Designing decision strategies for purchasing: results from an experimental study.

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Abstract

This paper is concerned with deciding on how and when to make purchasing decisions. Such a strategy for decision making, (in short: a decision strategy), is often only made unconsciously and/or lacks sufficient differentiation. In other words: purchasers take many decisions as they come, rely strictly on experience and common sense for solving them and often only have very general procedures and checklists available for guidance. While this may be an appropriate strategy in certain situations, we argue that in many other instances other (more explicit, conscious and proactive) strategies should be pursued. We discuss the development and empirical testing of a meta-model approach which enables purchasers to design appropriate decision strategies for the various different purchasing situations relevant to their organisations. The objective of the research described in this paper is to deliver: (1) useful decision models for supporting purchasing decisions and (2) a meta-model approach that should make it possible to link different purchasing situations to adequate and useful decision models.

Introduction

Few attempts have been made to address the spectrum of purchasing situations in relation to various decision models and approaches. Among these few attempts are Kraljic (1983), Soukup (1987) and Ellram (1996).
Moreover, the empirical testing of the existing contributions is limited. The purpose of the research discussed in this paper is to try to overcome this limitation of the current theory. The paper attempts to contribute to a prescriptive theory on purchasing decision making. Such a prescriptive theory is neither purely descriptive (such as e.g. Webster and Wind; 1972, Bunn; 1993) nor strongly normative (e.g. Pan; 1989, Weber and Current; 1993) but rather a combination of these streams aimed at supporting purchasers in making better decisions in their every day practice. So far, only a limited number of contributions have been made to a prescriptive theory on purchasing decision making, see e.g. Nydick and Hill (1992) and Barbarosoglu and Yazgac (1997).
In addition, the contributions are still very fragmented, i.e. the various authors each focus on a particular purchasing situation or industry sector. While building on existing contributions, the paper also contains strong input from the area of behavioural decision theory (e.g. Bell *et al*, 1988) as well as the more prescriptive streams within Operations Research (see e.g. Basadur *et al*, 1994 and Keeney; 1996).
The paper is organised as follows. In the next section, the theoretical background of the meta-model approach is explained. A number of sections in which the results of a field experiment using the meta-model approach are presented follow this. In the final section we draw preliminary conclusions and we discuss our future research on this topic.

A meta-model approach for designing purchasing decision strategies

In this section we discuss the design of a prototype of a meta-model of supplier selection which should enable a purchaser to design appropriate decision strategies for different purchasing and supply situations.
The first step in the design process consists of more precisely defining the concept of decision strategy. Beach and Mitchell (1978) define a decision strategy as: '...(a) a set of procedures that the decision maker engages in when attempting to select among alternative courses of action and (b) a decision rule that

dictates how the results of the engaged-in procedures will be used to make the actual decision'. However, for our purposes a more detailed definition is required. In Beach and Mitchell's definition it remains unclear what the procedures under (a) exactly consist of. Inspired however by Beach and Mitchell's definition, we arrive at the following working definition of a decision strategy. A decision strategy could be defined as making the following four decisions:

1. Deciding on where in the decision making process under consideration to fix the so-called 'Decision Decoupling Point (DDP)', i.e. deciding what is going to be arranged and performed in advance and what is going to be carried out once a decision must be made. The DDP-concept will be explained in more detail later on in this section.

2. Deciding which phase(s) of the decision process are going to be aided by means of one or more supportive decision models. In addition to supporting the phase in which the ultimate choice is made, we also consider the possibility of supporting the phase prior to this choice phase, i.e. supporting the phase of problem definition, e.g. aiding decision makers in formulating criteria.

3. For the phase(s) identified in the previous decision, we have to decide which supportive models or methods are to be used.

4. Deciding on the maintenance that should be carried out, i.e. periodic and/or event-triggered reviewing of the decisions described above.

