Improving decision making in CRE alignment, by using a preference-based accommodation strategy design approach

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Abstract

Purpose – One of the long-standing issues in the field of corporate real estate management is the alignment of an organisation's real estate to its corporate strategy. To date, 14 models for corporate real estate (CRE) alignment have been made, as well as four comparative studies about CRE alignment. Some of the CRE alignment models indicate that they strive for maximum or optimum added value. However, because most models take a so-called procedural rationality approach, where the focus is not on the content of the decision but on the way that the decision is made, "how a CRE manager can select an (optimum) alternative" stays a black box. The purpose of this paper is to open the black box and offer a Preference-based Accommodation Strategy (PAS) design procedure that enables CRE managers to design a real estate portfolio, makes use of scales for direct measurement of added value/preference, and allows the aggregation of individual ratings into an overall performance rating. This procedure can be used as add-on to existing alignment models.

Design/methodology/approach – The objective of this paper is to test if participants are able to successfully perform the PAS procedure in practice. The PAS procedure is in essence a design methodology that aims to solve strategic portfolio design/decision-making problems. In accordance with problem-solving methodology, mathematical models are made for two pilot studies at the Delft University of Technology. This paper describes a second test of the proposed procedure for designing a real estate strategy. The application of real estate strategy design methods in practice is very context-dependent. Applying the PAS procedure to multiple context-dependent cases yields more valuable results than just applying it to one case.

Findings – The PAS design procedure enables CRE managers to select the (optimal) solution and thereby enhances CRE decision-making. The pilot study results reveal that, by completing the steps in the PAS procedure, the participants are able to express their preferences accordingly. They designed an alternative portfolio with substantially more added value, i.e. a higher overall preference score, than their current real estate portfolio. In addition, they evaluated the design method positively.

Research limitations/implications – The positive results suggest that designing a strategy by using the PAS design procedure is a suitable approach to alignment.

Practical implications – The PAS design procedure enables CRE managers to determine the added value of a real estate strategy and quickly and iteratively design many alternatives. Moreover, the PAS design method is generic, it can be used for a wide range of real estate portfolio types.

Originality/value – The PAS procedure is original because it considers CRE alignment as a combined design and decision problem. The use of operational design and problem-solving methodologies along with an iterative procedure, instead of empirical/statistical methods and procedures, is a novel approach to CRE alignment. The PAS procedure is tested in a second pilot study to provide an assessment of the methodology

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through the study by testing it under different conditions to the first study. The novelty of this pilot is also that it allowed testing the procedure in its purest form, as the problem structure did not require the additional use of linear programming.

Keywords Decision-making, CRE alignment, Preference measurement, Adding value, Corporate real estate management, Decision support tool

Paper type Research paper

1. Introduction

A long-standing issue for corporate real estate management (CREM) is the alignment between corporate real estate (CRE) and organisational strategies to deliver value to the organisation (Heywood, 2011). CRE alignment is even defined as the raison d'être of CREM by Krumm et al (2000). According to Kaplan and Norton (2006), the "alignment of all an organisation's cost and value creation activities is important in achieving enterprise-wide value". Following Kaplan and Norton, Then and Tan (2010, p. 33) state that:

> Alignment in an active sense implies moving in the same direction, supporting a common purpose, being synchronized in timing and direction, being appropriate for the purpose and in a passive sense the absence of conflict.

In other CRE alignment models, "alignment" itself is often not explicitly defined; therefore, Heywood and Arkesteijn (2017) deepened the understanding of CRE alignment through a qualitative hermeneutic meta-study of 20 existing alignment models and found alignment to be more complex and pluralistic than the individual models assumed. They conclude that four dimensions operating simultaneously in CRE alignment were evident – a multi-valent relationship, multiple alignment forms, multiple cognitive objects to align and alignment in multiple directions.

Further extensive research into 14 of these CRE alignment models (De Jonge *et al.*, 2009; Heywood, 2011; Arkesteijn and Heywood, 2013) traced four building blocks and 12 components that are necessary to model CRE alignment (Table I). The building blocks are:

Table I. Four building blocks with 12 components to model aligning CRE to organisational strategies (Arkesteijn and Heywood, 2013)[a]

Building blocks			
Understanding corporate strategy	Understanding real estate performance	Making the real estate strategy	Implementing the real estate strategy
Components			
Business drivers and forces	Audit of existing real estate	CRE strategy (formation)	Actioning the real estate intervention
Internal strategic drivers	Assess the effect of CREM actions	Strategy integration (alignment)	Actioning the required CREM practices
Strategic triggers	Real estate market data/information	Integration with other corporate functions [Corporate Resource Infrastructure (Materna and Parker, 1998)/Integrated Resource Infrastructure SolutionsIRIS (Dunn *et al.*, 2004)]	
Corporate strategy (formation)			

Note: This categorisation differs slightly from a previous publication (Heywood, 2011), as subsequent work has tested and refined the original work resulting in different components and names

- understanding corporate strategy;
- understanding real estate performance;
- making real estate strategy; and
- implementing real estate strategy.

Although all studied models included these four main topics, not all models include all components, but they do include at least seven.

Another comparative alignment study by Appel-Meulenbroek *et al.* (2010) looked at eight of the existing CRE alignment models and aimed to choose the best model. They selected Nourse *et al.* (1993) as the best, which was defined by the authors as most extensive and useful and has the best fit with the strategic thinking map which they used as strategic management reference. However, the model also receives criticism (Appel-Meulenbroek *et al.*, 2010, p. 5) because "the alignment itself seems questionable and it is not clear why certain strategies should be aligned, and why others not. Nor what determines strength".

Arkesteijn *et al.* (2015) classified 14 existing alignment models to test if they are able to determine whether alignment as a (measurable) state is reached. They argued that therefore the following three requirements need to be met: (1) Is the CRE alignment method an evaluation or a design method? (2) Are scales used to determine whether both quantitative and qualitative requirements are met and if the requirements are established directly by the decision makers? Their last requirement was if (3) the performance on all variables is aggregated into an overall performance rating. They concluded that currently none of the classified alignment models were able to meet all three requirements at the same time.

In this research, the existing CRE alignment models are studied from a decision-making perspective in line with the previous study of Arkesteijn *et al.* (2015) to determine if in the existing models it is clear when, by whom and how is the (optimal) alternative chosen? The first observation is that CRE decision-making is not defined as a specific building block or as a component by Heywood and Arkesteijn (2017). The component closest to decision-making is "assess the effect of CREM actions". However, in this component the focus lies on the assessment of specific actions and not how to choose the best solution. Therefore, a closer look is given to the underlying CRE alignment models.

In the CRE alignment models, decision-making receives little attention. In the graphical representations of these models, nine models do not have a specific graphical item (i.e. box) representing decision-making (Weatherhead, 1997; O'Mara, 1999; Englert, 2001; Osgood, 2004; Then, 2005; Wills, 2005; Scheffer *et al.*, 2006; Haynes, 2008; Then and Tan, 2010), while five models have a specific "box" that at a certain point in the process indicates that one or more decisions need to be made [Nourse *et al.* (1993); Lindholm and Levainen (2006) refer to operating *decisions*, White (1998) to identify, evaluate options and *agree* strategic real estate plan, Edwards and Ellison (2003) *selection* of strategies, Den Heijer (2011) based on De Jonge *et al.* (2009), weigh and *select* alternative(s)]. However, this box often is a "black box" in which it remains unclear exactly how and by whom the best solution is chosen. Only some authors indicate which technique is used to decide, multi-criteria decision-making or conceptual linear programming (Nourse *et al.*, 1993). In conclusion, in most models, decision-making is only briefly touched upon and not elaborated upon.

To further clarify this statement, CRE alignment models are classified into three types of decision-making as distinguished by De Leeuw (2002, p. 249), which he refers to as three types of rationality, based on Kickert (1979). The classification scheme is as follows: the first type is substantive rationality in which it is about the choice of an (optimal satisfactory) alternative. Whereby, he states that there are different subtypes but all of them are about the choice – with or without handicaps – of an alternative. This type is characterised by the fact that there is only one decision maker and the aspect of time is mostly disregarded. In the second type, the procedural rationality, the focus is not on the content of the decision but on the way that the decision is made. Decision-making processes are seen as in time ordered steps leading to a decision. In this type, a meta level is present, since it is about decision-making. The third type is structural rationality – which is, like the former, a kind of meta level. It addresses the question of what is an appropriate (the best, satisfactory) organisation for decision-making. The decision problem is the order in which the various participants need to be dealt with by whom in the decision-making process. The decision is seen as the result of a decision-making process in time in which more decision makers participate.

