

How to develop corporate real estate? A decision support tool for CREM

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Abstract: Various forms of procurement are open to companies when constructing new owner-occupied properties. The selection of a form of procurement is an important decision-making problem for companies and their Corporate Real Estate Management (CREM) departments. With this in mind, a decision support tool has been developed to optimise the outcome and success of company's proposed real estate development projects and is presented in this paper. This model can also be used for current real estate portfolios to optimise returns in the long term.

In pursuit of this objective and in order to provide an academic basis for this study, decision-relevant goals and parameters were initially identified from the referenced literature used in our research. These were subsequently evaluated in a case study of a corporate development project and identified as specific decision criteria from the perspective of the CREM. The investigation identified 15 criteria that are relevant to the corporate decision-making process in procuring and/or developing property. A model for supporting and resolving decision-making problems of this type was derived from decision theory. In this paper, a decision-making tool is presented that takes into account all the decision criteria from the CREM point of view for the first time. This model should therefore serve as an aid in implementing the decision-making process for the development of real estate projects in a more structured and transparent manner.

Keywords: project development, corporate real estate management, sourcing model, decision theory

I. INTRODUCTION

German companies currently own the freehold interests in most of their properties. Particularly in Germany, the owner-occupation ratio of 75% shows that by international comparison with Asia and North America (Asia 20%, North America 30%), the question of alternative methods of procurement to satisfy new accommodation requirements normally involves new owner-occupied properties [1]. For the most of the Corporate Real Estate Management (CREM) units in industrial companies real estate procurement³ is not a core competence. Nevertheless, the decision of whether to "make or buy" and the consideration of outsourcing possibilities are gaining importance if new housing requirements are to be satisfied by developing owner-occupied properties [2]. The underlying decision-making problem concerns the choice of a specific method of procuring the property⁴, i.e. by individual subcontracting, appointing a general contractor, a total (full-service) contractor, or value-added partnerships. This means that the decision-makers in the company's CREM are confronted by a difficult task. According to Manning [3] "Real estate decisions often end up being some of the most complex a company can face". This complexity is based on different aspects. The decision-makers are typically comprised of a group of

heterogeneous stakeholders, often with very different objectives, who innately pursue their own particular interests. In addition, it is not uncommon that these individuals are not very well versed in the specific knowledge, competencies and experience of real estate development. The resulting asymmetry of information hampers the joint decision-making process [4]. Individual production methods or capacity bottlenecks also generate important underlying conditions for decision-making on specific projects, particularly in industrial companies [5].

Up to now, previous studies regarding the decision-making processes involved with this endeavour show that little transparency has been achieved [6]. Notwithstanding the fact that strategically important decisions are required when selecting a suitable form of procurement involving large sums of money with long-term commitments, studies show that these are often limited to only the financial perspective in practice at the time [7]. Thus the extent to which the decision-making processes and the chosen forms of procurement are sensible and efficient for the maximisation of property values are left open to question.

In this light, the objective of this paper is to develop a decision support tool that will create both more transparency in the CREM decision-making process, and also takes into account all of the variants used in making a specific procurement decision. To this end, the following research questions are answered in this study:

RQ 1: What alternatives to property development are open to a company and how do they differ from each other?

³ Real estate procurement is understood to mean the acquisition or construction of owner-occupied properties.

⁴ A form of procurement is understood to mean the type of property construction. The forms of procurement differ because of the organisation and provision of resources.

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RQ 2: Which determinants have an influence on procurement decisions in companies' CREM?

RQ 3: How should the corporate decision-making process specific to a project be structured for the selection of a suitable form of procurement?

This study was conducted as follows: First, the decision-making processes described in the referenced literature for companies procuring property are presented in detail. Thereby the focus lies on the objectives and underlying conditions in the companies and/or the corporate CREM concerning new development projects. Then the alternative forms of real estate procurement that are available to the CREM are presented, with a description and discussion of the approaches used to decision-making described in the literature.

Finally, a decision-making model was developed and tested and is presented here based on the researched literature and a case study from the fundamentals of property development. This model represents the framework for CREM decisions for real estate development projects.

As a part of this, both the decision-making situation and the decision process that led to the selected form of procurement are examined and analysed. The results of this analysis are then presented and the resulting decision criteria are formulated for the decision-making tool. Finally a tool specifically geared to the present decision-making problem is developed and presented. This is based firstly on the decision models from the literature already discussed, together with the basics of business decision-making theory; and secondly on the decision criteria formulated in the scope of the case study.

II. FRAMEWORK FOR PROCUREMENT DECISIONS IN CREM

A. Objectives and factors influencing property development processes

As real estate, together with capital, human resources, technology and information, is one of the most important capital resources for companies [8], the procurement of accommodation and/or properties is a major task in the CREM process. In this context, CREM includes all property-related tasks in non-property companies. The study is therefore carried out from the points of view of both the owner and occupier and that of the producer.

In the scope of real estate development procedures for the procurement of new owner-occupied corporate properties, the CREM normally pursues both strategic and financial objectives. According to Asson [2], this includes reducing costs, increasing productivity and a high level of customer satisfaction. In his view, cost reduction requires consideration of overall costs; i.e. not just the investment costs but also the operating, maintenance and repair costs must be optimised. In achieving these objectives, underlying conditions need to be taken into account. For example, the design of the building should ensure an optimal combination of flexibility and efficiency.

Duckworth [9] points out that the consideration of operating costs or costs per square metre is not sufficient to facilitate making a strategic decision or to assess the outcome of a development project. Furthermore, according to Cádiz [10], in project situations of this nature, other parameters, such as limited internal resources or limited availability of in-house technologies must be reflected in the decision. Cox [11] also emphasises that internal resources should be a relevant basic condition when deciding between "make or buy" alternatives. In this context, he specifies aspects such as internal abilities and competences, and an aspired degree of control by setting a project-specific goal. Ng et al. [12] widen the range of objectives of real estate development. In his view, important parameters affecting a decision-making situation include speed, certainty of timing and price, level of quality, flexibility, responsibility and influence, complexity, price competition, risk allocation, design, investment costs/budget as well as special management requirements. NEDO [13], Skitmore and Marsden [14] and Singh [15] present a different combination of the principal's decisive requirements for a successful property development. This includes speed of planning and construction, certainty of costs and timing, flexibility to requests for changes, quality, risk allocation, clear responsibilities, price competition and resolutions of conflicts. Brand [16] categorises these objectives and underlying conditions in the areas of organisational structure, project structure, information flow and procedural organisation. In addition, according to Cádiz [10], factors such as lack of capacity, shortage of specialist staff or a high level of complexity, as well as objectives including increasing responsiveness and quality, certainty of timing and acquisition costs, may be grounds for a decision to buy.

Other factors influencing the "make or buy" decision in the real estate industry can be derived from a consideration of the objectives pursued in outsourcing decisions in other industrial sectors. Bajec and Jakomin [17], for example, consider the outsourcing question in relation to logistics. In doing so, they emphasise the company's core competence and core activity as a key requirement. In particular, the key strategic question is whether a firm can perform the activity itself just as well as can the "best provider in the world". Nevertheless, according to their approach, the final decision whether to "make or buy" is based solely on the goal of minimising total costs [17].