The DDP-concept requires further explanation. Let us consider the model of individual decision making (based once again on Beach and Mitchell; 1978):

(See Figure 1)

The first stage involves problem recognition: becoming aware of or 'deciding' that there is a problem, i.e. a discrepancy between some desired and the actual state of a system. This discrepancy may just be a very vague idea or a merely a feeling ' ..that something is not right'. This first stage however, immediately triggers the next stage which basically consists of finding out what should be done, e.g. what do we need to know, what are the parameters of this problem or what are the alternatives and what are the criteria? In the third stage, it is 'decided' how, given the results of the previous stage, a final decision is going to be reached. The method 'chosen' however, does not necessarily have to be a formal or analytical method. In addition, in most cases, the first three stages are carried out in the decision-maker's mind without any explicit support or evidence. The necessary information for arriving at the decision is gathered in stage 4. Finally, stages 5 and 6 involve the actual execution of the method leading to the ultimate decision.
Now, similar to sequences of production or logistics processes, some processes (stages) may be carried out in advance, i.e. anticipating on future decisions. The results of these anticipative processes can be seen as some kind of 'stock'. In case of an actual need or opportunity for a final decision, the decision-maker proceeds from this stock and uses its contents to arrive at a final decision. The content of the stock depends on where this stock-point or Decision Decoupling Point is positioned. Principally, this may be at any point in the whole decision process, see figure 2. We can further clarify figure 2 through an example in purchasing.

(See Figure 2)

In case of a checklist with evaluation criteria to be used in supplier visits, the DPP is often placed just after stage 2. The need to carry out supplier visits and having to decide whether the supplier visit results in a 'satisfactory' or a 'non-satisfactory' label for the supplier is anticipated in advance. Furthermore, the step

of task evaluation (stage 2) can be carried out in advance, e.g. the criteria to be used are stated in advance. So, at this point in the process the stock of results consists of:

- A clear description for recognising the problem, e.g. if we consider to purchase an item from a new supplier, this supplier must be subjected to a supplier visit;
- A list of criteria that may be used when visiting the supplier.

However, this is as far as the process is carried out in advance. The decision which method should be used to aggregate the scores on the various criteria is not made in advance here, just as the stages of actual information gathering and finally deciding are not carried out until the supplier visit has actually taken place. Naturally, the DDP for a supplier visit might be fixed at other points, e.g. after the first or after the third stage. Considering various possible positions of the DDP is part of designing a decision strategy for an activity.
Designing a decision strategy for a purchasing activity is a decision process in itself in which the DDP is placed after the third stage. The first stage (i.e. problem recognition) involves specifying a particular purchasing situation. Next, the required tasks (activities) that are to be carried out are defined. Thirdly, supportive decision models that may be used in these activities are identified. However, the actual information processing, i.e. using the decision models and performing the activities is not carried out until the problem (i.e. the purchasing situation) really occurs.
We now describe how the design process of decision strategies for supplier selection might be carried out. A possible generic (or meta-) model format for a supplier selection decision strategy is given in table 1. Some tentative applications of this meta-model format using Fisher's (1970) framework of purchasing situations are presented in the table 2.

The differences between the purchasing situations in table 2 consequently result in different supplier selection strategies. Summarised: the more familiar the situation is, e.g. in case of established products that have been purchased before, the further downstream the DDP may be positioned. Obviously, the opposite applies for situations characterised by first time purchases of new products. At the same time, situations characterised by high product complexity as well as high commercial complexity require and justify thorough analysis and support. Please note that the summing up of methods suggested under 'support' is not exhaustive. The methods mentioned here merely serve as illustrations. Many more possibly useful methods have been identified (De Boer; 1997). These methods are currently being tested with respect to their applicability in various supplier selection situations and will accordingly be allocated to appropriate supplier selection meta-models. In the final design of these meta models, the influence of the personal characteristics of the decision maker will also be recognised, that is to say the starting point is that the final form and contents of a particular supplier selection strategy cannot be given in advance completely, but needs to be tailored to the specific situation on hand, using the appropriate meta model as guiding frame work.

