Minimally Restrictive Decision Support Systems

Completed Research Paper

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Abstract

Decision-making behavior is heterogeneous. We therefore suggest building a decision support system for online purchase decisions that can support various different decision strategies and also allows users to mix them. We design this minimally restrictive system by decomposing different strategies into their component steps and implementing aids for supporting these steps. We empirically compare this system to a typical one, which restricts the users by supporting only one normative, utility-maximizing strategy. Users perceive the minimally restrictive system as requiring lesser effort and being more enjoyable to use than the typical decision support system. Furthermore, they exhibit a higher intention to re-use the minimally restrictive system. However, there is no difference with respect to the perceived usefulness. Our results imply that webstores should implement minimally restrictive systems not only because of high user satisfaction, but also because analyzing clicks on the aids provides information as to which strategies are being used.

Keywords: Decision aids, Consumer decision making, Usability/usability evaluation

Introduction

Many studies in the field of human decision behavior have shown that people apply a decision strategy from among a set of available strategies which they have in mind (e.g., Gigerenzer and Selten 2001). The decision maker’s choice of the appropriate strategy is influenced by the decision environment, for example the complexity of the choice task, the decision maker’s mental capabilities and/or the decision maker’s involvement in the decision (e.g., Payne et al. 1993). In addition to the fact that decision makers adapt their decision-making behavior to the environment, people oftentimes do not follow one pure strategy
when making a decision, but they mix up different strategies (Bettman and Park 1980; Gilbride and Allenby 2004; Pfeiffer et al. 2014; Russo and Leclerc 1994).

When decision maker rely on a decision support system, their decision-making process is restricted to those processes supported by the system’s functional capabilities (Silver 1988). Restricting users to a decision strategy that does not present the user’s preferred decision process, can increase the user’s reluctance to use the system and decrease the user’s satisfaction (Wang and Benbasat 2009). Hence, designers of decision support systems (DSSs) should deliberately choose the ways in which a DSS restricts its users. On the one extreme, there are DSSs which are very restrictive: they support only one decision strategy and enforce the decision maker to apply this strategy. We call these DSSs maximally restrictive DSSs. Major reasons for maximally restrictive DSSs are to improve the quality of the decisions made by prescribing a normative decision strategy, to decrease decision-making effort by structuring the decision process according to the process of the prescribed decision strategy or to foster structured learning (Alter 1980; Silver 1988).

While a lot of research, for instance in the field of decision analysis, has designed and analyzed systems that are maximally restrictive, for example when they like to make users apply a utility-maximizing rule, there is little work on minimally restrictive DSSs. A minimally restrictive DSS does not restrict the user to apply a prescribed behavior, rather it supports the variety that we find in human decision behavior. In line with the above described nature of human decision making behavior, we therefore see two requirements that minimally restrictive DSSs should fulfill: (i) they should support all possible decision strategies that users might intend to apply in the given environment, and (ii) they should allow for the mixture of different decision strategies.

Building a minimally restrictive system is a challenge for designers of DSSs, because, first, it is hard to build a system that supports a large variety of decision strategies and allows mixing. For building such a DSS, a profound knowledge about different kinds of possible decision strategies is needed and most probably, a variety of decision aids needs to be offered to support the large variety of decision behaviors that users might follow. Second, with offering a large amount of different decision aids, users might feel overwhelmed by the choice of too many aids and perceive the effort for using the system to be high (Alter 1981; Spiekermann and Paraschiv 2002; Reisen and Hoffrage 2010).

Against this background, we present an approach for designing a system with minimal restrictiveness. We show that the system is evaluated favorably compared to a system which only supports a utility-maximizing strategy.

Minimally restrictive DSSs might be of particular use when designers of the DSS have no knowledge about the decision makers themselves and their environment. One field where – because of the anonymity of the decision makers - very little is known about the preferred decision processes are online DSSs, for example DSSs that support consumers finding their preferred product, i.e., so-called interactive decision aids (IDAs) (Häubl and Trifts 2000; Wang and Benbasat 2009).

We will follow an approach of building IDAs that was suggested by Pfeiffer et al. (2009b) and Pfeiffer et al. (2010). We present a prototype that keeps the number of decision aids low while, at the same time, supports as many as possible strategies with the aim of solving the above mentioned problem of overwhelming the user with too many aids. The design of the system’s decision aids is derived directly from various kinds of decision strategies that were observed in a plethora of decision-making studies. Our results show that users evaluate such a minimally restrictive DSS more positively in terms of perceived effort, enjoyment and intention to re-use than a system that is restrictive and supports only a normative strategy. However, the two systems do not differ with respect to the perceived usefulness.