In his investigation, Padillo [5] also considers the make or buy decision from the point of view of different disciplines, such as operational research and strategic operations management. He differentiates between four competing major objectives: Maximising strategic competitive performance, maximising management performance, minimising the procurement risk, and maximising the financial performance. Under these goals he includes criteria such as flexibility, internal and external relationships, costs and investment.

An overview of the objectives and framework conditions for real estate development and sourcing decisions mentioned in the literature is shown in Table 1.

TABLE I
LITERATURE REVIEW OF OBJECTIVES AND INFLUENCE FACTORS IN REAL ESTATE DEVELOPMENT

Source	Objectives	Influence factors
Asson (2002)	Reducing costs, increasing productivity, high customer satisfaction	
Cánez (2000)	Increasing responsiveness and quality, time certainty, procurement costs	Limited internal resources, limited availability of in-house technologies, lack of specialist staff, high complexity
Cox (1997)	Aspired degree of control	Internal resources, internal skills
Ng (2002)	Speed, certainty of timing and price, level of quality, flexibility, responsibility and influence, complexity, price competition, risk allocation, design, investment costs/budget	Complexity, special management requirements
Love (1998)	Speed of planning and construction, certainty of costs and timing, flexibility to requests for changes, quality, risk allocation, clear responsibilities, price competition and resolution of conflicts	
Bajec (2010)		Own core competence and core activity
Padillo (1999)	Maximising strategic competitive performance, maximising management performance, minimising procurement risk, maximising financial performance	

Consequently, the objectives set by companies are usually formulated very specifically. However, in practice it is evident that hardly any companies formulate and evaluate these targets and conditions as criteria in a structured approach to decision-making in the differing project situations, to compare the procurement possibilities against each other [10] (see also Section III C)). It is also apparent that the objectives pursued and the interests of the stakeholders might be very different. Both the focus of the objectives, i.e. financial (cost reduction, price competition) or strategic (flexibility, competitiveness), and the influencing factors such as complexity and available resources, may vary considerably. It therefore appears to be particularly important to include these in the decision-making process in a transparent and structured manner.

B. Alternative forms of procurement

The continually widening range of construction services, combined with the realisation of new, innovative procurement methods in practice, show that the question of a suitable form of procurement for development projects is

increasingly critical and relevant for players in the construction industry [18]. The decisive factors for these projects are, in particular, rapid procurement with an early start to construction, as well as certainty of costs, quality and timing [19]. The major alternative forms of procurement for achieving these objectives that are available to companies when building new properties and can be fundamentally differentiated in practice, are described in the following. For this, explicit reference is made only to the organisation, control and responsibilities, while the different types of contract and financing are disregarded.

Implementing the project in-house

The traditional form of procurement in real estate development is thought of as in-house planning, with separate award of contracts for individual trades to individual companies and individual planners. Although, in this variant, the principal has the largest possible influence on the progress of the entire project, it also must carry out the coordination and control of services and the interfaces between them, as well as assuming responsibility for the overall risks [21]. Experience shows that the traditional form of procurement provides the principal also with a high degree of quality assurance. Conversely, because there is no possibility of carrying out planning and implementation in parallel, this variant is regarded as the slowest form of procurement [19]. The traditional method, which enables pure competition on price, is used particularly for projects with a low level of uncertainty [22].

In-house planning with general contractor

When appointing a general contractor, as in traditional procurement, the principal still must carry out the coordination and control in the planning phase, although the general contractor takes over all services and responsibilities, as a package, in the execution phase. The general contractor performs these services itself, or subcontracts them. Although this reduces the number of interfaces between the individual trades, the critical interface between planning and construction nevertheless remains [23]. An advantage of this variant is that the principal benefits from guaranteed costs, timing and quality [24], and some construction services can be carried out in parallel [21]. This variant is often preferred by principals with large, standardised projects involving multiple trades

Total contractor

Appointing a total contractor allows the principal to assign all planning and construction services ("design and build") to one contractor. This enables a comprehensive solution, with no interface problems and lower potential for conflicts. Although the principal has little influence on the running of the project in this variant, and must define its functional requirements at an early state, it is able to transfer all risks to the total contractor [27]. The common contract can also be extended in respect of integrated

operational services. Nevertheless, despite the possibility of commissioning planning, construction and operation, it still fails to cover an overall life cycle [21], as the operational perspective is not considered in the planning

and construction. The early definition of requirements means that any subsequent requests for alterations by the principal often have serious consequences, in the form of time- and cost-intensive amendments to the contract.

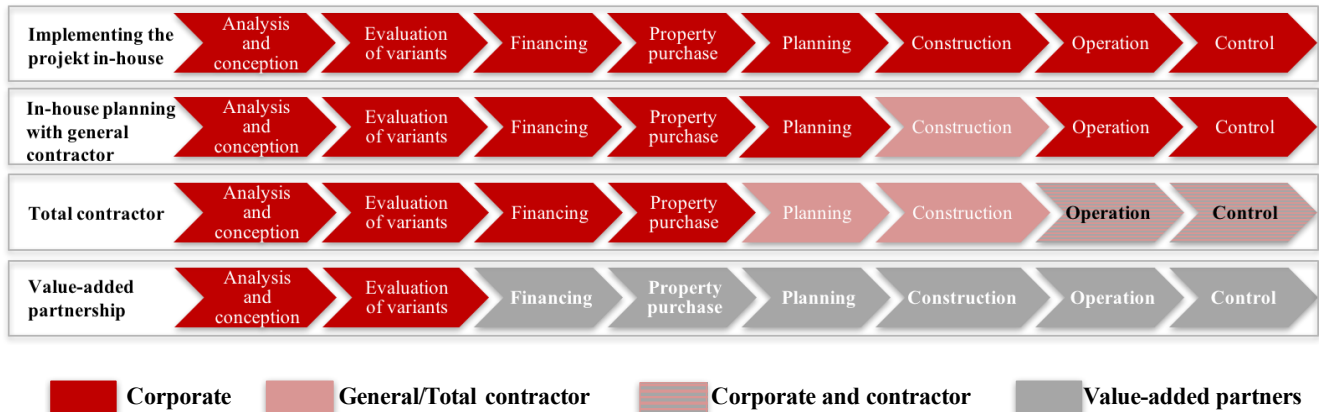


FIGURE I
RESPONSIBILITIES OF INVOLVED PARTIES IN ALTERNATIVE FORMS OF PROCUREMENT

[25], provided that the principal's effort and expense of coordination can be reduced as much as possible.

Value added partnerships

Value-added partnerships spanning the whole life cycle are an innovative form of procurement, based on the international concept known as "partnering". For this, a joint project team is formed, with participants from the principal and the system provider. The team strives to achieve a common objective over the whole life cycle. This is supported by clear responsibilities for management and decision-making, standards for collaboration, incentives and penalties, transparent communication and integration of the operational function from the start [21].