Testing of the approach in a field-experiment

The meta-model approach was tested in three supplier selections cases in three organisations. Based upon semi-structured interviews with the (purchasing) decision-makers involved, a detailed description was obtained of the particular supplier selection case. Next, the meta-model approach was applied to this description, i.e. retrospectively a decision strategy was designed for this situation. The decision strategy was proposed to the decision-makers. In addition, the decision-makers participated in (partly) repeating the supplier selection process, however, this time using the supportive decision models suggested by the strategy. In this way, the effectiveness and efficiency of the decision process following the decision strategy could be evaluated and compared with the effectiveness and efficiency of the actual supplier selection process. The evaluation criteria included: decision quality, indirect benefits of using decision

models, practicality of the decision models, user satisfaction and cost/benefit issues. In the following sections the design, testing and evaluation of a decision strategy for one of the three cases is described.

Brief description of the case

The case concerned the replacement of a telephone exchange system at the University of Twente. The telephone exchange system is a combination of hard and software that enables and facilitates all internal and external telephone and fax communication at the University. The replacement was triggered by a combination of factors. First, the current telephone exchange system had been scheduled for replacement already four years ago. Secondly, this system lacked sufficient capacity. In addition, the system could not meet present-day technological and functional requirements, e.g. voice-mail. Also, maintenance of the system could not be guaranteed anymore. Finally, (future) technological developments in the field of IT, e.g. connecting telephones to computer systems, would require a new telephone exchange system.
Because the expected size of the investment exceeded the threshold set by the EU, the University had to follow the EU-directives on public procurement. In this case, the so-called 'open procedure' was used, which means that the invitation to tender (ITT) was published right away in the appropriate EU-journals thereby making the invitation open to all possible suppliers in the EU. The reason for using this procedure instead of the 'closed procedure' (which involves a screening of potential suppliers prior to the actual tendering which is only open to a subset of screened suppliers) was that only a limited number of suppliers were expected to send in a tender. The ITT resulted in tenders from four suppliers. Next, the committee responsible for the purchasing process paid visits to the four suppliers. These visits led to several minor changes in the tenders. In line with the EU-directives, all communication between a supplier and the committee was forwarded to the other three suppliers.
An external advisor prepared a written summary of the information that was gathered from the tenders and the supplier visits. Based upon this, the advisor proposed a final overall ranking of the suppliers on the set of ten pre-defined criteria.

Choosing and fine-tuning of a decision strategy

In case of the telephone exchange system, we are (strictly speaking) dealing with a modified rebuy. However, there is clearly a high degree of modification and a high level of product complexity. In addition, such systems are purchased only every eight to ten years. During such intervals, technological developments are bound to take place (especially in telecommunication and IT segments) as well as changes in the supply market. Therefore, it seems that only a limited (yet important) number of activities can be prepared in advance. Still, similar decisions will become actual again at some point in the future, i.e. the new telephone exchange system will also have to be replaced. Considering the basic purchasing characteristics of this case, we proposed to use meta-Strategy B (see table 2) as the basis for a decision strategy for this particular case as well as future case with similar characteristics.
In this decision strategy, therefore, activities before the DDP are:

- Problem definition/recognition; In this case this boils down to answering such questions as: 'What do we want or what would we want to achieve with replacing the system under consideration?', 'Are there perhaps other ways of also achieving this?' or 'Under which circumstances is replacing (and purchasing) the telephone exchange system a good alternative?'
- Formulation of criteria; Some of the basic categories of criteria related to the characteristics of a supplier may be formulated in advance. In addition, some categories of criteria related to the telephone exchange system (or other complex infrastructural investments) may be formulated as well at this stage.