Most models take a *procedural rationality* approach to decision-making. This is also concluded by Heywood in his 2011 paper in which he refers to them as an "algorithmic" approach as well as by Heywood and Arkesteijn (2017) where they refer a "process" as one of the four CRE alignment forms. The procedural rationality models of Weatherhead (1997), White (1998), Edwards and Ellison (2003), Osgood (2004), Wills (2005), Then (2005), Haynes (2008), De Jonge *et al.* (2009), Then and Tan (2010) and Then *et al.* (2014) indicate what needs to be taken into account and give a certain order to reach alignment.

The *structural approach* is only present in Englert's (2001) CRE alignment model. His message is to have a horizontal dimension to strategic planning based on Michael Porter's (1985) competitive advantage through a managed process. This process consists of communication networks, which are a trick, as Englert (2001, p. 9) explains, to link and integrate strategies to engineer collaborative results that tie to organisational objectives.

There are no models that have a substantive rationality approach in which they offer a well-defined procedure how to select the best option. A substantive approach is only partially present in four existing CRE alignment models: O'Mara (1999), Nourse *et al.* (1993), Lindholm and Levainen (2006) and Den Heijer (2011). O'Mara (1999), for instance, has three strategies organisations can choose from: standardisation, incrementalism and value based. She indicates (in her Figure II.1) that the choice for a strategy varies according to strategic uncertainty (ranging from low to high uncertainty) and also on the "theoretical bases of decision making criteria" (ranging from rational instrumental to valuational symbolic). However, next to this, she also has a "basic model of a structuring process" which has a procedural rationality approach. Nourse *et al.* (1993) and Lindholm and Levainen (2006) explain how alternatives can be generated by combining several real estate strategies. Lindholm's list of strategies is: increase value of assets, promote marketing and sale, increase innovation, increase employee satisfaction, increase productivity, increase flexibility, reduce costs which she, amongst others, based on Nourse *et al.* (1993). Den Heijer (2011) has a similar but longer list based on De Jonge (1994) and but calls this way to add value. Her research is focused on universities and gives models (traditional, network or virtual university or the university college) that organisations can choose from. Den Heijer provides information to support real estate decisions; the management of the organisation itself needs to make the decision. In general, one can say that these CRE alignment models function like so-called reference models. De Leeuw (2002, p. 301) indicates that stakeholders can use explicit reference models (also called performance measurement systems), when defining their problem situation. A very well-known example is the balanced scorecard (Kaplan and Norton, 2006). The models with a partial substantive rationality approach help the stakeholders to translate objectives into concrete variables (also called performance indicators).

If a closer look is given to this *substantive approach*, it is important to realise that Englert (2001), for instance, indicated that one of the potential barriers to alignment is that "higher level strategies may not be clear or may be difficult to implement". Having a clear vision and well-defined metrics to measure progress is therefore essential according to him. He even stresses that it is the single most important initiative to achieve alignment to establish corporate metrics and targets (Englert, 2001, p. 8 and p. 15). Of the four partially substantive CRE alignment models should be one does not have well-defined metrics (O'Mara, 1999), and while Nourse (1993) and Roulac (2001) and Lindholm and Levainen (2006) translate the strategies into operating decisions, the decisions are not at the level of well-defined metrics. Den Heijer (2011) does have well-defined metrics. Other CRE alignment models (from the procedural decision-making approach) confirm the importance of metrics implicitly or explicitly, like White (1998), Then (2005), Haynes (2008), De Jonge (2008, 2009), Then and Tan (2010) and Then *et al.* (2014). It is clear that all CRE alignment models aim to add value to the organisation and to use well-defined metrics for this; it is however not clear how the best option can be chosen.

Arkesteijn *et al.* (2015) and Arkesteijn and Binnekamp (2013) developed a Preference-based Accommodation Strategy (PAS) design approach that opens the "black box" of CRE decision-making and clearly defines how the best option, i.e. the real estate strategy with the most added value can be chosen. They do this by offering an approach that incorporates all three rationalities (De Leeuw, 2002). The first pilot study with this approach has been published in Arkesteijn *et al.* (2015). This paper describes a second test of the proposed approach for designing a real estate strategy. It can be argued that the application of a real estate strategy design approach in practice is very context-dependent. The results of using the same design approach twice can be very different depending on the people involved in the process, the roles and responsibilities of these people within the organisation, the characteristics of the portfolio/the type of space it is applied to, etc. The authors' stance is that applying the design approach to multiple context-dependent cases yields more valuable results than just applying it to one case.

Before explaining the PAS design approach in Section 3, we will explain two important concepts determining the approach in Section 2. The research methods will be discussed in Section 4. The pilot study is introduced in Section 5, and the results of the study are dealt with in Section 6. In Section 7, the PAS approach is evaluated and the paper ends with conclusions in Section 8 and recommendations in Section 9.

2. Two main concepts

Before showing the PAS design approach, two main concepts underlying the approach have to be explained in more detail. First, we explain that, if CRE alignment is seen as a design and decision problem, it requires integrating aspects of the domains of design, decision-making and problem-solving. Second, because adding value is a key concept in the alignment process it requires the measurement of value. We solve the measurement problem by using a mathematical operational approach from decision theory where value is considered equivalent to preference.

2.1 A CRE alignment process as a design and decision process

As can be seen from Table I, part of an alignment process is to establish a CRE strategy (sometimes referred to as a plan) to achieve a better state of alignment. Some CRE alignment models only indicate that this plan needs to be made but no further directions are given. In other models, the CRE strategy consists of a mission and vision that states the objectives organisations strive for or a proposal on how to change (parts of) the existing corporate's real estate portfolio to solve certain accommodation problems and to improve the fulfilling of a corporate's accommodation goals within the organisation's boundary conditions. Some models refer to changing part of the portfolio as actioning the real estate intervention.

In this study, the CRE alignment process is a design and decision process which integrates aspects of the domains of design, decision-making, problem-solving and systems thinking. The optimal portfolio is then defined as the portfolio of building that best serves the aims of the organisation within a particular set of boundary conditions. Similarly, the optimal design is the configuration of characteristics that best meets the programme of requirements given design limitations. See Table II for the parallel terminology across the other fields of enquiry. The PAS approach integrates all of these.

The most preferred or valuable solution in CRE alignment is sometimes seen as the accommodation with the highest financial performance (Weatherhead, 1997; Englert, 2001; Osgood, 2004). The highest financial performance is often either defined as the net present value or the economic value add and is referred to as the shareholders' approach. However, in this research, the stakeholders' approach is used where all stakeholders are involved and their requirements expressed in both financial, quantitative aspects (such as square meters) and qualitative aspects (such as aesthetics). That means that if – in the phase of selecting the best option, i.e. an alternative – this choice is not only based on financial aspects, then a kind of measurement of all these different values is needed to select the most preferred alternative.

Since the decisions on the selection of accommodation strategies are rarely made by one decision maker, this process is regarded as group decision-making. This means that measuring values should take place across all actors.

2.2 A mathematical operational approach; value is equivalent to preference

To ensure that the CRE alignment process adds value, it is necessary to determine both the value of the existing real estate portfolio as well as the value of a proposed alternative portfolio. The assignment of values to objects such as real estate portfolios, i.e. the construction of value scales, is a fundamental concept of decision theory. Since value (or preference) is not a physical property of the objects being valued, it is a personal or psychological (sometimes referred to as "subjective") variable, and the measurement of value requires specifying both what is being valued and whose values are being measured.