Apart from that, this form of procurement offers the principal some advantages that substantially differentiate this variant from the forms of procurement commonly used in practice. These include, for example, a high level of flexibility, long-term contractual relationships, security of total costs over the life cycle, an alleviation of the occupier's management burden and the optimisation of all interfaces [28]. Gidado [29] adds that cooperative procurement methods are very appropriate for the trend towards more complex projects that are subject to time pressure and uncertainty. They can therefore have positive effects on the performance of the project.

Comparison

As the papers show, the procurement variants differ in respect of the allocation of duties between the principal and the contractor, in particular about the distribution of risks and responsibilities, the principal's influence, the progress of the project and its organisation [19]. Schematically, the differences can be assigned to phases and can be shown regarding to responsibilities (see Fig. 1).

In practice, a decision is usually made between traditional procurement, the award of construction contracts as a package, and "design and build" [19]. However, as the papers show, innovative collaborative approaches to a value-added partnership spanning the life cycle also present an alternative for the development of real estate projects by corporates.

C. Literature on the process of decision-making in real estate procurement

Among other factors, the selection of a suitable form of procurement for developing owner-occupied property can influence the success or failure of a construction project. It is important to optimise the "fit" between the chosen form of procurement, the specific conditions of the situation and the project, and the corporate objectives. Since there is no "best" form of procurement for any project [30], the extent to which the existing conditions for a project fit the characteristics of each form of procurement must be examined.

A few theoretical models for determining a suitable procurement alternative, or deciding between make or buy for specific real estate development projects, have already been presented in the literature. These differ from each other, not only in respect of the alternatives considered and the criteria taken into account, but also in the weighting of criteria and appraisal of alternatives.

Kumaraswamy and Dissanayaka [6] developed an aid to decision-making that enables a decision between three procurement alternatives (design and build, build operate transfer, build own operate) to be made. In their model, eleven so-called performance criteria in the decision-making process, such as certainty of timing, low capital costs, minimisation of conflicts and efficient and effective communication, are considered. Three independent

variables are also considered: internal conditions specific to the project, alternative methods of procurement, and underlying external conditions. In the decision-making process presented by Kumaraswamy and Dissanayaka, these variables are related to a specific project profile. The weighting of these criteria for prioritisation is determined by means of a pilot study. The three alternatives are evaluated on a likert scale of 1-7, based on the previously formulated criteria. The decision is then made, based on the utility value of the individual variants, which is determined by multiplying the weightings by the evaluations. The variant that is most compatible with the different underlying conditions and the project profile, and therefore has the highest utility value, is determined on this basis. This approach only partly maps the decision-making situation and/or the decision-making process. First, there is no consideration of the traditional award of contracts for individual trades, which in practice is still the most widespread form of procurement. Second, the weighting corresponding to the results of case studies does not allow specific prioritisation for a particular company.

In contrast, Racky analyses only the difference between awarding contracts for individual trades and appointing a general contractor. In particular, in respect of distribution of risks, he initially derives a matrix of target values, in order subsequently to monetarise the risks relevant for the principal, using the amount at risk method. This enables comparison of the different forms of procurement based on the costs incurred [31]. In respect of potential transfer to the present decision problem, this approach can be criticised for being heavily financially-dominated and thereby lacking strategic focus.

In order to select suitable alternative forms of procurement (such as design and build, or more stringently, design control), Luu et al. [32] initially derive so-called procurement selection criteria from the literature and measure their relevance on that basis. For this, they organise the factors into the categories of client characteristics and objectives, project characteristics and external environment. In a next step, they give an overview about the authors that have assessed the respective criteria as relevant in their studies. The decision-making system they have developed uses a case-based approach, i.e. referring to similar projects that already been completed, in order to determine the suitable form of procurement in a specific project situation. The project profile of the current projects and the existing underlying conditions are compared with other projects and an evaluation is made of the extent to which the form of procurement selected in the past was successful. Finally, the alternative that has the best "fit" to the characteristics, underlying conditions and objectives of the current project is selected. However, transference of this approach is only possible if there is sufficient experience based on past projects, and if the underlying conditions and objectives are not too specific.

In their decision model, Griffith and Headley [33] present a combination of qualitative and quantitative approaches that should aid the choice of procurement for smaller building works. This model differentiates between

"contract work" (without documentation and with no formal consultation between principal and contractor), "organised work" (shorter than standard contracts but requiring a structured approach to procurement and management) and "smaller projects" (award of shorter construction contracts). The model enables a multi-criterial decision process, in which the weightings of each criterion are based on experience, or a project-specific survey of clients and project participants. The utility value of each alternative is calculated as the sum of the products of its weighting and evaluation. In procedures of this nature, there is a risk that, depending on subjective importance, the decision-maker may weight some criteria too heavily [34], thereby distorting the result. Transference to the forms of processing in property development is also necessary.

The method developed by Padillo et al. [5] for a make or buy decision between the generally distinguished alternatives of "sourcing", "outsourcing" and "subcontracting", takes place in seven stages. In the first stage, the decision problem is formulated and the planning horizon is defined. Next, criteria are established, by which the different alternatives should be assessed. The possible alternatives are also defined. Based on the formulated criteria, firstly an attribute is defined and secondly the importance of the criteria is determined. Using the criteria, the alternatives are then assessed in terms of their performance. With the aid of a composite programming model, a ranking of the alternatives is therefore generated and then the decision is made.

The submissions show that, in the literature, various aids to decision-making and lists of criteria have already been developed. However, these either refer to alternative decisions that differ from the decision problem investigated in this paper, or their selected decision criteria do not adequately represent the individual objectives, prerequisites or parameters of the specified project situation. Although the methods selected for weighting and assessing the alternatives offer a few possibilities for the tool to be developed, it must be possible in particular for each company to prioritise them individually, in order to enable company-specific data and weightings as well. So far, therefore, there is no model that offers a practicable approach for corporates to undertake a decision-making process that reduces complexity and is understandable. Such a model should finally emerge from this paper.

D. Model for the decision-making process

Based on the current status of research from the literature, in the following a model that replicates a specific project situation is derived. The authors firstly refer to the differences previously identified from the literature in order to differentiate the various forms of procurement, and

TABLE II
LITERATURE CONCERNING THE DECISION MODEL

Category	Criteria	Formulation of the decision question	Source
Goals	Cost certainty	Does the company primarily seek cost certainty?	Cánez (2000), Ng (2002), Kadefors (2005) [35], Rashid (2006)
	Certainty of timing	Does the company primarily seek certainty of timing?	Cánez (2000), Ng (2002), Love (1998), Rashid (2006)
	Quality assurance	Does the company primarily seek assurance of quality?	Cánez (2000), Eriksson (2010) [36]
	Price competition	Is price competition sought-after?	Cánez (2000), Love (1998)
Institutionalisation	Own abilities / competences	Does the company have the competence internally (for planning and/or construction)?	Cox (1997), Bajec (2010)
	Internal resources and capacities	Does the company have free resources internally (for planning and/or construction)?	Cox (1997)
	Special management requirements	Are there special demands on the (project) management?	Ng (2002)
	Risk allocation	Does the company want to transfer risks (that must be factored in)?	Skitmore (1988), Love (1998)
	Influence by the principal	How strong an influence should the principal have on the progress of the project?	Ng (2002), Pfnür, Schetter et al. (2010)
	Project conditions	Complexity of building	How complex is the planned building?
Project characteristics, standard building		What type of building is to be realised?	Ng (2002)

secondly augment the criteria that, in the literature, have already been used for decision models in property development. The criteria formulated in this way are brought into conceptual association in the framework of the model.