The decision strategy involves a periodic review of these (basically generic) steps, which may be for example every two years. In case of an actual (or at least formally expressed) need for replacement, the following (more specific) activities are carried out after the DDP:

- Checking the problem formulation using the problem definition-analysis that was carried out before the DDP;
- Detailed formulation of specific criteria (both with respect to the supplier and the telephone exchange system) within the categories that were formulated before the DDP;
- Deciding on which EC-procure should be used, i.e. the open procedure or the closed procedure;
- Evaluation of suppliers and/or tenders on the criteria formulated after the DDP;
- Final decision and implementation of this decision.

At first glance, the situation may seem rather structured, i.e. it seems very reasonable to replace a telephone exchange system if such a system can no longer meet the (functional) requirements set by the users of the system. However, a closer look at the problem may result in a less obvious picture. First, perhaps many different technical solutions are possible for solving the problems caused by the 'old' system. Secondly, it may not be obvious to 'purchase a new telephone exchange system' because there may be other solutions, e.g. leasing a new system or adapting the current system (leasing was actually considered and investigated). Thirdly, the high commercial complexity of this purchase justifies a systematic problem analysis and definition. Therefore, we would plead for supporting this problem definition/recognition process.

In addition, we would also suggest the use of decision models for formulating the categories of criteria (regarding suppliers as well as regarding the system) and evaluating the suppliers and/or tenders with respect to the specific criteria within these categories of criteria. The importance of this purchase in terms of the size of the investment as well as the organisational impact constitutes sufficient reason for considering the use of supportive decision models. Besides, the EU-directives also urge FS to explicitly formulate evaluation criteria and apply transparent decision processes, e.g. being able to explain to suppliers why their tender was not awarded a contract.

For each of the (supported) activities we chose one or more useful and appropriate decision models suggested by decision strategy B (again see table 2). Subsequently, together with the Chairman of the committee, which had been responsible for the purchase of the new telephone exchange system, we applied these decision models to the case. In other words, the purchasing process was repeated, however, this time a decision strategy (including various decision models) was used. A brief description of these decision models is given in table 3.

Evaluation of the decision strategy

The aim of the experiments is to assess in a systematic manner the usefulness of the decision models for supplier selection and with that, the usefulness of the meta-decision strategies. Basically, there are two categories of criteria for the assessing the appropriateness or usefulness of a decision model for a given situation, namely the degree to which the model deals with the complexity of the decision situation and the degree to which the costs of using the model seem to justify the gains (De Boer; 1997). For a further breakdown of the overall criteria 'dealing with complexity' and 'cost/benefit', we used the work of Timmermans (1991) and Rohrmann (1986). This resulted in thirteen evaluation criteria. The performance of the decision models with regard to these criteria was thus discussed with the chairman of the purchasing committee. In table 4 the outcome of this evaluation is summarised.

In addition to the evaluation by the chairman of the purchasing committee, we also evaluated the decision models (and thereby the decision strategy) ourselves with respect to the thirteen criteria as well as two additional criteria: (1) the ex post 'goodness' of the decision and (2) dependency of the decision maker on assistance from a facilitator. Due to the limited space available here, only the main results of this evaluation are discussed in this section.

As to the final outcome of the experiment, there was no difference compared to the original process, i.e. the experiment resulted in choosing the same supplier as the committee had done previously. However, it

should be noted that in the testing of the AHP-method (which was used to evaluate the final quotations from the suppliers) the original criteria were used. Using (some of) the criteria that resulted from applying the brainstorming-techniques, might have lead to another outcome. Furthermore, the WWS-analysis resulted in several actions (in addition to the purchasing of a new system) that also would contribute to an improved quality of the tele-communication at the University, which was one of the reasons for initiating the replacement of the telephone exchange system.
Throughout the testing of the decision models, it was clear that the chairman of the purchasing committee was dependent on our assistance as 'decision support facilitator'. Obviously, and as expected, the chairman was not familiar with any of the decision models, except for the 'conjunctive' method (see table 3). Therefore the assistance consisted of introducing and explaining the decision models as well as assisting in the actual use of the models (especially in the case of the WWS-analysis, ISM and AHP). The assistance in actually using the models involved interpreting and processing information (following the 'rules' of the decision models) given by the chairman.