We note that to decide is to choose. We choose the alternative that we prefer, and prefer the alternative that adds value. This means that value can be measured by measuring preference, that is, evaluating/judging the alternatives as to the value they add, and in this context, *value* and *preference* are equivalent. Although the dictionary definitions of these terms are similar but not identical, they both refer to "a judgment" about "something" by

		Field of enquiry		
Aligning	Designing	Choosing	Solving	Systems thinking
Optimal added value	Optimal design	Optimal choice	Optimal solution	Optimal system state
Portfolio of buildings	Configuration of characteristics	Alternative (aggregation of preference ratings)	Vector of variables	Set of relevant properties
Aims of organisation	Aims of all actors	Overall preference	Objective function	Goal/output
Boundary conditions	Limitations	Veto-criteria	Constraints	Environment

Table II.
Parallel terminology across different fields of enquiry

"someone" (e.g. in Longman Dictionary of Contemporary English). Evaluating is a human cognitive judgment which is consistent with the observation that the value of alternatives is a non-physical property of the alternatives and value is a personal/psychological variable. Of course, in multi-criteria evaluation, some of the criteria (i.e. variables) may be physical, for example, the floor size of a building.

3. Preference-based accommodation strategy design

The PAS design approach is a managerial operations research modelling approach to enhance CRE alignment. The PAS approach should enable the selection of the optimum alternative as well as the generation of alternatives. The PAS procedure consists of three parts and combines the three types of rationality. The parts are steps (procedural rationality), activities (structural rationality) and a mathematical model (substantive rationality) (see Figure 1). In the steps, decision makers define decision variables representing accommodation aspects and iteratively test and adjust these variables by designing new accommodations, i.e. real estate portfolios. The alternative design that adds most value to the organisation, i.e. has the highest overall preference, is suggested as the portfolio that optimally aligns real estate to corporate strategy. The activities that the participants perform are a series of interviews and workshops, while in between the system engineer builds the accompanying mathematical models.

The approach overcomes the problems inherent to the current models and uses explicit scales for measuring value/preference by stakeholders themselves. It also allows for aggregating individual preference ratings into an overall rating (Arkesteijn *et al.*, 2015). The PAS design procedure is based on Preference Function Modelling (PFM) which enables proper preference measurement (Barzilai, 1997; Barzilai, 2010; Arkesteijn and Binnekamp, 2013).

The 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:

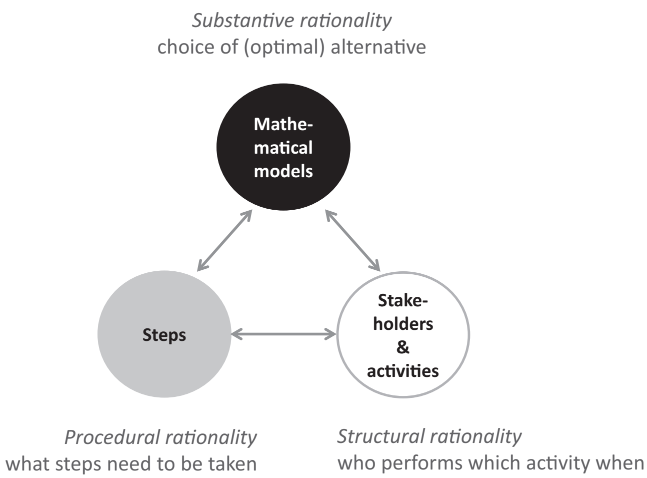


Figure 1. Components of preference-based accommodation strategy design approach

- the decision maker establishes (synthetic) reference alternatives which define two points on a Lagrange curve:
  - 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 (x_0, y_0);
  - 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 (x_1, y_1);
- 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 (x_2, y_2);

(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;

(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.

An important element in the procedure is the measurement of stakeholder preferences in Step 2. During this step, the stakeholders determine the relationship between the physical values for each variable and their preference. They do so by establishing a top and a bottom reference alternative, with, respectively, a preference rating of 100 and 0, supplemented with a third alternative that determines the shape of this so-called Lagrange curve (Figure 2). These are stated preferences as there are no observations of stakeholder behaviour that would provide revealed preferences. For example, in Step 1, the student council indicated their interest in the walking distance to a restaurant for lunch. They define a "bottom" reference as an accommodation requiring students to walk 3 min to the nearest restaurant for lunch and a "top" reference as an accommodation requiring students to walk for 1 min. The intermediate third point of the curve is defined by the students as an accommodation requiring students to walk 2 min and is rated at 60.

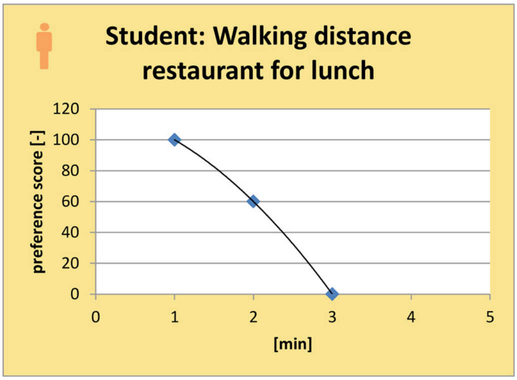


Figure 2.
Example of a lagrange curve: See also Figure 8, variable 1

The purpose of measurement in Steps 1 and 2, i.e. representing variables by devising scales, is to enable the application of mathematical operations to these scale values. This is necessary in Steps 5 and 6 of the procedure to determine the overall preference score for the current situation as well as for the design alternatives. The overall preference score is determined by using the weighted arithmetic mean instead of using Barzilai's PFM algorithm. The latter is not readily available for use, and the weighted arithmetic mean is a good approximation of the overall preference score. This enabled us to give immediate feedback to the decision makers during this step.

3.1 The PAS activities and mathematical model

In problem-solving De Leeuw (2002, p. 281) makes a distinction between (1) the stakeholders, (2) the responsible management and (3) the problem solver in his role as professional researcher or consultant. In this approach, the stakeholders are equivalent to the decision makers. The problem solver is also called a systems engineer.

To perform the steps of the PAS procedure in an iterative way, the decision makers need to perform several activities and one or more mathematical models need to be built. The activities consist of interviews and workshops which are done individually or with all stakeholders, respectively. The interviews are used to perform Steps 1 to 4 of the PAS procedure and the workshops for Steps 5 and 6. There is a feedback loop present from Step 5 to Step 1, i.e. to be able to perform the steps in an iterative way, so that the model could be adjusted in accordance with the results in the intermediate steps. To facilitate this iteration, the interviews and workshops were completed a number of times in a sequence: Interview 1 – Workshop 1 – Interview 2 – Workshop 2 – Interview 3. The sequence can be completed more times if necessary (add this sentence if Option 2 is used). In this pilot, two 3-h workshops were sufficient and in total 20 1-h interviews were held. In Figure 3(a), flowchart is presented that shows the relationship between the stakeholders, steps, activities and the model building as well as the feedback loop.

4. Research method

As mentioned before, one aspect of the CRE alignment process, if considered a design and decision-making process, concerns a problem-solving methodology. Operations Research, nowadays called Management Science, is a discipline dealing with the application of analytical methods to aid decision-making and solve organisational problems. We can therefore make use of Operations Research for solving CRE alignment problems (note that we do not use empirical/statistical research methods to solve the alignment problem). The PAS approach was tested in accordance with the five stages of an operations research project (Ackoff and Sasieni, 1968, p. 11):

(1) formulating the problem;
(2) constructing the model;
(3) deriving a solution;
(4) testing the model and evaluating the solution; and
(5) implementing and maintaining the solution.