An initial overview shows the categorisation undertaken of the criteria that were recognised as relevant, in the three categories: project and corporate goals, institutionalisation⁵, and project conditions (see Table 2).

⁵ The institutionalisation of a project means in particular the respective organisational structure (available resources) and the management systems (influence by the principal, control, incentives).

In the decision-making situation modelled, the decision-makers must be faced with the decision questions formulated here.

Following Pfnür [28], the model covers the three categories of goals, institutionalisation and project environment. These have a direct effect on the decision-making process in the choice of a form of procurement. It is essential to maximise the "fit" between the goals and conditions, and the selected method (see Fig. 2) [37]. Moreover, the choice of a suitable form of procurement has a direct influence on the outcome and the success of the project. The success of the project is measured at this stage using the "magic triangle" of costs, time and quality [38].

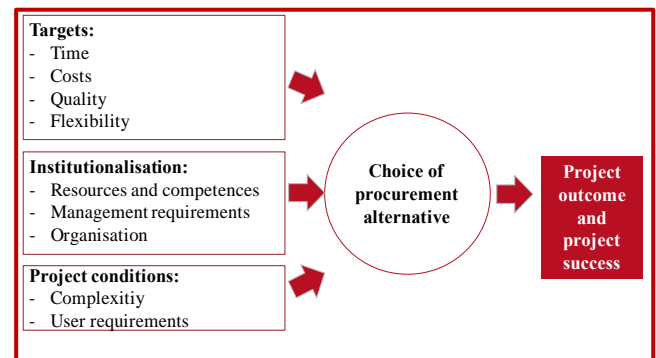


FIGURE II
MODEL FOR THE DECISION-MAKING PROCESS – FRAMEWORK FOR DECISION IN REAL ESTATE DEVELOPMENT

Although this model, derived from the literature and previous studies, represents the decision-making situation in a real estate development project from a theoretical-conceptual perspective, its applicability and practical relevance need to be tested by means of a case study. In a next step, therefore, the model is verified in a case study and, if necessary, adapted for application by a corporate based on the of data determined empirically. This also raises the question of whether the criteria and questions that have been formulated from decision-making practice need to be expanded. For example, it should be checked whether it is relevant for the decision-maker to include internal safety regulations in the decision-making process. For instance, new buildings on sites belonging to industrial firms, to which specific safety regulations apply, may be subject to restrictions that allow only internally-available technologies to be used. Another criterion, which transpired from personal interviews, is the distinction between prestigious new buildings, the cost factor of which is often regarded as only secondary, and standard buildings.

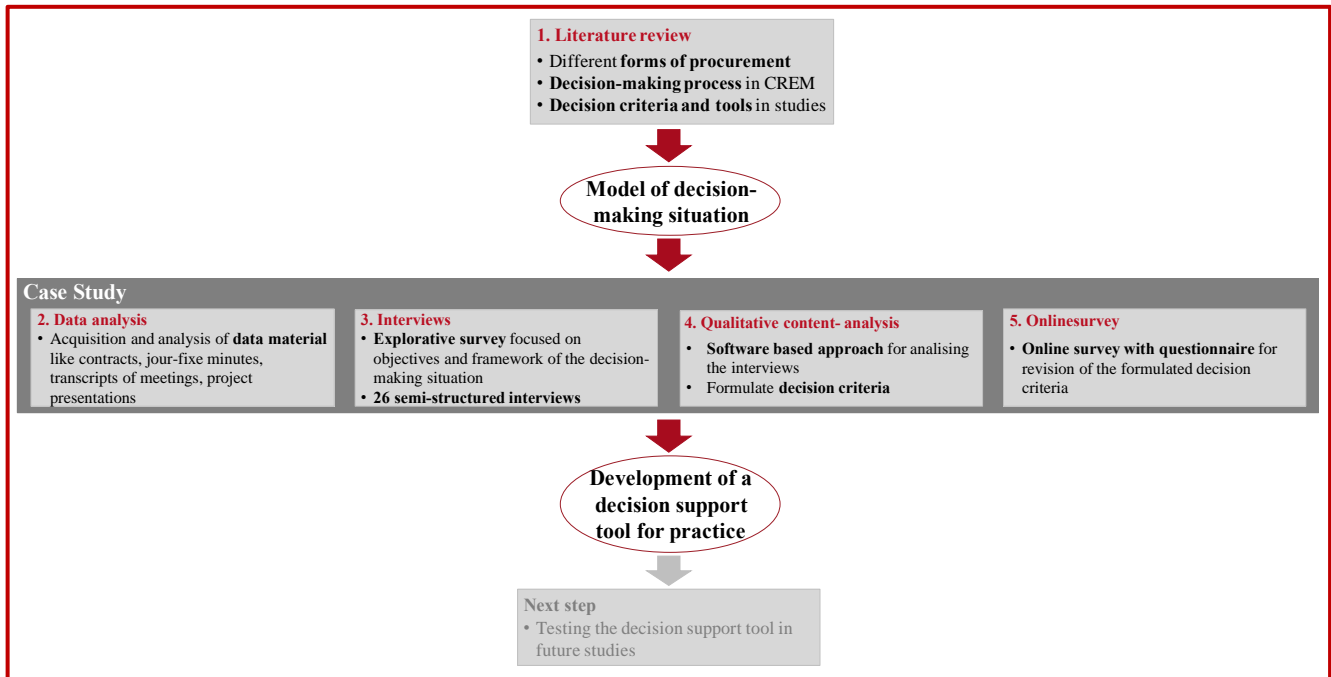


FIGURE 3
METHODOLOGY OF THE CASE-STUDY BASED RESEARCH

III. RESEARCH DESIGN

In order to assess and supplement the decision-making frameworks derived from the literature, in the selection of a form of procurement, a qualitative investigation was carried out using a case study from practice. For this, one of the first pilot projects of a development by a primarily value-added partnership was analysed after its completion. The data were collected in three stages:

1. Acquisition of available data material in the form of contracts, jour-fixe minutes, transcripts of meetings and project presentations
2. Conducting a series of interviews
3. Carrying out a computer-aided online survey

In the first stage, the available data material and the interviews were analysed using a qualitative content analysis, following Mayring [39]. For this, using an exploratory process, the decision framework previously developed with the aid of the literature was tested and refined, with the aid of the interviews. In order to increase the stringency and quantitatively confirm the decision criteria formulated, in a second stage the interview participants were again questioned, in the framework of a computer-aided survey. Finally, the formulated decision criteria were transferred to a tool that should aid the company in solving the specific decision problem in differing project situations (see Fig. 3).

