and improved again.

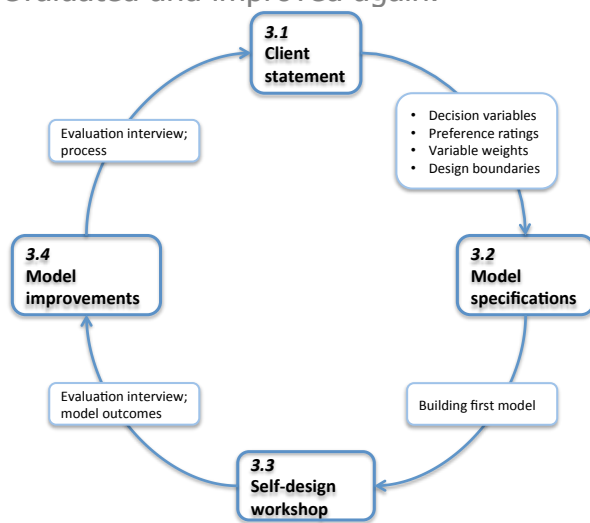


Figure 5 - Model design iterations in the formal cycle (own illustration based on Barendse et al., 2012, p. 6).

Step 4

In the formal cycle, this step comprises of the final model of the PAS that is developed in the modelling cycles. This model is then connected to the search algorithm to find an alternative with a higher preference rating. In the empirical cycle, the first hypothesis will be tested by comparing the outcome of the algorithm to the preference rating achieved through the self-design process. The evaluation of the implementation process of the algorithm is confronted with the second hypothesis. This yields the validated result. This result comprises of a full evaluation of the PAS in terms of procedure, process and model and two hypotheses that are confirmed or disapproved to some extent.

Step 5

The model will be compared to the problem statement in the formal research cycle, which results in conclusions regarding the usability of the model by the company that provided the case. From the empirical perspective, the outcomes of the evaluation on the PAS procedure, process and the model are compared to previous research in order to improve the PAS and possibly add conclusions regarding the implementation of the algorithm to the existing knowledge. Also conclusions regarding the extent to which the approach can be generalised are applicable here.

Research methods

The research methods that are used in this research project to answer the main question are both formal and empirical. The model building belongs to the former category, the literature study and interviews belong to the latter. The literature study is used to construct a theoretical framework prior to the building of the model. The interviews are used to acquire the data that is required to build the model and are used to evaluate the PAS after the test of the model.

In addition to the theoretical implementation of the methods discussed in this sub-paragraph, chapter 3 presents the results of the literature study and chapter 4 presents the first modelling experiments.

Literature study

The literature study that was conducted can be roughly divided in two parts, one on the development of the PAS so far, and the other on the determinants of successful implementation of decision support systems. An exploratory literature review is used to analyse the problem and explore the research field. It is also used to set up the main research question and conceptual model. The final literature study is used to construct a theoretical framework on the topic of research.

The literature study on the development of the PAS has been conducted based on the publications that are suggested by the two mentors in this research who developed the procedure. The combination of this literature provides an overview of the steps in the development of the PAS so far, and the next step that is made with this research.

The literature search on the determinants of successful implementation of the search algorithm is started with search queries in Scopus, based on the following set of keywords.

	← AND →			
	Aspect 1	Aspect 2	Aspect 3	Aspect 4
↑ O R ↓	<ul style="list-style-type: none"> • Decision support system • Decision support systems • DSS • Decision making • Multi criteria decision making • Man-machine interaction 	<ul style="list-style-type: none"> • Computer aided • Implementation 	<ul style="list-style-type: none"> • Trust • Credibility • Acceptance 	<ul style="list-style-type: none"> • Review • Literature review • Meta analysis

Table 1 - Literature search keywords.

However, this approach mainly delivered rather dated reports and none of them

comprised of a structural review of the literature on acceptance and implementation of decision support systems or equivalent systems to that date.

Therefore, the approach was shifted towards selecting interesting articles from the reference lists of the most recent articles. The articles were selected based on their keywords, of which at least one had to resemble the keywords under "aspect 1" in table 1. Furthermore the function "cited by" in Scopus was used to find publications that cited the publications found through the search queries. This process yielded about seven relevant publications. Among these publications there were only two recent literature reviews, one of which focuses on the field of implementation of the search algorithm. This is a research paper by Riedel et al. (2011).