These five stages have been used on three levels:

(1) the development of the steps of the PAS approach;
(2) the construction of a mathematical model; and

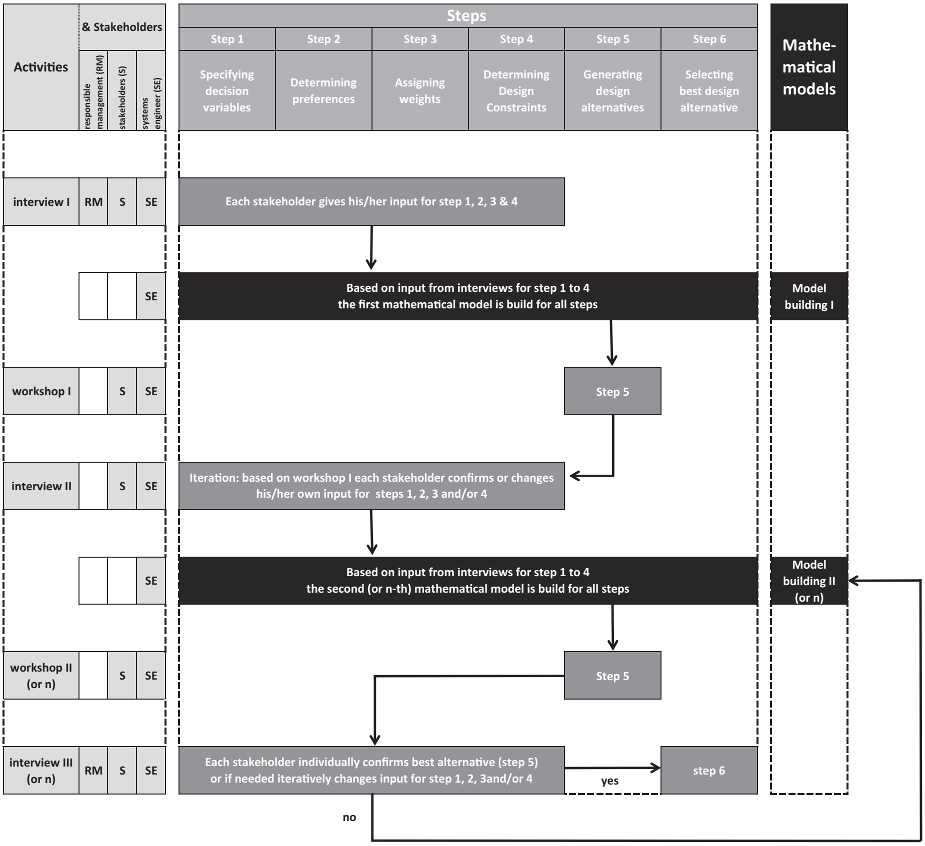


Figure 3.
Flowchart preference-based accommodation strategy design approach

(3) with the stakeholders to derive at a solution for the problem in practice in this (second) pilot study.

In this paper, we report about the latter. Because this was a pilot study, the PAS approach was limited to the first four stages. Stage 1 incorporates Steps 1 to 4 of the PAS approach (via interviews). Stages 3 and 4 were combined to incorporate Steps 5 and 6 of the PAS approach (via workshops). The decision makers themselves derived the solution (Stage 3) during the test of the model (Stage 4) while evaluating the solution. There was a feedback loop present from Stage 4 to Stage 1, i.e. the stages were used in an iterative way, so that the model could be adjusted in accordance with the results of the evaluation of the (intermediate) solutions. The mathematical model was constructed by the systems engineer in Stage 2.

In the pilot study, we established a mathematical (formal) model representing the university's food facilities and the preferences pertaining to them. The construction of this model aims to solve two problems. Primarily, it wants to demonstrate generically if and how the best option is chosen, i.e. how the alignment problem can be solved by using the PAS approach. Secondarily, it wants to generate and select alternative solutions to solve the specific problem in the pilot study. To test the PAS approach, the approach itself is evaluated in each interview with the pilot's participants. We used three aspects as indicated by Joldersma and Roelofs (2004, pp. 697-698) to assess the impact of methods such as the PAS approach on problem structuring:

- experiences with the method;
- attractiveness of the method; and
- perception of effectiveness of the method.

In this paper, it is shown how the PAS approach can be used successfully on the real estate portfolio level to enhance CRE alignment. We considered the PAS procedure successful if:

- the participants are able to complete each step and activity of the approach, i.e. to determine their preferences and constraints;
- design alternative real estate portfolios; and
- choose a portfolio design with a higher overall preference score than in the current situation.

This will be demonstrated in Section 6 were the results for each step of the PAS approach will be discussed; the results are based on the second workshop and the third series of interviews. Lastly, the approach is seen as successful if the stakeholders evaluate it positively (see Section 7).

5. Introducing the pilot study

The PAS procedure was tested with the real estate portfolio of food facilities at the Delft University of Technology (TU Delft) in 2012 and 2013. TU Delft is located in the city of Delft, between the cities of Rotterdam and The Hague in The Netherlands. At that time, the university accommodated 18,800 students and 7,600 employees (including 1,600 guests). In terms of land and buildings, TU Delft is the second largest university in The Netherlands: its building portfolio consisted of 570,000 m^2 gross floor area. In addition, the university owns approximately 170 hectares of land. All university buildings are located on a campus south of the city centre, between a Canal (the Schie) and a highway (A13). The campus consists of three areas – TUD North, TUD Central and TUD South – each with a unique character (Figure 4).

A substantial part of its portfolio was built in the 1960s and 1970s and will require large-scale renovation in the near future. The university has defined a new campus vision – "the living campus" – and made plans to renovate parts of the campus, to reduce the size of its portfolio and to lower its accommodation costs. The university's facility and real estate department has expressed the desire to develop these plans together with the various stakeholders on the campus, to determine which improvements are necessary and where space can be used more effectively and efficiently.

The food facilities on campus (i.e. facilities that serve coffee, lunch and/or dinner) are a critical asset when it comes to realising a living campus. The ambition of the living campus is to maximise the function of the campus as a place to meet each other and work together. Therefore an important condition for the living campus is to have high-quality food facilities located at strategic locations. The current facilities of TU Delft (Figure 4) do not meet the requirements of students and staff – especially amongst international users – according to various surveys. The exact requirements of the users are not clear, however: Are the facilities at the wrong locations? Are there not enough facilities that serve coffee, or too many facilities that serve dinner?

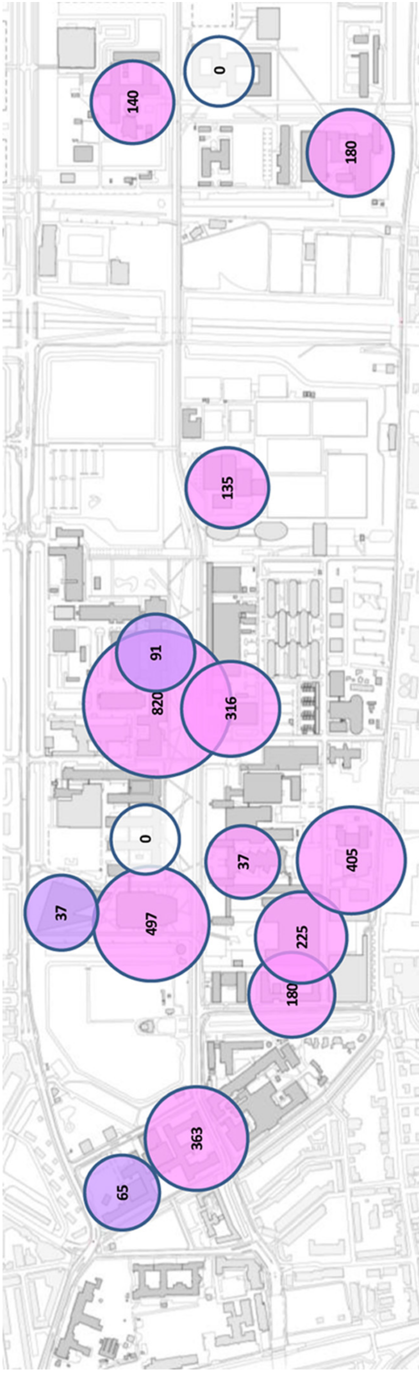
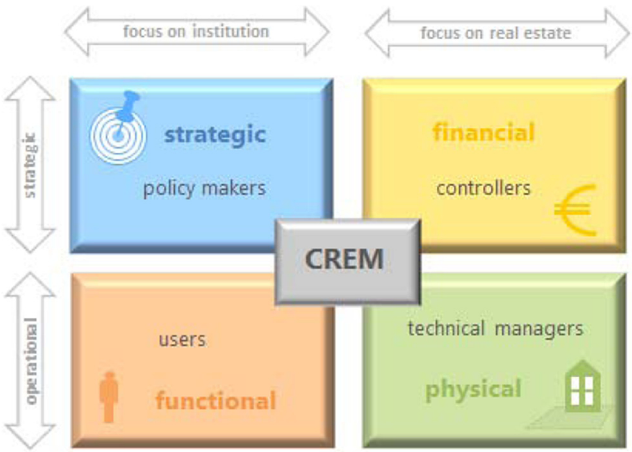


Figure 4.
Food facilities TU Delft campus; purple circles represent coffee corners, pink circles are restaurants either for lunch and/ or dinner with or without coffee corner: The size of the circles is an indication of the size of the facility and the numbers in the circle indicate the gross floor area of a food facility

The pilot study focuses on the question of how to maximise the function of the living campus by designing a strategy for the university's food facilities. The strategy looks to optimise the amount of food facilities on campus, the types of food facilities and their locations within the campus and buildings based on the specific requirements formulated by users. Which portfolio of food facilities will enable TU Delft to reach her objectives best? The types of questions that need to be answered are: How many food facilities and which types are needed? Where are the food facilities located? What is their preferred size?