A. Case Study

The development of an office building for a major German chemicals group was selected as a case study of a property development project. In this pilot project, the

procurement can be categorised as a value creation partnership. Its key objectives were the consolidation of different locations, together with the creation of modern workplaces. The site to be developed was outside the grounds of the plant. The new building was put into operation after an eighteen-month construction period. [37]

The company has its own construction and planning units, so that all four of the previously presented forms of procurement were considered.

In the scope of its process of consideration, the principal decided on a purely functional call for tenders, which would also improve the adaptability of the new office building for alternative uses. It awarded the contract to a system provider. One reason for this was the workload on its own construction department, because of another major project. Moreover, the tenders submitted undertook to optimise the investment and operating costs, as well as the execution of various factors favouring the project because of the partnership approach. The selected contractor was a German system provider, which offered the services of planning and execution bundled in the framework of a value-added partnership. The ensuing operation of the building was subsequently awarded to the same company.

The case study is particularly suitable for application to the research project because of the different procurement opportunities in the company and the specific new organisational structure selected for the development [37].

B. Interviews and qualitative content analysis

The cross-perspective input of the entire decision situation in the case study took place in the framework of a series of interviews with all the selected participants in the project from the different stakeholder groups. In this way,

participants involved on behalf of the principal, the contractor, the investor, the local authority, the planners and the subsequent occupiers were selected, using selection criteria such as their perceived roles in the scope of the case study and their general experience of development, with the aim of obtaining 360° feedback. The interviews, which were conducted with the aid of a guidance document, lasted an average of 60 minutes. The aim of the exploratory process was to record the factors influencing the specific decision situation concerning the choice of a form of procurement for new buildings in the company, by the experts, with no external limitations [40]. The decision model derived from the literature was also evaluated, using a deductive approach. The interview questions therefore concerned the goals, the institutionalisation and the conditions, as well as the characteristics of the project.

26 interviews were recorded and subsequently transcribed. These transcripts were supplemented by minutes of focus group meetings and round-table discussions in various configurations.

Qualitative content analysis following Mayring [39] was selected for the analysis of the interview transcripts. The method is based on 5 stages:

1. Derivation of a criteria grid from the literature and setting up coding rules and anchoring examples (see Table 3).

TABLE 3
EXAMPLES OF CODING IN CASE STUDY

Criterion	Description	Question	Examples
Resources (internal/external)	Involves internal and external staff and competences, workload, capacities	Which internal/external resources will be needed in the chosen implementation variant?	Competences on the corporate side, depth of expertise and increased likelihood of capacity bottlenecks by the principal, heavy integration of global engineering, internal planning and outstanding specialist

2. Step-by-step analysis of the material based on the criteria, using MaxQDA software (encode text passages)
3. Amending/supplementing the criteria based on the content (inductive)⁶
4. Re-analyse the materials based on the expanded structural framework
5. Summarising the content and criteria for specific decision-making criteria

This method is serves solely to analyse the content of the interview. It does not enable any conclusions to be made about the quality of the opinions.

C. Online survey for quantification and validation

The content-based results collected from the interviews were next revised and quantified by means of some specific queries. This involved confronting the same participants in the project with the specific results, in the framework of an online survey. The questions included an individual assessment of the relevance of the decision criteria derived to the selection of a form of procurement for a real estate development project.

The evaluation was carried out using purely descriptive statistics with some frequency distribution (see for example Fig 4 and 5). Any differences between the statements of the respondents on the principal's and contractor's sides were also investigated.

IV. RESEARCH RESULTS

The criteria that were derived, both deductively from the literature and inductively from the interviews, served as a basis for the derivation of specific decision criteria for the real estate development decision situation under investigation. As regards content, the criteria were therefore formulated from the criteria grid that was applied for the qualitative analysis of content. The linguistic formulation is always based on the question: Which criterion is relevant to the decision for or against a form of procurement, i.e. the only criteria that were selected were those that distinguish between at least two of the available forms of procurement. The 15 decision criteria identified in this way could be ascribed deductively to the three areas from conceptual framework: target system, institutionalisation, and project characteristics (see section II D). This results in the following list of the selected decision criteria [37]:

In the scope of the group discussions, two further criteria were added to this list:

1. A consistent BIM process to safeguard the digital value chain
2. Transferability of security risks to the contractor

The criteria identified can be assigned to the decision framework previously established:

- Target system:
1. Amount of investment costs
 2. Amount of lifecycle costs
 3. The intention to put the project out to tender based on a functional specification
 4. The intention to put the project out to tender based on a detailed specification

⁶ Reliability was ensured by encoding three transcripts in parallel by two different encoders.

- Institutionalisation:**
1. Availability of internal planning resources for the project
 2. Availability of internal managerial capabilities for the project
 3. The principal's planning competence for the specific type of building to be procured
 4. Transferability of the overall deadline risks to the contractor
 5. Transferability of the overall cost risks to the contractor
 6. Transferability of quality risks to the contractor
 7. Reducing the number of interfaces between the participants
 8. Transparency of the entire project processes through communication and information for the principal
- Project characteristics:**
1. The site is in the grounds of the plant
 2. The fact that the company may retain ownership of the property
 3. The fact that the company may be the tenant of the property

TABLE IV
LIST OF CRITERIA

Criteria in model	Decision criterion/criteria derived for the tool
Own abilities / competences	1. The principal's planning competence for the specific type of building to be procured
Internal resource capacity	2. Availability of internal planning resources for the project 3. Availability of internal managerial capabilities for the project
Special management requirements	4. Reducing the number of interfaces between the participants 5. Transparency of the entire project processes through communication and information for the principal 6. A consistent BIM process to safeguard the digital value chain
Risk allocation	7. Transferability of security risks to the contractor
Influence by the principal	8. The intention to put the project out to tender based a functional specification 9. The intention to put the project out to tender based on a detailed specification
Cost certainty	10. Transferability of the overall cost risks to the contractor
Certainty of timing	11. Transferability of the overall deadline risks to the contractor
Quality assurance	12. Transferability of quality risks to the contractor
Price competition	13. Amount of investment costs 14. Amount of lifecycle costs
Complexity of the building	15. The site is in the grounds of the plant
Project characteristics, standard building	16. The fact that the company may retain ownership of the property 17. The fact that the company may be the tenant of the property

In the framework of the online survey, the respondents were asked to state the extent to which, in their view, these 15 criteria were relevant to the decision situation of a form of procurement. The total response rate was only 58 % and so the results are only from a descriptive statistic.

The results in Fig 4 [37] show that, for all respondents across the board, a large proportion of the criteria have major significance in the selection of a form of procurement. Furthermore, no differences could be detected in the relevance of the decision criteria, as regards the views of a particular group of respondents.

A direct comparison nevertheless shows that the respondents assess the relevance of some criteria more highly than others. It is also apparent that some criteria may not be capable of evaluation from every point of view. This is demonstrated, for example, by the high proportion of "no answers" from contractors regarding the "Principal's planning competence for the specific type of building" criterion (see Fig. 5). Examples of highly relevant criteria are "the transferability of the different risk groups to the contractor" and "reducing the number of interfaces between the participants". In contrast, criteria that the respondents considered to be less important included "the situation of the site in the grounds of the plant" and "whether the company retains ownership of the property or rents it".