The literature study discovering determinants for successful implementation of the search algorithm in the PAS is mainly based on this research paper by Riedel et al. (2011). The authors published a broadly oriented research paper on the acceptance of such algorithms in decision-making. They performed multiple literature studies on human factors in design and implementation of this kind of algorithms, focused around the model development process and the role of trust in the entire process. The findings from this paper are combined with other publications that were selected.

Model building

The model will be built in an iterative sequence of interviews and workshops as described above. The process will at least comprise of three interviews and two workshops in the following sequence; I-W-I-W-I. This method of building the model is also used in a previous test with the PAS and was evaluated positively (Arkesteijn et al., 2015, pp. 107, 118). The iterative sequence in the model building process is also supported by the findings from the literature study into the successful implementation of the algorithm. Therefore it will also be used in this research.

The interviews are meant to acquire the information needed to build the model and are held with each stakeholder individually. In the first interview, the following elements are discussed:

1. Specify decision variable(s);
2. Assign the stakeholder's preference rating to each variable;
3. Assign the stakeholder's weight to each variable;
4. Determine design constraints;

The output of this interview is used to develop and test an initial model in the first workshop. The following interview discusses these same elements in order to identify additions in decision variables and/or adaptations in either of the elements. These topics are part of step three of the formal cycle as described above.

Evaluation interviews

In each interview round, the PAS will also be evaluated. This will be done according to the four assessment criteria as suggested by Joldersma and Roelofs (2004). They use four criteria. The first one is *experiences with the method*; this criterion measures the impact of the method based on the user's experience. The *attractiveness of the method* as second, is related to confidence in the method and its outcomes which translate into satisfaction. The third criterion is *participants' perceptions of effectiveness of the method* and inquires on the extent to which the method contributes to the results. This is combined with the *observers' perceptions of the effectiveness of the method* in order to achieve a more balanced view of the quality of the results (Joldersma & Roelofs, 2004, pp. 697-698). Three of these criteria are based on the input of the stakeholders in the pilot, this results in the

following interview elements:

1. Describe experiences with the method;
2. Describe the attractiveness of the method;
3. Describe perception of effectiveness of the method.

When looking at the checklist in table 2 that was composed out of the literature study into the determinants of successful implementation of DSSs, the characteristics that are related to the process seem to be indicators for the users' experience with the method under the first interview element. The characteristics of the system seem to be indicators for the attractiveness of the method because they reflect the acceptance of the system and its outcomes, which is also incorporated in the second interview element (Joldersma & Roelofs, 2004, pp. 697-698).

Process (p)/ system (s)	Characteristic	Operationalization	Measurement unit
P	Participation & involvement of users and use of the apprenticeship model	Workshops, interviews and evaluation sessions	Frequency of workshops, interviews and evaluation sessions during the process
P	Iterative process	Interaction between model designer and user and possibility to change decisions made earlier	Frequency of workshops, interviews and evaluation sessions during the process
P	Perceived control	Influence on model design and possibility to change decisions made earlier	Perceived level of control Fully=100-Totally not=0
P	Flexibility of initial variables/preferences	Iterative model development and self-design	Y=100-N=0
S	Reflection of real decision-making process	Iterative model building process	Realistic=100-Non realistic=0
S	Perceived usefulness	System complexity and perceived control	Useful Y=100-N=0
S	Perceived ease of use	System complexity	Easy to use Y=100-N=0
S	Trust (outcomes meet system expectations)	Participation and involvement of users	System performs as expected =100-system does not

			perform as expected=0
S	Backside of system understood	Iterative model development and self-design	Y=100-N=0
S	System justifies solutions	Showing how outcome is reached	Y=100-N=0
S	System is used for its original purpose	Iterative model building process	System fits the purpose Y=100-N=0
P & S	Satisfaction	System complexity	Sufficient level of complexity=100-non sufficient level of complexity=0

Table 2 - Checklist for DSSs and their development process (based on paragraph 3.2).

The interview elements are part of the empirical cycle that is used to improve the PAS. In each intermediate interview these elements are discussed and in the end of the pilot they are used to make an overall evaluation where they are combined with the observer's perception of the effectiveness of the method in order to arrive at a validated outcome in step 4.