In the following section, we will provide a literature review on decision strategies and interactive decision aids. The section presents main parts of the knowledge base that we use for the design of the system (Hevner et al. 2004). In section three, we present the prototype that supports the different decision strategies. Then, we will investigate in an empirical study how the minimally restrictive system is evaluated by users. We end the paper with conclusions and ideas for future research.
Literature Review

Decision Strategies

In the context of consumer decision behavior, a decision strategy describes the process which consumers follow when choosing a product, and thus describes the way the decision maker acquires, evaluates and compares product information (Payne et al. 1992). Formally, the choice of the preferred product is a multi-alternative multi-attribute problem, which consists of \( n \) alternatives (products) \( \text{alt}_1, j = 1, \ldots, n \) which are described by \( a_{ij} \) attribute levels, one for each of the \( m \) attributes, \( \text{attr}_i, i = 1, \ldots, m \) (Harte and Koele 2001; Keeney and Raiffa 1993). Attribute levels are concrete occurrences of the attributes. As an example, imagine a set of different cell phones which are described across different attributes, such as price, brand, and battery runtime. Each cell phone is specified by the attribute levels it takes for each of the attributes, such as 250 €, Samsung, and 25h battery runtime. Some strategies further assume that decision makers assign so-called attribute values to attribute levels. These attribute values reflect the degree of attractiveness the decision maker assigns to the attribute level. Each decision maker hence has \( m \) value functions, \( v_i \), that assign attribute values to all available attribute levels, \( v_i(a_{ij}), \forall i, j \).

In a literature review, we identified fifteen decision strategies (Payne et al. 1993; Pfeiffer et al. 2009b; Riedl et al. 2008). One well-known example is the weighted-additive utility function (WADD); the user computes a utility for each alternative in form of a weighted linear additive utility-function and chooses the product that maximizes this utility function, \( \max_{j=1,\ldots,n} \sum_{i=1}^{m} w_i v_i(a_{ij}) \), where \( w_i \) is supposed to reflect the attribute weight (importance) of attribute \( i \) (Anderson 1974). WADD is often used as normative decision strategy. Other simpler strategies, like the lexicographic rule (LEX) assumes the decision maker chooses the alternative with the best attribute value on the most important attribute, e.g., the product with the lowest price (Fishburn 1974). If there is a tie on the most important attribute, the decision maker compares the alternatives that performed best on the second most important attribute. Thus, LEX eliminates inferior alternatives step-by-step until only one alternative is left. Another common strategy that eliminates alternatives is elimination-by-aspect (EBA). Decision makers consider attributes probabilistically according to attribute weights (Tversky 1972). They iteratively remove alternatives if they do not meet the aspiration level of the considered attribute which can be interpreted as an acceptable level such as a maximum price the decision maker is at most willing to pay for a product. EBA stops the elimination-process if there is only one alternative left or all attributes are considered. Table 1 in the appendix provides a short description of the fifteen decision strategies. A more detailed description can be found in Pfeiffer et al. (2009b).

DSSs for online-consumers: Interactive Decision Aids

IDAs “help consumers in making informed purchase decisions amidst the vast availability of online product offerings” (Wang and Benbasat 2009, p. 3). Typical examples of IDAs are tools for sorting the products and filters. Filters allow users to eliminate products that do not have certain attribute levels, such as an undesired color, and can be found on almost all web stores.

Oftentimes, the products are displayed in a product-comparison matrix which helps comparing them. In product-comparison matrices alternatives (products) are organized in columns and attributes in rows (Häubl and Trifts 2000). Thus, the product-comparison matrix usually includes alternatives that the consumers want to evaluate in more detail (the so-called consideration set) in the in-depth comparison phase. An example of a product-comparison matrix is shown in Figure 1.