To provide a comprehensive representation of the decision problem in the decision tool, all 15 criteria will continue to be considered. However, as only a single case study was investigated, there is only limited general validity.

V. DEVELOPMENT OF A DECISION SUPPORT TOOL

With the objective of representing the CREM viewpoint of the decision situation for the development of a new corporate building, a reference framework was first derived from the literature and then explorative supplemented and refined by means of interviews and qualitative content analysis. Emerging from the interviews and the subsequent online survey were 15 decision criteria, which should be carefully considered by decision-makers in a specific decision situation. From this result there is a corollary for the CREM, as to the way that the decision process can be supported with the aid of a decision-making tool. This tool should include some queries to the individual project situation and so, the tool should determine, which procurement form is suitable for the specific project development. In the following stage a decision model/process for this tool had to be derived from decision theory and then adapted to the present decision problem.

A. Methodological consideration for the decision method

The question of a suitable method for aiding corporate decisions has been increasingly discussed in specialist journals for several years. A major reason for this is that strategic decision-making is now considered to be a core element of management responsibilities in large companies [41]. However, this contrasts with the current situation in practice, where, across all sectors, a fragmented, cost-

oriented, culture of barely systematic or value-oriented decision-making is apparent [42].

The literature on decision theory offers various models, most of which are based on mathematical calculations. An important distinction is whether a choice problem or an optimisation problem is to be solved [41]. The selection of a form of procurement does not allow an arbitrary

assembly of attributes but rather presents the decision-maker with a choice between predefined alternatives in a specific decision situation. It is therefore a discrete choice problem. The large number of relevant criteria that must be taken into account in the decision process means that the consideration of a multiple criteria decision-making (MCDM) problem [43] is required.

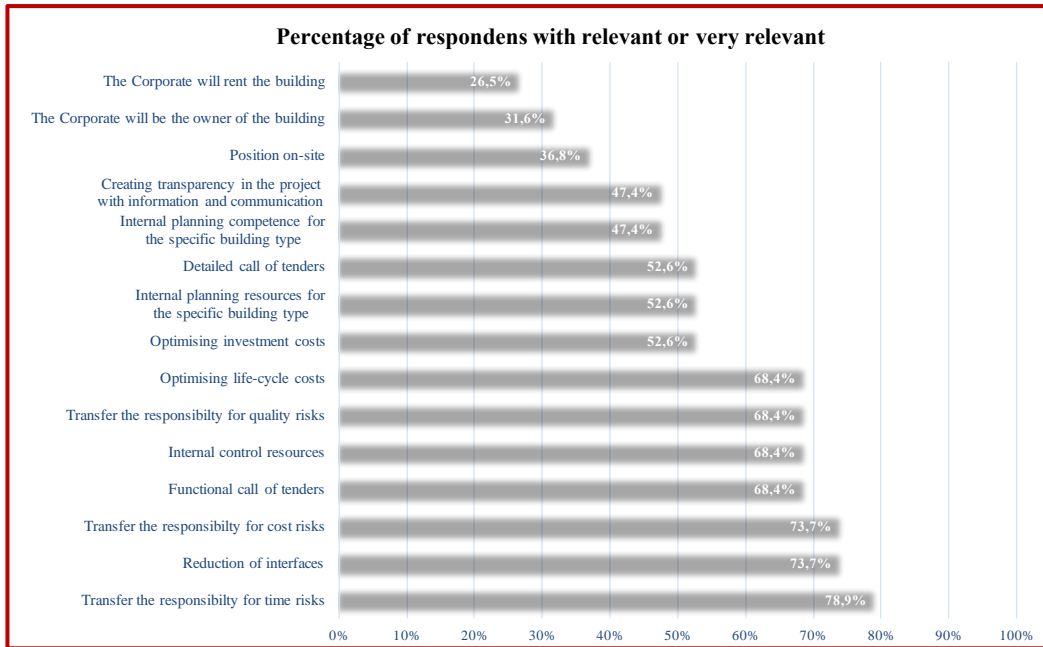


FIGURE 4 RESULTS FROM QUESTIONNAIRE TO THE RELEVANCE OF DECISION CRITERIA

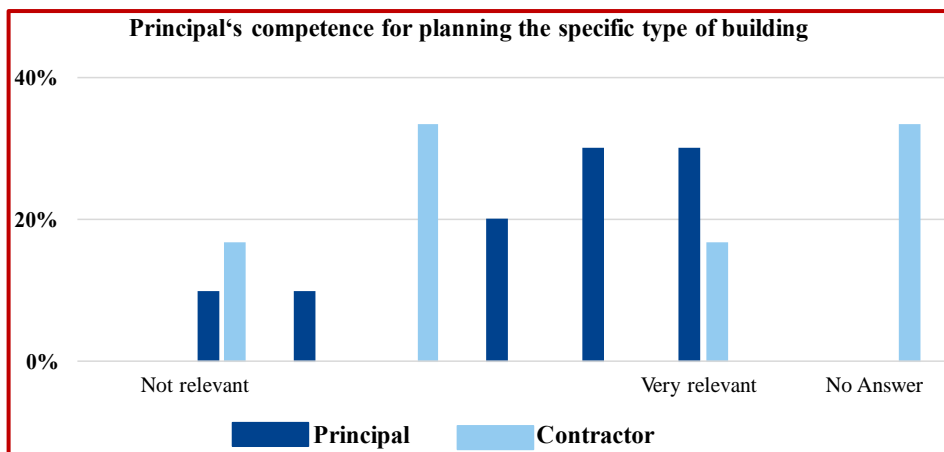


FIGURE 5 DIFFERENCES IN RESPONSES BETWEEN PRINCIPAL AND CONTRACTOR

Determining the best alternative is possible using a simple method, if one alternative outshines the others in respect of all the criteria assessed as relevant [44]. This is not possible for the alternatives defined here in respect of the criteria identified. Such a procedure can therefore be ruled out. However, in this context, it is also possible to identify so-called dominance criteria for the present decision problem. These can lead to the direct exclusion of some alternatives. "A dominance criterion checks whether

an alternative is dominated in the sense of at least one other alternative, so that any decision-maker who accepts simple and easily-acceptable basic requirements for rational decisions would never choose this alternative" [45]. In the present decision problem, the question of available planning resources represents a dominance criterion. If there are internal capacity bottlenecks, conventional in-house planning with individual award of contracts cannot be carried out without buying in additional resources.

Another dominance criterion is that, when deciding on the total contractor variant including operation, the usage requirements and/or the type of use must be predictable in the long term, as in this case the operation is included in the contract when awarded. These criteria can lead to the exclusion of alternatives on an initial query in the framework of the tool.