Literature and general practical preference

- Arkesteijn, M. H., & Binnekamp, R. (2013). Real estate portfolio decision making. In A. V. Gheorghe & M. Masera (Eds.), *Infranomics: sustainability, engineering, design and governance* (pp. 89-99): Springer International Publishing.
- Arkesteijn, M. H., Valks, B., Binnekamp, R., Barendse, P., & De Jonge, H. (2015). Designing a preference-based accommodation strategy: a pilot study at Delft University of Technology. *Journal of Corporate Real Estate*, 17(2), 98-121.
- Barendse, P., Binnekamp, R., De Graaf, R. P., Van Gunsteren, L. A., & Van Loon, P. P. (2012). *Operations research methods: for managerial multi-actor design and decision analysis* (R. Binnekamp Ed.). Amsterdam: IOS Press.
- Barzilai, J. (2005). Measurement and preference function modelling. *International Transactions in Operational Research*, 12(2), 173-183.
- Beynon, M., Rasmeyan, S., & Russ, S. (2002). A new paradigm for computer-based decision support. *Decision Support Systems*, 33(2), 127-142.
- Binnekamp, R. (2010). *Preference based design in architecture*. Delft: IOS Press.
- Bryman, A. (2012). *Social research methods* (4th ed.). Oxford: Oxford University Press.
- De Jonge, H., Arkesteijn, M. H., Den Heijer, A. C., Vande Putte, H. J. M., De Vries, J. C., & Van der Zwart, J. (2009). Designing an accommodation strategy (DAS frame). Delft: Faculty of Architecture.
- Den Heijer, A. C. (2011). *Managing the University Campus: Information to support real estate decisions*. Delft: Eburon Academic Publishers.
- Dym, C. L., & Little, P. (2004). *Engineering design: a project-based introduction*. New-York: Wiley.

- Heywood, C. (2011). *Approaches to aligning corporate real estate and organisational strategy*. Paper presented at the European Real Estate Society 17th annual conference 2010.
- Heywood, C., Kenley, R., & Waddell, D. (2009). *The CRE toolbox: addressing persistent issues in corporate real estate management*. Paper presented at the 15th Pacific Rim Real Estate Society (PRRES) conference, Sydney.
- Joldersma, C., & Roelofs, E. (2004). The impact of soft OR-methods on problem structuring. *European Journal of Operational Research*, 152(3), 696-708.
- Kumar, R. (2011). *Research methodology*. London: Sage.
- Mintzberg, H., Ahlstrand, B. W., & Lampel, J. (2005). *Strategy bites back: it is a lot more, and less, than you ever imagined*. Harlow: Person Education.
- Pruyt, E. (2013). *Small system dynamics models for big issues: triple jump towards real-world complexity*. Delft: TU Delft Library.
- Razmak, J., & Aouni, B. (2015). Decision support system and multi-criteria decision aid: a state of the art and perspectives. *Journal of Multi-Criteria Decision Analysis*, 22(1-2), 101-117.
- Riedel, R., Fransoo, J. C., Wiers, V., Fischer, K., Cegarra, J., & Jentsch, D. (2011). Building decision support systems for acceptance. In J. C. Fransoo, T. Waefler, & J. R. Wilson (Eds.), *Behavioral operations in planning and scheduling* (pp. 231-295). Berlin Heidelberg: Springer.
- Schrenk, L. P. (1969). Aiding the decision maker: a decision process model. *Ergonomics*, 12(4), 543-557.
- Valks, B., Arkesteijn, M. H., Binnekamp, R., Barendse, P., & De Jonge, H. (2014). *Designing a preference-based accommodation strategy: a pilot study at Delft University of Technology*. Paper presented at the ERES, Bucharest, Romania.
- Van Loon, P. P., Heurkens, E. W., & Bronkhorst, S. (2008). *The urban decision room*. Amsterdam: IOS Press.
- Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: toward a unified view. *MIS Quarterly*, 27(3), 425-478.
- Wærn, Y., & Ramberg, R. (1996). People's perception of human and computer advice. *Computers in Human Behavior*, 12(1), 17-27.

Reflection

Relevance

Scientific relevance

As Heywood (2011) points out, there are rather few researchers worldwide that are dedicated to CREM. Also, models have been often developed from practical situations, possibly resulting in a lack of scientific foundation in the models (Heywood, 2011, p. 10). Therefore scientific research in the development of alignment models is relevant (Heywood et al., 2009, p. 9).