At the outset of the project, an executive board member was appointed as responsible management who, together with the real estate manager, determined which stakeholders were to participate in the pilot. They used the CREM model by Den Heijer (2011) (Figure 5) as a reference to involve each of these four stakeholder perspectives in the decision-making process, so as to incorporate all relevant information (Den Heijer, 2011, p. 108). Figure 6 displays the stakeholders that participated in the pilot. As explained earlier, the stakeholders are the decision makers in the PAS procedure. Some decision makers' groups were represented by multiple participants (e.g. the members of the works council), whilst others consisted of only one participant (e.g. the faculty secretary).



Source: Den Heijer (2011)

Figure 5. Stakeholder perspectives

	Stakeholder	Examples of decision variables and design constraints
	executive board	Walking distance, user satisfaction
	project leader (pl) social innovation	Findability work places in food facility
	faculty secretary	Walking distance, coziness
	student council	Walking distance, work places in food facility
	works council	Walking distance, diversity
	Facility Management &	Running costs,
	Real Estate department (FMVG)	Investment costs

Figure 6. Participating decision makers in the pilot study

6. Results: a new accommodation strategy with a significant added value

In this paper, the results of both the steps and the activities of the PAS approach are presented for this particular case. The results and the activities are based on the mathematical model of Workshop 2 that was built specifically for this case.

6.1 Results from the steps of the PAS approach

6.1.1 Step 1: Specifying the decision variables. The decision makers specified 17 decision variables (Figure 7). There are three variables which are of interest to four different decision makers: walking time to the middle-sized (Variables 1, 7 and 12) and large-sized food facilities (Variables 2, 8 and 13) and the number of places in the restaurant which can be used for working (Variables 3, 9 and 12). Apart from these variables, which are quantitatively oriented, the decision makers also use qualitatively oriented variables such as ambiance (Variable 11) and coziness (Variable 15).

6.1.2 Step 2: Determining preferences. For each variable, the decision makers determined a bottom reference alternative (x_0, y_0), a top reference alternative (x_1, y_1) and an intermediate reference alternative (x_2, y_2). The preference ratings are displayed in Figure 7. For example, Figure 8 displays preference ratings of the participant "Faculty Secretariats" to the variable "food facility place as work place". The bottom reference (preference score 0) alternative (x_0, y_0) is set at 0 per cent, the top reference (preference score 100) alternative (x_1, y_1) is set at 50 per cent and the intermediate reference (preference score 80) alternative at 40 per cent.

As can be seen in Step 1, some decision makers are interested in the same variables. However, they do not give the same preference scores to the same decision variable values (Table III). For instance, the students want to have the food facility for lunch within a maximum walking distance of 3 min, while the works council prefer this walking distance to be 8 min.

6.1.3 Step 3: Assigning weights. The decision makers assigned the weights to each variable that they have specified (Figure 9). The weights between the four decision makers were determined by the executive board and were split equally: therefore, each has a weight of 25 per cent.

Decision maker		Variable	[x_0, y_0]	[x_1, y_1]	[x_2, y_2]
student council	1	Maximum walking time from a faculty building to a food facility for lunch [minutes]	[3, 0]	[1, 100]	[2, 60]
	2	Maximum walking time from a faculty building to a food facility for dinner [minutes]	[10, 0]	[4, 100]	[8, 20]
	3	Percentage of places in all food facilities which can be used for working [%]	[0, 0]	[100, 100]	[50, 30]
	4	Average vertical location of food facility [floors]	[2, 0]	[0, 100]	1, 30]
	5	Amount of doors between outside and the food facility [doors]	[4, 0]	[1, 100]	[2, 30]
	6	Average walking time from an entrance to a food facility [minutes]	[3, 0]	[1, 100]	[2, 20]
faculty secretary	7	Maximum walking time from a faculty building to a food facility for lunch [minutes]	[9, 0]	[3, 100]	[6, 60]
	8	Maximum walking time from a faculty building to a food facility for dinner [minutes]	[18, 0]	[6, 100]	[12, 60]
	9	Percentage of places in all food facilities which can be used for working [%]	[0, 0]	[50, 100]	[40, 80]
	10	Percentage of places in the facilities having sufficient acoustics [%]	[0, 0]	[40, 100]	[20, 80]
	11	Average preference rating on ambience for the food facilities [-]	[20, 0]	[100, 100]	[80, 80]
works council	12	Maximum walking time from a faculty building to a food facility for lunch [minutes]	[5, 0]	[2, 100]	[4, 60]
	13	Maximum walking time from a faculty building to a food facility for dinner [minutes]	[8, 0]	[3, 100]	[6, 60]
	14	Percentage of food facilities labelled diverse [%]	[0, 0]	[100, 100]	[50, 50]
	15	Average preference rating on coziness for the food facilities [-]	[0, 0]	[100, 100]	[50, 50]
pl social innovation	16	Percentage of places in all food facilities which can be used for working [%]	[0, 0]	[100, 100]	[50, 95]
	17	Average preference rating on find-ability of the food facilities [-]	[0, 0]	[100, 100]	[90, 90]

Figure 7.
Variables and coordinates of the curves relating decision variable values to preference ratings

Both the works council and the faculty secretary give most weight to the walking time for the food facility at lunch time, respectively, 30 and 35 per cent. The works council gives 40 per cent weight to the cosiness of the food facilities, while the project leader social innovation is interested in two variables which both receive equal weight. A closer look at the variables and their respective weights show that there are three types of groups of variables. Variables with regard to location, both on campus and in the building (1, 2, 4, 5, 6, 7, 8, 12, 13, 17), variables regarding the use of the food facility as work place (3, 9, 16) and the interior design of the restaurant (10, 11, 14, 15), which respectively account for 53, 21 and 26 per cent of the weights.

6.1.4 Step 4: Determining design constraints. A total of six design constraints were determined by the stakeholders. The executive board defined constraints related to variables of other stakeholders. For instance, their constraint user satisfaction is defined as the minimum average satisfaction of the preference score on the variables acoustics (10), ambiance (11) and cosiness (15). These variables relate to two decision makers. The facility and real estate department has two constraints based on costs. See Figure 10 for an overview of all design constraints.

6.1.5 Step 5: Generating design alternatives. The main objective of this step is to try to maximise the overall preference rating by designing alternatives. Alternatives are designed using the current situation as a starting point. In the current situation the decision maker can choose an intervention for each specific food facility. In this particular case the following types of real estate interventions are identified:

- refrain from action;
- remove the food facility;
- convert the existing food facility to new concept “middle”, “large” or “faculty club”;
- create a new concept “middle”, “large” or “faculty club”; and
- upgrade the existing food facility.