The other 13 criteria cannot be used to directly exclude alternatives: a different model must be selected for them. The literature suggests various methods / models for taking different criteria with differing priorities into account in a decision:

TABLE 5
METHODS FROM DECISION THEORY

Method	Description	Sources
Simple additive weighting (NWA)	Simple arithmetical method: The various criteria are weighted with a total of 100%. The evaluation of alternatives is carried out on an individually defined scale. Comparative values are then the sum of the weighted evaluations for each alternative.	Stevens-Navarro (2006) [46]
Multiplicative Exponent Weighting	Criteria are weighted by exponents (>1 indicates above-average significance, <1 indicates below-average significance). The difference in the weighting of the characteristics indicates, as a distance measurement, the relative importance of the characteristics with each other.	Arora (2012) [47]
Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)	Determining the assessment of each individual alternative using the criteria (on a selected scale). Developing an alternative that combines the "best"/"worst" assessment for each criterion and determining the geometric distance of each alternative from the notional best and worst alternatives. (measure of efficiency)	Hwang (1981) [48]
Elimination and Choice Expressing Reality (ELECTRE)	The decision-maker determines an accordance index and a disagreement index for each alternative. The first index represents the sum of the weights of the attributes for which A is better than B, the second is calculated as the absolute difference between the attributes.	Zanakis (1998) [49]
Simple multiattribute rating technique (SMART)	The model is regarded as a procedure for direct estimate of utility. Weightings are set without any initial restrictions and are then normalised.	Edwards (1977) [50]
Analytic hierarchy process (AHP)	Establishment of a hierarchy of criteria. Consideration of all criteria on a hierarchical level in paired comparison. Normalisation of the relative weightings determined in this way. The weighting matrix can then be multiplied by the alternative weightings using a mathematical method.	Saaty (2008) [51]
Point allocation (PA)	Simple method in which a hypothetical number of points (typically 100) is apportioned to criteria/attributes according to their significance.	Doyle (1997) [52]
Scenario Analysis	Determination of best-case and worse-case scenarios (alternatives). Analysis of the effects and comparison of the	Mahmoud (2009) [53]

	results of the scenarios.	
Conjoint Measurement	Individual characteristics of the alternatives are arbitrarily combined and decision-makers are queried about their utility, in order to determine an optimal alternative.	Tversky (1967) [54]
Fuzzy Logic	Modelling the uncertainty of fuzziness in vague descriptions. Discrete values are replaced by a continuous range (interval from 0 to 1).	Mardani (2015) [55]

The present decision problem presents various demands on the decision model:

1. 15 different criteria need to be considered, while retaining transparency and consistency
2. Individual prioritisation of the criteria should be allowed (depending on corporate objectives, etc.)
3. The application should be transparent for the user (the CREM)

For this reason, a few of the potential decision models can be discarded from the intended application at this stage:

The Simple Additive Weighting Process and the Point Allocation Process are not suitable, because a distribution of 100 per cent (100 points) across the 15 criteria in the approach is not only impractical but also carries the risk of inconsistency. The use of Multiplicative Exponent Weighting can be regarded as inappropriate for the same reasons. ELECTRE and SMART lack transparency for the user. A Scenario Analysis does not appear to be suitable for this example: it would be highly complex, particularly because of the multiplicity of scenarios required to accord with the different criteria. Conjoint Measurement is also not appropriate at this juncture, as no new alternatives can be created. CREM can only decide between the clearly defined alternative methods of procurement available on the market.

These conclusions resulted in the development of a tool that uses the AHP method to structure and prioritise the criteria, and TOPSIS to assess and compare the alternatives. Although the large amount of effort required to carry out a paired comparison between the criteria is recognised [50], using this method enables a consistent, integrated weighting of all the criteria. Another significant advantage of the AHP method is the easier handling of large, unstructured decision problems by splitting (subdivision) into manageable and comparable elements. The large amount of computational work needed to calculate the levels of efficiency for TOPSIS can be facilitated by a calculation running in the background of the tool.

For this individual problem, the addition of the Fuzzy Logic is not necessary because the model will be transparent when using AHP and the paired comparison helps to identify the weights with simplify the complexity.

B. Decision support tool

In accordance with the approach to the AHP method described by Saaty, the decision problem, with its possible alternatives and the criteria identified, are first presented as a hierarchy [51] (Fig. 6 [37]). This includes formulating main criteria, which aggregate the identified (sub-) criteria thematically.

These are:

1. Using internal resources
2. Transfer of the full responsibility for risks
3. Creating transparency in the project
4. Optimising cost factors
5. Determining level of details

The four fundamentally different forms of procurement, discussed in Section II B), are specified as alternatives.

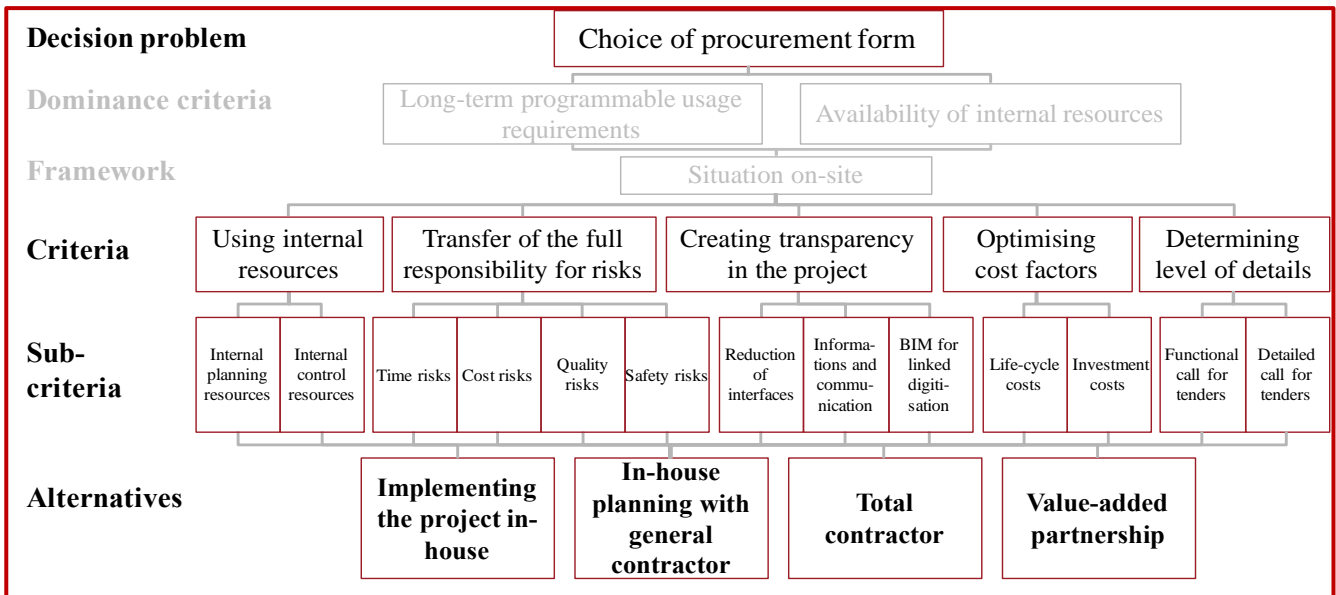


FIGURE VI
HIERARCHY OF DECISION PROBLEM AND CRITERIA

Question 1: For procurement of corporate real estate you have to decide between ownership and rental. Is your usage requirement and type of usage predictable for at least 5 years?	yes	no
	<input type="radio"/>	<input type="radio"/>
Question 2: For real estate development there are many different kinds of human resources necessary. Are resources for planning with the required competences available in your company?	yes	no
	<input type="radio"/>	<input type="radio"/>
Question 3: In many companies there are specific restrictions for working on-site. Is your project situated on-site?	yes	no
	<input type="radio"/>	<input type="radio"/>