Furthermore, the previous paragraph showed that the models that have been developed, cover a variety of aspects of the alignment activity, however none of them seems to cover the complete set of components that was identified by Heywood (2011, pp. 6, 10). This could be the reason that they are not used in practice very often (Heywood, 2011, p. 10). Moreover, none of those methods incorporates correct preference measurement to obtain an optimum solution although this is required to obtain meaningful results (Arkesteijn & Binnekamp, 2013,

p. 94; Binnekamp, 2010, p. 29). Therefore, the PAS procedure is one of the first procedures that combines a structured approach towards the design of portfolio alternatives with correct preference measurement to rate the alternatives and select the best design (Arkesteijn & Binnekamp, 2013, p. 94; Arkesteijn et al., 2015, p. 103). This makes the research into the PAS procedure relevant.

The current PAS procedure has been tested and is working (Arkesteijn et al., 2015, pp. 117-118). However there have been several calls for optimising the PAS procedure by means of the use of a search algorithm, which is to find a better optimised solution than can be achieved in the current setup (Arkesteijn & Binnekamp, 2013; Arkesteijn et al., 2015). This provides additional scientific relevance to this research project.

With the above perspective on the PAS and its improvement, this research project into the PAS contributes to the PhD research of Monique Arkesteijn in the department of MBE at Delft University of Technology. The research aims to add to the current scientific knowledge in this field by bringing the PAS procedure a step further. It focuses on the theoretically most optimal way to implement the algorithm in the procedure and to test and evaluate the resulting model in practice.

Societal relevance

The societal relevance of this research is related to the improvement of the decision making process, which could lead to a better alignment of corporate strategies and real estate strategies. This could improve the efficiency in use of resources due to a more efficient use of space. The PAS procedure could help to maintain buildings in a real estate portfolio instead of divesting them and building/renting new accommodation, thereby leaving behind a lot of vacant space. This is enabled by the possibilities of the PAS procedure to incorporate more complex considerations between alternatives.

Better alignment of corporate real estate and business strategy will lead to more added value of the real estate to organisations. This might result in higher profitability of companies, which could increase their value. In the end this might lead to more prosperity in general.

Time planning

	Period 1 September - November	Period 2 November - January	Period 3 February - April	Period 4 April - May	Period 5 June
Deadlines	2 weeks	P2 report 08/01 (wk2)	P3 report 28/03 (wk3)	P4 report 02/05 (wk3)	P5 report 13/06 (wk6)
Problem analysis & definition	<ul style="list-style-type: none"> - The alignment problem - Problem with heuristics - Preference measurement problems - Research done so far & next step 	<ul style="list-style-type: none"> - Further development of problem analysis in specific fields 	P3 pres 04- 15/04	P4 pres 09- 20/05	P5 pres 20- 30/06
State-of-the-art in research on the PAS procedure	<ul style="list-style-type: none"> - Literature study - Importance of research - Research so far - Next step - Importance of this next step 	<ul style="list-style-type: none"> - WK 7: Preference measurement and heuristics - WK 7: The PAS procedure in perspective of CREM practice - WK 6-7: Participatory group decision making 			
Determinants for successful implementation of decision support systems	<ul style="list-style-type: none"> - Literature study - Model or determinants for acceptance of DSS - Dynamic design process of DSS described by the model - Trust as important factor for system acceptance 	<ul style="list-style-type: none"> - WK 1-2: Confront findings Riedel et al.(2011) with additional literature 			
Conclusions and implications for research	Development of a theoretical framework	<ul style="list-style-type: none"> - WK 1-2: Write conclusions - WK 3: Interview Monique on aspects covered in PAS - WK 3: Write suggested improvements for PAS and implications for research 			
Modeling PAS in Matlab		<ul style="list-style-type: none"> - WK 1: Develop conceptual model - WK 1: first discovery of Matlab - WK 2-4: discover restaurant case - WK 4-6 Modeling lecture hall case - WK 6-7 visualisation screen 			
Implementation in practice		<ul style="list-style-type: none"> - WK 1-2: Intro company - WK 3: PAS introduction - First interview/workshop - WK 4-6: Development simplified PAS model - Workshops/design sessions - Model testing & validation sessions - WK 7-10: Expand PAS model - Improve representation 			
Reporting		<ul style="list-style-type: none"> - WK 5 start writing 	<ul style="list-style-type: none"> - WK 6 Brief progress report 	<ul style="list-style-type: none"> - WK 2-3: Final model pilot tests - WK 3-4: Compare cases & evaluate 	<ul style="list-style-type: none"> - WK 4 start writing
					Final conclusions