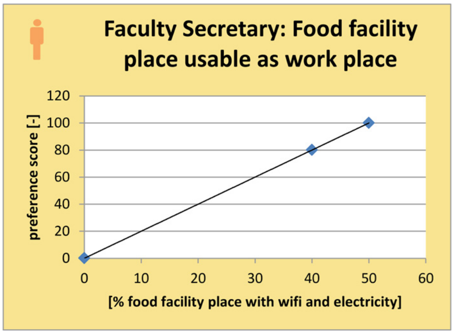


Figure 8.
Lagrange curve for the variable “ability to work in the food facility” (see also in Figure 8, variable 9); the curve represents the demand and relates the preference rating (vertical axis) to variable value (on the horizontal axis)

Food facility	Student council	Faculty secretary	Works council
For lunch	3	9	5
For lunch and diner	10	18	8

Table III.
Maximum walking distance in minutes per decision maker

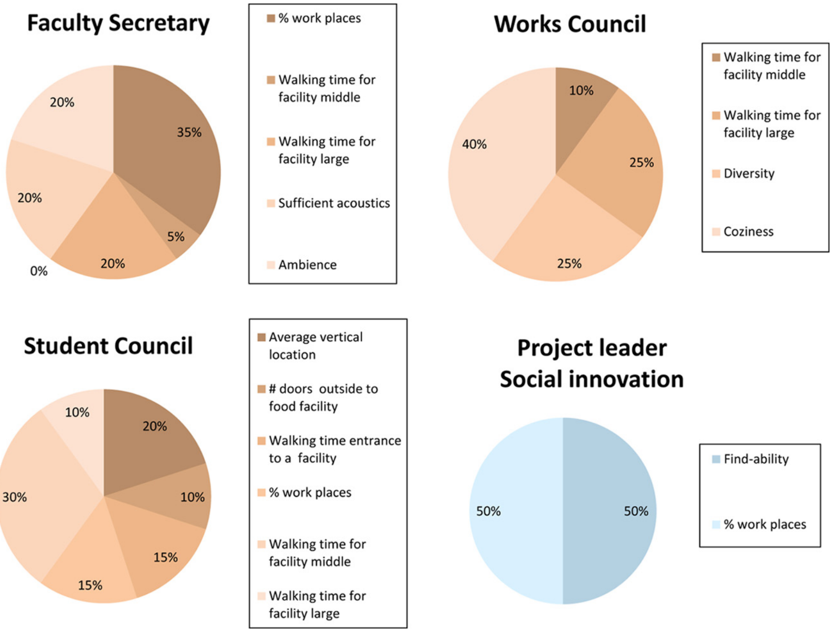


Figure 9.
The division of weights per variable, as determined by each decision maker

Decision maker		Design constraint	
executive board	1	Minimum availability of food facility for lunch within the maximum walking time	95%
	2	Minimum availability of facility for lunch and dinner within the maximum walking time	95%
	3	Minimum availability of facility faculty club within the maximum walking time	95%
	4	Minimum average satisfaction of the preference score on the criteria acoustics, ambience and coziness	40%
FMVG department	5	Maximum investment costs	1.850.000 euro
	6	Maximum operational costs	500.000 euro

Figure 10.
Design constraints

The new concepts “middle” and “large” are respectively food facilities exclusively intended for lunch and for both lunch and dinner. However, because the concepts are different from the current food facilities, they have been given a different name.

In this step, based on the input from Steps 1 to 4 and the abovementioned interventions, a mathematical (formal) model representing the university’s food facilities and the preferences pertaining to them was created. The model’s main interface is the map of the university showing the current situation of food facilities as well as the overall preference score of 44 for this design alternative D_0 (Figure 11).

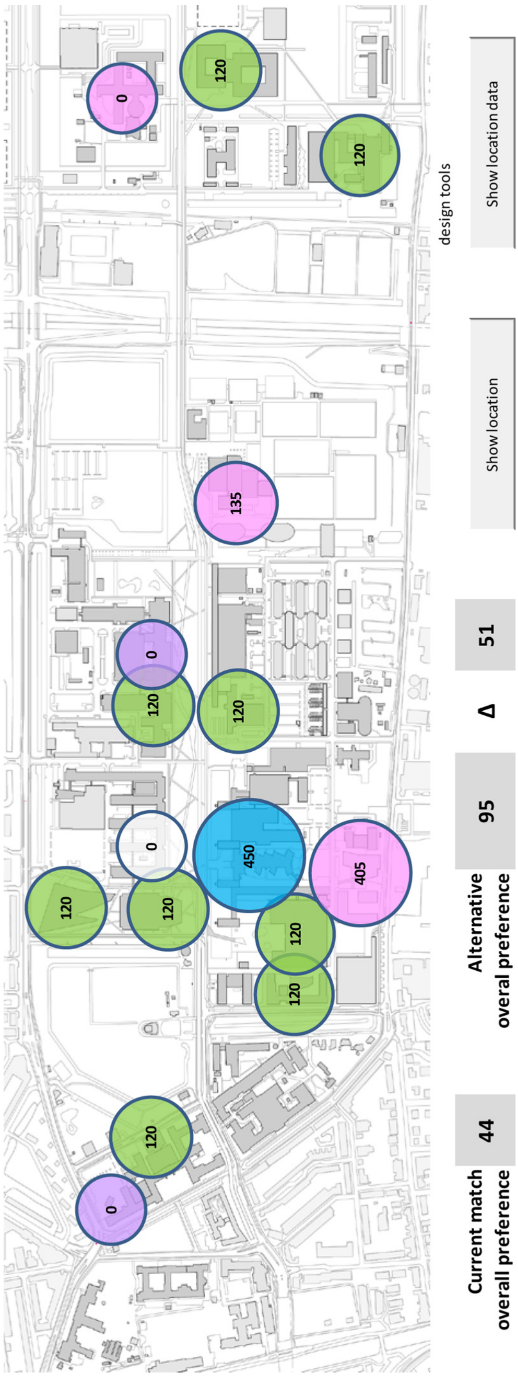


Figure 11.
Main interface for generating design alternatives depicting the chosen alternative with the highest overall preference score: Purple circles indicate coffee corners; pink circles indicate restaurants either for lunch and/or dinner, with or without coffee corner; green circles indicate a new food facility middle; and blue circles a new large food facility

In the workshops, the decision makers could select each food facility. A dialogue window appears showing several benchmark data for this facility. It contains a pull down menu which enables them to select an intervention for this specific facility. After the decision makers had chosen a set of interventions for the food facilities of their choosing, they generated a design alternative. The decision makers interactively saw the overall preference score for this design alternative during this design process, as well as the difference in preference score between the designed alternative and the current (zero) alternative. They did not only see the overall preference scores but were also able to see the preference scores for each specific variable. The decision makers generated several design alternatives to search for the highest possible overall preference. The design alternative with the highest overall preference score is shown in Figure 11.

In each workshop the objective of the pilot study was repeated and the decision makers received information on the assumptions made about the interventions which indirectly influence the preference scores of the stakeholders. For instance, a new or converted food facility middle would have 100 places and 120 gross floor area (g.f.a.), while a food facility large would have 300 places and 450 g.f.a. The decision makers were also informed about the values each decision variable would receive when a certain intervention was chosen including the cost related to the intervention. For instance, an intervention towards concept middle would be placed on the ground floor, with one door in between the main entrance and the facility, and a value preference score of 40 per cent for acoustics and 100 for cosiness and ambience. The investment costs of a new facility large is 1,500 euro per g.f.a. and 90 euro/g.f.a. operating expenses, while a conversion towards large has investment costs of 1000 euro/g.f.a. and 60 euro/g.f.a. operating expenses.

6.1.6 Step 6: Selecting the design alternative. The decision makers selected the design alternative they had generated with the highest overall preference score as the best alternative (Figures 11 and 12). This alternative has an overall preference score of 95, which is 51 more than the current situation.

Decision maker		Variable	D_0	D_1
student council	1	Maximum walking time from a faculty building to a food facility for lunch [minutes]	0	60
	2	Maximum walking time from a faculty building to a food facility for dinner [minutes]	0	100
	3	Percentage of places in all food facilities which can be used for working [%]	3	72
	4	Average vertical location of food facility [floors]	100	100
	5	Amount of doors between outside and the food facility [doors]	52	100
	6	Average walking time from an entrance to a food facility [minutes]	60	81
faculty secretary	7	Maximum walking time from a faculty building to a food facility for lunch [minutes]	89	100
	8	Maximum walking time from a faculty building to a food facility for dinner [minutes]	0	100
	9	Percentage of places in all food facilities which can be used for working [%]	21	100
	10	Percentage of places in the facilities having sufficient acoustics [%]	21	98
	11	Average preference rating on ambience for the food facilities [-]	61	100
works council	12	Maximum walking time from a faculty building to a food facility for lunch [minutes]	60	100
	13	Maximum walking time from a faculty building to a food facility for dinner [minutes]	0	100
	14	Percentage of food facilities labelled diverse [%]	63	100
	15	Average preference rating on coziness for the food facilities [-]	45	96
pl social innovation	16	Percentage of places in all food facilities which can be used for working [%]	77	100
	17	Average preference rating on find-ability of the food facilities [-]	11	100

Figure 12.
Preference score per criterion; current and future design alternatives

This design alternative is selected based on the condition that concept middle would not only be a coffee corner but a restaurant with warm meals as well. This was especially important for the decision makers because during the development of the pilot study the definition of the concept middle was not always clear. At certain times it looked as if it would only be a coffee corner, while in the final workshop, the real estate department gave the impression it could be a restaurant with hot meals as well. Therefore, the minutes of the workshop noted this precondition (i.e. that solution is only accepted if the concept middle serves hot meals).