FIGURE VII
FIRST SECTION OF DECISION TOOL

Use of internal resources	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Transfer the responsibility for risks
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
Use of internal resources	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Creating transparency of procedures
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
Use of internal resources	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Optimising costs
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
Use of internal resources	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Determining degree of detail
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	

FIGURE VIII
AHP PORCESS FOR CRITERIA

The tool that was developed based on this hierarchy comprises three sections:

1. Retrieving the dominance criteria (see Fig. 7)
2. Indirectly prioritising the criteria by paired comparison, using AHP
3. Evaluating the alternatives using TOPSIS

The input into the first two stages is project-specific and therefore required individually for each project. The third stage only must be completed once. As the matter of the location of the planned project ("on-site", i.e. in the grounds of the plant, or outside them) only affects the security requirements, it is placed in the first stage of the tool with the dominance criteria.

This query can lead the immediate discarding of some alternatives, which no longer need to be taken into account in the subsequent weighting process. The paired comparison is initially carried out using the main criteria. An example of this is shown in Fig. 8.

The evaluation takes place on a AHP characteristic scale of 1 to 9. The following levels of importance are assigned to the ordinal scale:

TABLE VI
IMPORTANCE OF SCALE FIGURES

Scale	Importance/Relevance
1	Equally important
3	Somewhat more important
5	More important
7	Much more important
9	Extremely important
2,4,6,8	Intermediate values

In the background, a weighting matrix is therefore calculated. In the next stage, a query of the paired comparison of all sub-criteria is carried out for each main criterion. The normalised weightings of each individual criterion represent the prioritisation.

In this instance, based on the criteria, the four alternative forms of procurement are assessed on a likert scale of 1 to 7. On this scale, a rating of 1 means "the alternative does not fit the criterion" and 7 means "the alternative completely fits the criterion". Each of these assessments is then multiplied by the weightings in the background of the tool, resulting in a weighted normalised decision matrix (with values v_{ij}). "Best case" and "worst case" alternatives, summarising the maximum and minimum assessments for each individual criterion, are then adopted.

Determination of the distance between each alternative and the best / worst case is then used as a preparation for the calculation of the measure of efficiency (see Fig. 9). The measure of efficiency of each individual alternative is finally used as a comparative value in the decision-making process.

The alternative determined to be the most suitable by this process should serve as a recommendation and should indicate, from an academic perspective, the alternatives that should be subjected to further internal discussion by

the corporate decision-makers in the specific framework conditions of the project.

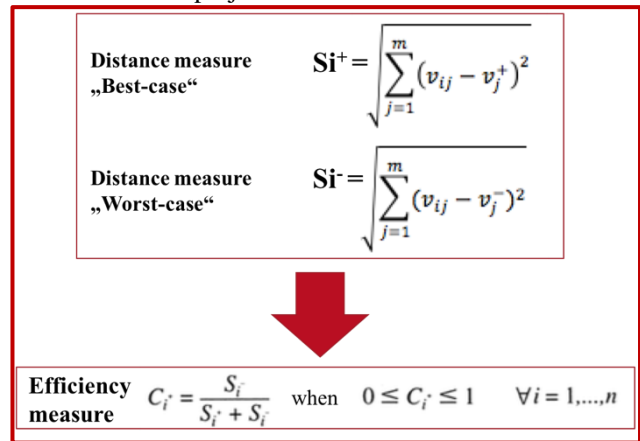


FIGURE IX
FORMULA FOR CALCULATING THE EFFICIENCY

VI. DISCUSSION AND LIMITATIONS

The decision-making tool presented here is intended to serve as a managerial aid to companies when selecting a form of procurement for new corporate properties. The criteria integrated in this framework were partly based on the literature and partly specifically determined in the scope of a research project. This is a limitation, as it means that the tool cannot be assessed as generally valid. The data used in the research project, which were collected from a large chemicals group, are based on a project in which a new office building was developed in the framework of a value-added partnership. It is therefore possible that additional, different criteria may be relevant to very specific types of buildings or in other sectors.

Conducting individual interviews, as were used in this case for purposes of qualitative analysis of content, carries the risk that the selection of participants may not cover the whole range of opinions. It is also possible that brainstorming ideas from individual participants might promote deeper consideration and hence additional statements from others. This methodology does not allow this. However, with the aid of the online survey, it was ensured that all interview participants could be queried for a second time on the qualitatively compiled content whereby the return rate is only 58%.

Another factor is that the application of the tool is relatively time-consuming. Querying all pairs also requires the objectives and conditions of the specific project to be clearly formulated. This is a precondition for consistent input into the tool and is therefore a helpful recommendation. Experience shows, however, that this may also present a problem, since past decisions involving the procurement of new development projects often lacked transparency or structure. In this case, though, the tool can impose discipline: its users are forced to consider specific issues/criteria. Moreover, the relatively large amount of time required to use the tool can be justified by the major importance of such decisions and the large investments involved.

VII. CONCLUSION AND FUTURE RESEARCH

In this presentation, an aid to the selection of a form of procurement for new development projects by CREM was developed in the form of a tool, based on existing investigations in international papers and a specific case study. Our research concentrated on the four basic forms of procurement that are fundamentally different in terms of objectives, organisational and control structures, and responsibilities. In addition, an overview of the existing decision models in the construction industry was provided and the decision models proposed by general decision theory were evaluated and their applicability to the present decision problem was investigated.

The model finally developed includes 15 decision criteria, which can be represented in a hierarchical structure of dominance criteria, main criteria and sub-criteria. As a method for prioritising the criteria and appraising the four distinctive forms of procurement, a paired comparison using the AHP method, in accordance with Saaty, was selected, in combination with an evaluation of alternatives using TOPSIS.

The comparison of the alternatives shows that, in practice, the realisation of construction projects by a value-added partnership, an innovative and so far, seldom selected form of procurement, can certainly make sense. However, so far, this examination has been based solely on theoretical relationships and one case study taken from practice. Future research based on these results should examine, in particular, the applicability to other project situations of the decision criteria proposed here. This presents the opportunity to allow companies to use the tool as a management base in order to test whether it would confirm their past decisions concerning investment in real estate projects. In this way, the tool could gain further general validity and legitimacy for application in practice. In the next stage, it is therefore planned to carry out a large-scale survey on this issue, of the various stakeholders reference to investing in development projects. On this basis, a next result should be to formulate profiles for every procurement form, which shows the project conditions under which the procurement form will bring about a positive outcome.

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