Preliminary conclusions and further research

Application of the meta-model approach in a practical situation resulted in a decision strategy that was judged as useful by a one of the key-decision makers involved. The decision models, as part of the decision strategy, create a more explicit, consistent and complete decision making process. This does not only facilitate improved communication about the decision (both within the purchasing committee and between the committee and the University Board) but it also improves the quality of the committee's own judgements and reasoning and with that, ultimately, its choices. The decision strategy also seems to be practical from a cost/benefit perspective. None of the decision models, as they were used in the experiment, required expensive or time-consuming information gathering and/or calculations.
Nevertheless, the high level of dependency on a facilitator requires further consideration in this respect. It is expected (and also suggested by the chairman of the purchasing committee who participated in the experiments) that this dependency will decrease substantially as purchasers learn how to use the models and acquire experience. Many of the decision models are very flexible and can thus be used frequently which enhances the learning effect. Longitudinal studies would however be helpful in further investigating this learning process.
Currently, the author of this paper is involved in three other projects in which the meta-model approach is used in practice to design supplier selection decision strategies. The projects concern different purchasing situations (in terms of complexity and importance) in different industries (process industry, high volume manufacturing industry and the healthcare sector). The results of these research projects will be discussed in detail in the author's forthcoming Ph.D. thesis on formal decision models for supplier selection.

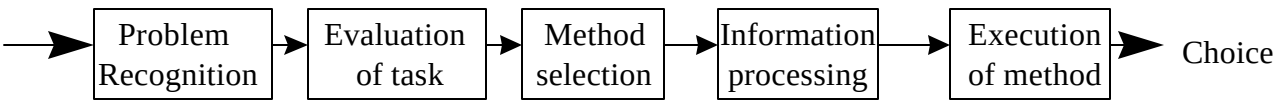

Figure 1: Model of individual decision making (Beach and Mitchell 1978)

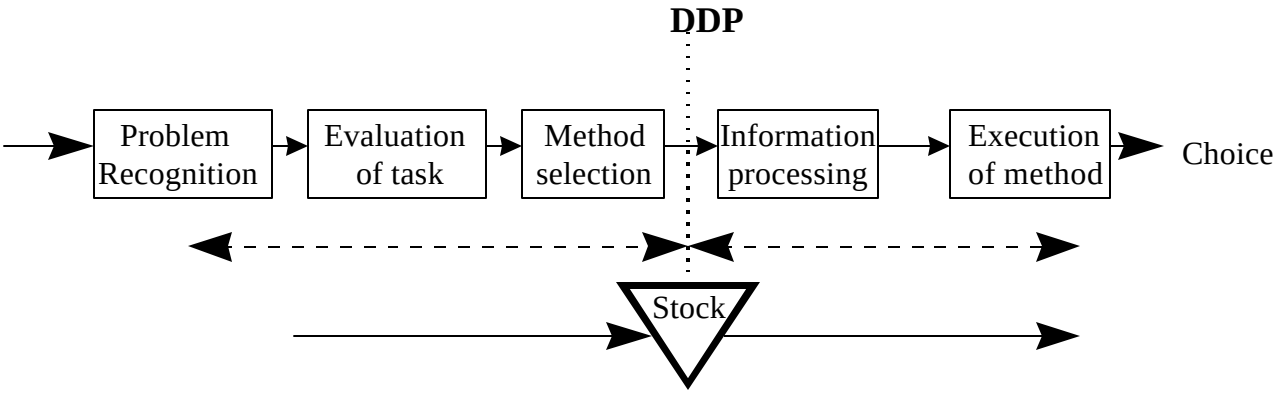

Figure 2: Example of positioning of Decision Decoupling Point

Purchasing situation:	Decision Decoupling Point:	Support?	Method?	Maintenance:
typical purchasing situation	Activities before and after the DDP	Whether or not to use supportive decision models in various stages	identification of possibly useful decision models for various stages	whether or not to review the strategy (and if so, when to do this)