6.2 Results from the activities of the PAS approach

6.2.1 Iterating the steps in the PAS procedure. The participants were required to design alternatives themselves in Step 5. In the workshops, the starting point was the current portfolio (design alternative D_0) with the overall performance score based on the weighted sum of all the preference scores. The objective was to iteratively design the highest possible overall preference score by modifying both the real estate objects in the portfolio and, if necessary, alter the variables, curves, weights or design constraints from Step 1 to 4. In the first workshop, the participants were divided in three groups and optimised solely based on their own variables, while in the second workshop, the stakeholders optimised based on all variables. Figure 13 shows that iterations were used during the workshop by demonstrating the development of the variables (V) given by the student council. They did not define any design constraints. After Workshop 1, the student council participant modified two variables (V2 and V6) and added a new one (which is called V1). Three variables (not numbered) were mentioned in the first interview but not incorporated in the model. He also changed the weights between the variables, both after the first and the second workshop.

What this demonstrates is that the feedback from self-design helps the users to better understand their input and to improve it if necessary. By doing so, the representation of

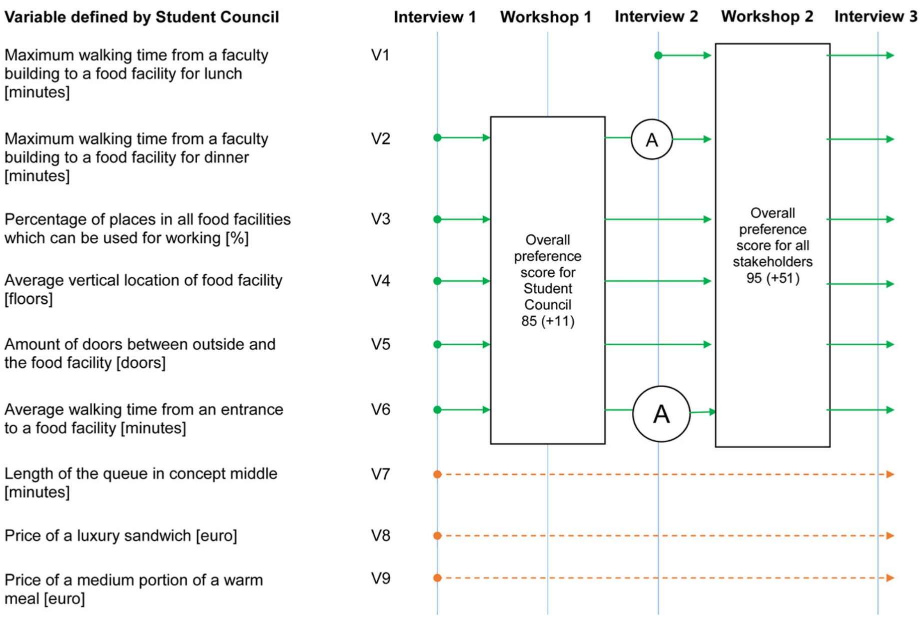


Figure 13. Development of the variables and design constraints determined by the student council: a green arrow means that the variable was incorporated in the model; a red arrow means that it was not incorporated in the model; a box with the letter "I" in it means that a variable was adjusted in an interview

their preferences in the model better depicts the actual situation. The use of such a learning process in the context of work practice and problem-solving is described by Schön (1987) as reflection in action.

7. Evaluating the PAS approach

At the beginning of the pilot study, it was stressed that the pilot focused on testing the PAS approach on a real problem that the real estate department of the TU Delft was facing at the time. However, the results of the pilot would not constitute a final decision and would not be implemented as such. The reason is that, although all relevant stakeholder groups were involved, not all of them were able to involve their colleagues. At the same time, the pilot was stopped when the group declared the result satisfactory. In a real situation, more checks and balances and perhaps an extra workshop would have been necessary. However, the department promised to take the information as gathered during the pilot and the results of the pilot into account when further developing the solution. Although this has been clarified, some participants mentioned during the evaluation that they would like to verify their input with their colleagues. The student council had their feedback system in place and actually did verify all their input and discussed the results in a larger setting. While everybody agreed upon the results, in the final interview one of the participants, who only defined boundary conditions and was absent from both workshops, felt the need for a last check.

During the test of the PAS approach, the approach was (partly) evaluated with each of the participants mostly in three interviews. In total, 20 interviews were held. In the interviews, the participants were able to alter their input for the first four steps of the procedure. At the end of each interview, they were asked to determine the impact of the procedure by reacting to their experiences with the method, the attractiveness of the method and their perception of the effectiveness of the method.

7.1 Initial attitude towards the pilot

In the first interview, apart from giving input for the first four steps of the PAS approach, the participants were asked to give a first evaluation of the procedure. The answers from the interviewees in combination with our observation painted the following picture: most of the users were open to the procedure and willing to participate. One participant questioned the possibility to include emotions into the model, and one of the users was suspicious of the model and questioned whether it could work as intended.

7.2 Experience with the approach

After the first workshop, most users were mainly positive. The theme that was mentioned most often in all interviews at all stages, was the possibility of iteration in the model. Iteration made it possible for them to formulate the variables as they intended. Two other traits of the procedure (the group interaction and the transparency of process) were also highly valued. The use of the model and their positive experiences with it generated trust in the model. After the second workshop, a result of an overall preference score of 95 was achieved. Participants indicated that they had not expected to reach such a high score. One of them specified that, therefore, he had not been tempted to use any strategic behaviour.

The second workshop confronted us with a problem: the concepts food facility middle and large were unclear. The real estate department intended the food facility middle to be a coffee corner, without the traditional hot servings at lunch, while the other participants preferred it to be a small restaurant. We agreed that the results of the model would only hold under the condition that concept middle would be the latter option.

7.3 Attractiveness of the approach

The users found the experienced interaction, iteration and transparency attractive mainly because they could give and determine their own input. Their main attitude was one of satisfaction. However, they were encouraged to give feedback to improve the approach (steps, activities and/or model). They have been especially critical of the design interface of the model. It was not always easy for them to keep an overview, although the model helped them to do so. It seems that this was caused by several factors for different people. Two participants wanted to understand more of the backend of the model, i.e. how the relationships were defined between the variables, to be able to define their variables and curves better and in the end accept the model and its results. Another stated that the model is less attractive because it is not operated by the users themselves and suggested that this might need more time.

7.4 Perception of effectiveness

The approach has been described as very effective. It does not take much time, is to the point and much more results oriented than similar processes. The self-design of the alternatives is seen as a trial-and-error process, whereas the effects of the interventions are clear: they function as input to realise an optimal solution. This process deepens the conversation about the alternatives. Another user acknowledges the transparency of the model, the speed of its execution, and especially, the clarity of which demands have or have not been taking into account in the chosen alternative. One participant wondered whether the expected effects could indeed be achieved in practice.

The student council even indicated that they prefer to make this the standard way of communicating with the real estate department. Some even indicate that better decisions can be taken based on the insights into the effects provided by the procedure. This might also improve the quality of their discussions with their colleagues. The councils specifically indicated that they value the fact that everybody is equally well informed. Decisions are not taken on a gut feeling or determined by power relations which was seen as a positive aspect. Although the procedure itself did not take much time, the lead time of the pilot was long.

8. Conclusion and discussion

In accordance with the client in the pilot study, the specific objective was to generate and select solutions to solve the problem of the TU Delft's food facilities by using the PAS approach. The results demonstrate that the participating decision makers could perform the steps and activities of the PAS approach and determined variables and design constraints relevant to them. A model was subsequently designed by the systems engineer in which, in the workshops the participants could make a design alternative for the real estate portfolio. In the second workshop, they designed an alternative with a much higher overall preference score of 95, compared to a score of 44 for the current portfolio. The participants think that the quality of the end result is higher and stated that the process to reach that end result is more efficient than is the case in other traditional design processes.

In this pilot study, it is shown for the first time that the PAS design approach can be performed independently of any other decision-making techniques (like linear programming). The PAS approach enables CRE managers to actually calculate the added value of an alternative real estate strategy (in this case for food facilities). The generic objective of the PAS was to open the "black box of decision-making" in the existing CRE alignment models and offer an approach in which it is able to select the best option. The approach has made that possible because it consists of three parts: steps (procedural rationality), activities (structural rationality) and a mathematical model (substantive rationality). The approach needed to be able to design a real estate strategy that incorporates explicit scales to measure value and to aggregate individual preference ratings into an overall preference rating. The use of an overall preference rating makes it possible to take into account financial, quantitative and qualitative portfolio requirements of the diverse stakeholders. By iteratively performing the steps from the PAS approach a number of times and by self-designing solutions, the participants improve the representation of their preferences in the model.

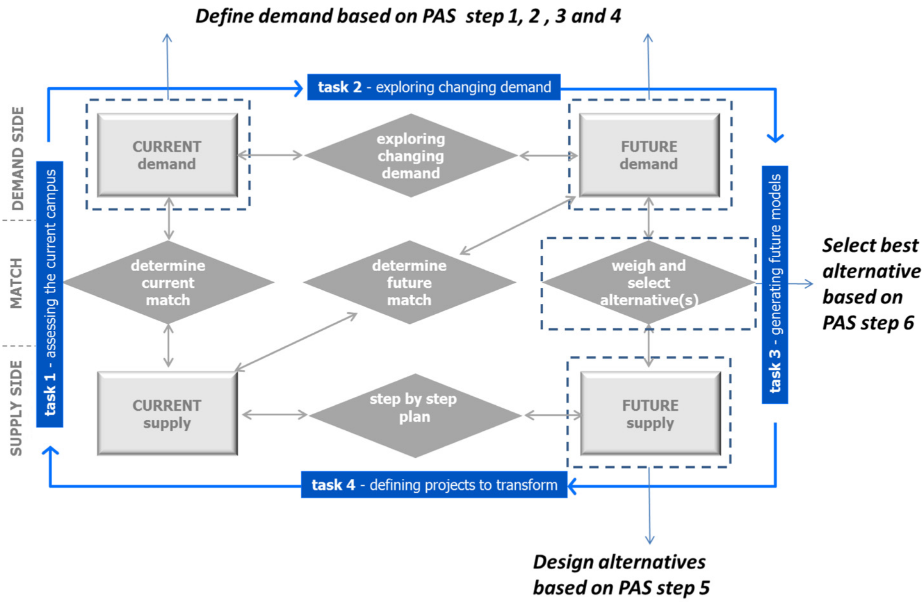
The evaluation of the PAS design approach was also positive. According to the participants, determining preferences and refining and adjusting them in collective workshops is the attractive part of the method. Understanding the relation between variables, preference ratings and interventions was considered difficult and time-consuming, but even then, participants indicated that it takes them less time to understand how to select certain interventions.

In relation to existing CRE alignment models, the PAS approach opens the "black box" of decision-making present in the CRE alignment models, which the review noted was deficient, by offering a design and decision approach to CRE alignment. The PAS approach consisted of three parts: steps, stakeholders and activities and mathematical model(s). The PAS design approach does not replace the current alignment models. It offers an approach to select the best option and can be incorporated as an add-on in existing CRE alignment models. The existing alignment model would function as reference model to help stakeholders to determine relevant variables in line with their objectives. To support the claim that the PAS approach can be used as add-on two examples will be given. In the first example, the PAS approach is added to the CRE alignment model of Designing an Accommodation Strategy (DAS) frame (Den Heijer, 2011; De Jonge *et al.*, 2009). This framework can be used as a checklist to structure the process of DAS. This process is perceived as a cyclic and iterative process that moves along two axes, from demand to supply and from current to future and can be started at different points. The four key issues in the framework are:

(1) "What we need" versus "what we have": determines the mismatch between current demand and current supply.
(2) "What we need in the future" versus "what we have now": determines the mismatch between future demand and current supply.
(3) "Alternatives of what we could have": design, evaluate and select solutions for the mismatch.
(4) "Step-by-step plan to realise what we want to have in the future", i.e. how to transform the current supply into the selected future supply.

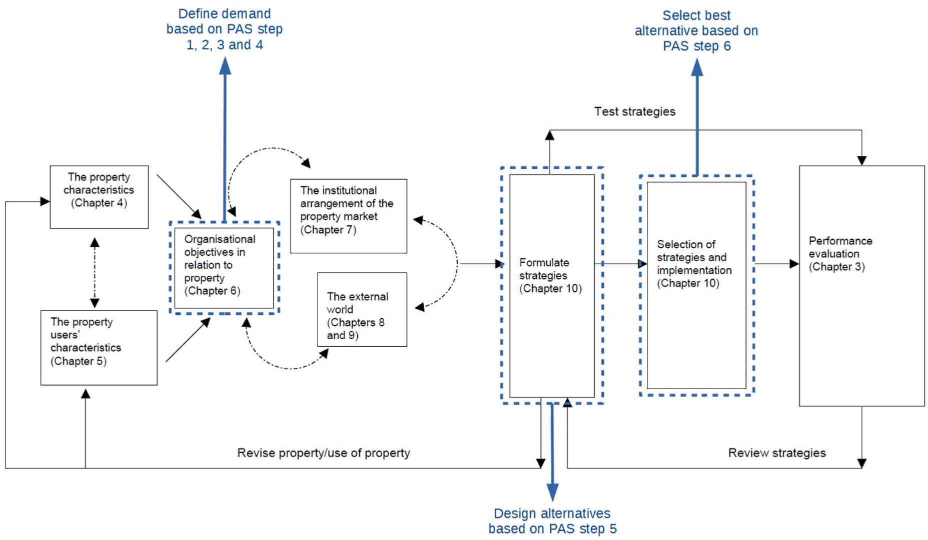
The steps of the PAS approach can be implemented by changing four parts of the framework (indicated with a dotted line in Figure 14).

As a second example, the PAS approach is added to Edwards and Ellison's alignment model (see Figure 15). The "organisational objectives in relation to property" can be expressed based on PAS Steps 1–4, while the "strategies can be formulated" based on PAS Step 5 and the selection based on PAS Step 6. The variables that are defined by the stakeholders to select the best option could also, in a later stage, be used to carry out the performance evaluation. Of course, during the use of a CRE portfolio the requirements can and probably will change over time. The PAS approach allows alterations in variables, preference ratings, weights as well as in constraints over time.



Source: Den Heijer (2011 based on De Jonge *et al.*, 2009)

Figure 14. Steps of the preference-based accommodation strategy design approach (indicated with dotted lines) implemented in DAS frame



Source: Edwards and Ellison (2003, p.18)

Figure 15. Steps of the preference-based accommodation strategy design approach (indicated with dotted lines) implemented in alignment model

9. Recommendations

In this pilot study, the participants designed the alternatives themselves in the PAS approach. The participants indicated that the design interface could be improved in two ways: first, by better explaining the backend of the model making it possible for the users to understand the relationships between the variables and the interventions even more quickly. Second, by making it possible that the mathematical model is operated by the participants themselves instead of by the system engineer.

This second pilot study confirms the recommendations for further developing the PAS design approach as indicated in the paper reporting the results of the first pilot about the lecture halls. These were: involving more people in the process, developing an algorithm to find an optimal alternative and researching the difference in quality of the solution found by the algorithm and the participants. Finally, the approach of PAS is generic and can be used for a wide range of problems in real estate portfolios.

Note

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