Table 1: Generic format for supplier selection strategy

	Purchasing situation:	Before Decision Decoupling Point:		After Decision Decoupling Point:	
Strategy A	Standard product, established, easy to install, low investment, small order and impact on profitability	*Activities:* - problem identification -formulation of criteria (supplier as well as product)	*Support:*	*Activities:* - Simultaneous qualification of suppliers and evaluation of tenders	*Support:* - Costratio, AHP, Electre I
Strategy B	Differentiated product, technically complex, first purchase, new application, large investment and impact on profitability	*Activities:* - problem identification - formulation of categories of criteria for qualifying suppliers	*Support:* - Cognitive mapping, Value Focused Thinking, Brainstorming	*Activities:* - qualifying suppliers - formulation of criteria for tender evaluation - tender evaluation	*Support:* - Electre - Brainstorming - Electre, AHP, SMART
Strategy C	Standard product, purchased before, technically simple, large order, large impact on profitability - formulation of criteria (supplier as well as product)	*Activities:* - problem identification - formulation of criteria for supplier evaluation - qualifying suppliers - formulation of criteria for tender evaluation	*Support:* - WWS-analyse - Brainstorming - Electre - Brainstorming	*Activities:* - Evaluation of tenders	*Support:* - Electre

Table 2: Examples of supplier selection decision strategies

Steps in the decision process that are supported by decision models	Decision models applied	Brief description	Outcome

Problem definition	WWS-analysis (Basadur *et al*., 1994)	Structured interview technique	Hierarchy of broader as well as narrower problem statements (also graphically displayed) which can be used to identify solutions other than purchasing a new system. It facilitates a structure for a thorough justification of initiating or not initiating the purchase and/or creating future decision opportunities.
Formulation of criteria categories	Brainstorm-techniques based on Value Focused Thinking (Keeney; 1996) Interpretive structural modelling (Sage; 1977)	Structured interview technique Systematic analysis of relations and interdependencies between criteria	An extensive list with categories of criteria for the possible evaluation of suppliers and quotations. Final list with independent criteria for evaluation
Evaluation of suppliers and quotations	Conjunctive method (see Chen and Hwang; 1992) Analytical Hierarchy Process (Saaty; 1980)	Screening method to filter out unacceptable quotations A systematic method in which the purchaser is asked to evaluate all pairs of criteria and suppliers using a verbal scale. The consistency of the purchaser's assessments is checked and sensitivity analysis is carried out.	Set of quotations which are acceptable on all criteria A final (weighted) ranking of the suppliers and their quotations. The sensitivity analysis (which is strongly supported by graphical representations of the scores and weights) provides insight in the robustness of this ranking.

Table 3: Overview of decision models used

Evaluation criteria for WWS-analysis	**Comments from decision maker**
Is the outcome of the analysis useful?	Yes, it creates commitment to the starting points of the decision situation and stimulates thinking about the functional specification of the system
Is the outcome of the analysis acceptable?	Yes, the identified alternatives are not absurd
Is information aggregated or processed correctly?	Yes
Does the method sufficiently utilise available information?	Yes
Does the method sufficiently allow for expression of opinions?	Yes
Does the method sufficiently allow for equitable participation of purchasers?	Yes, the external advisor could have acted as facilitator in the analysis
Is the method sufficiently flexible?	Yes, in other cases the analysis does not have to be carried out so extensively
Are the efforts/investments justifiable?	Yes, the purchase means a huge investment for more than ten years. (The WWS-analysis took around one and a half-hour.)
Is the method sufficiently user-friendly?	Yes
Is the method's technology or working-principle sufficiently clear?	Yes
Does the method increase the purchaser's insight in the situation?	Not really, but the existing (intuitive) ideas are systematically linked together
Does the method contribute to improved communication about and justification of the decision?	Absolutely, it would strengthen the presentation of the decision for the University Board
Does the method contribute to the purchaser's decision-making skills?	Yes, it increases systematic thinking.

Table 4: evaluation of the decision models by the chairman of the purchasing committee

Evaluation criteria for Brainstorming	**Comments from decision maker**
Is the outcome of the analysis useful?	Yes
Is the outcome of the analysis acceptable?	Yes, the identified criteria are acceptable although some criteria are missing that should be used in the decision
Is information aggregated or processed correctly?	Yes, however, it remains to be seen whether comparisons between hypothetical

	suppliers are made objectively
Does the method sufficiently utilise available information?	Yes
Does the method sufficiently allow for expression of opinions?	Yes, absolutely
Does the method sufficiently allow for equitable participation of purchasers?	Yes
Is the method sufficiently flexible?	Yes
Are the efforts/investments justifiable?	Yes, especially because it will save time further on in the process
Is the method sufficiently user-friendly?	Yes, however, some of the techniques required some instruction from a facilitator
Is the method's technology or working-principle sufficiently clear?	Yes
Does the method increase the purchaser's insight in the situation?	Not really, but it will make discussions more transparent.
Does the method contribute to improved communication about and justification of the decision?	Yes, it will facilitate communication within the purchasing committee as well as towards other parties involved
Does the method contribute to the purchaser's decision-making skills?	Yes, especially with regard to planning and managing the discussions.
Evaluation criteria for Conjunctive method	**Comments from decision maker**
Is the outcome of the analysis useful?	Yes, although this method is already applied implicitly, making the analysis explicit is good
Is the outcome of the analysis acceptable?	Yes
Is information aggregated or processed correctly?	Yes
Does the method sufficiently utilise available information?	Yes
Does the method sufficiently allow for expression of opinions?	Yes. However, when using the method there should be no more discussion about suppliers not meeting a knock-out criterion
Does the method sufficiently allow for equitable participation of purchasers?	Yes
Is the method sufficiently flexible?	Yes
Are the efforts/investments justifiable?	Yes, the method helps avoiding endless discussions
Is the method sufficiently user-friendly?	Yes
Is the method's technology or working-principle sufficiently clear?	Yes
Does the method increase the purchaser's insight in the situation?	?
Does the method contribute to improved communication about and justification of the decision?	Absolutely, it would strengthen the presentation of the decision for the University Board and facilitate communication within the committee
Does the method contribute to the purchaser's decision making skills?	It is too difficult to answer this question
Evaluation criteria for AHP-method	**Comments from decision maker**
Is the outcome of the analysis useful?	Yes, this is a very good method. It objectifies the purchaser's assessments.
Is the outcome of the analysis acceptable?	Yes
Is information aggregated or processed correctly?	Yes
Does the method sufficiently utilise available information?	Yes
Does the method sufficiently allow for expression of opinions?	Yes
Does the method sufficiently allow for equitable participation of purchasers?	Yes
Is the method sufficiently flexible?	Yes
Are the efforts/investments justifiable?	Yes
Is the method sufficiently user-friendly?	Yes, as far as this is assessable right now
Is the method's technology or working-principle sufficiently clear?	It is not completely clear how the method works
Does the method increase the purchaser's insight in the situation?	Yes, it prevents the purchaser from making inconsistent judgements
Does the method contribute to improved communication about and justification of the decision?	Yes, especially the graphical representations of the assessments would have been used in presentations
Does the method contribute to the purchaser's decision-making skills?	Yes

Table 4 (continued): evaluation of the decision models by the chairman of the purchasing committee

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