IDAs that help users to make their decision by using a product-comparison matrix are the main interest of this study, because also in the in-depth comparison phase users might apply different kinds of decision strategies (Pfeiffer et al. 2009a; Pfeiffer et al. 2014). Thus, in this phase, a minimally restrictive DSS must support a variety of decision strategies.
The strategies that are supported by the IDAs for product-comparison matrices which are proposed in literature are mainly LEX, EBA and WADD. Häubl and Trifts (2000), for example, studied product-comparison matrices with only one decision aid: alternatives could be sorted by any attribute. The ability to sort attributes supports LEX at least partially, assuming that there is no tie among alternatives on the most important attribute. Gupta et al. (2009) focused their study on perceived trust for the seller and showed that a system offering two IDAs increased trust compared to not offering IDAs at all. IDAs afforded some basic operations for manipulation of product-comparison matrices, namely sorting alternatives according to more than one attribute and removing attributes and alternatives. Sorting supports LEX while removing alternatives supports the step of eliminating alternatives that some strategies rely on. However, most strategies that eliminate alternatives are more sophisticated and involve other steps which is why allowing to remove alternatives does not completely support any strategy. Todd and Benbasat (2000) studied IDAs in form of commands prompted to a command window for manipulating a product-comparison matrix. Entering the commands CREATE, GLOBAL, ROW TOTAL, for instance, assisted the respondents in using a WADD strategy. With the command CREATE one could assign attribute weights which were multiplied with attribute values by the command GLOBAL. Finally, the command ROW TOTAL summed up the weighted scores for each alternative. Furthermore, they offered support for an EBA strategy by allowing commands that eliminated alternatives that did not meet aspiration levels. Kamis and Davern (2005) also analyzed the effect of offering multiple IDAs. They considered one aid for supporting a conjunctive strategy (CONJ, see Table 1 in the appendix), one for supporting EBA, and one simple product-comparison matrix with no additional aids. Their results show that the sequence and the amount (2 vs. 3) of IDAs offered to the respondent had no effects on the three dependent variables: perceived ease of use, perceived usefulness and decision quality. Reisen and Hoffrage (2010) suggested a system that combines EBA with WADD. In a first step, the user can indicate unacceptable levels to narrow down the set of products. In the second step, a product-comparison matrix shows the remaining products. The matrix allows user to specify the importance of attributes which helps to implement a simplified version of a WADD strategy. They compared their system with a product-comparison matrix without any IDA. Their system did improve the ease of comparison but not the overall perceived ease of use, understandability and confidence with the decision when compared to the control group without any IDA. Indeed, they even found a negative effect on perceived ease of use. Zhang and Pu (2006) proposed a hybrid IDA which supports five strategies but did not evaluate their system with users.

1 Strategies that stepwise remove alternatives are ADD, COM, CONJ, DIS, MCD, LED, LEX, SAT, SAT+ (EBA is better supported by a FILTER than by removing alternatives step by step, see Table 1 in the appendix for a description of strategies). There is no strategy where removing of attributes is necessary.

2 The system assumes a linear utility function with slope 1.
In simulations, they focused on the effort and accuracy of their IDAs and concluded that hybrid decision aids have the potential to increase the quality of a decision and decrease effort.

The above mentioned studies argued that offering some IDAs is better than none, because decision accuracy can be increased and decision effort decreased. The rationale behind this finding is the effort-accuracy framework that postulates that decision makers trade off benefits gained from an accurate decision (i.e., one with high decision quality) with the effort (cost) of deciding for or against the application of a decision strategy (Johnson and Payne 1985). As consequence, decision aids do not only reduce the effort of using a strategy but can also improve accuracy when a decision aid makes a more accurate strategy “at least as easy to employ as any simpler but less accurate heuristic [strategy]” (Todd and Benbasat 2000, p.92).

Another argument can be made in favor of offering more IDAs. Supporting several decision aids can increase user’s satisfaction because they feel less restricted to use only particular strategies. Wang and Benbasat (2009) studied the strategy restrictiveness when supporting WADD, EBA and a hybrid aid that supported both strategies, and found that users have a higher intention to use a system when they feel less restricted. However, while users found the WADD-aid to be less restrictive than the EBA-aid, they did not find the hybrid aid to be less restrictive than the WADD or the EBA-aid, nor did they perceive a lower effort or higher decision accuracy. Thus, showing aids for two instead of only one decision strategy had no effect on the users.

In sum, the literature does not provide coherent empirical findings on the effects of IDAs with low restrictiveness. Kamis and Davern (2005) do not find any positive influence and Reisen and Hoffrage (2010) find a decreased perceived ease of use. Wang and Benbasat (2009) find a positive influence of less restrictive systems (WADD-aid vs. EBA-aid) but their hybrid system that supports both strategies is not perceived to be less restrictive. We argue that the limited positive findings are caused by the limited number of strategies that are supported because the difference of perceived restrictiveness for systems supporting one versus two strategies might be negligible. Indeed, following Silver’s definition of system restrictiveness as “the degree to which, and the manner in which, a DSS limits its users’ decision-making processes to a subset of all possible processes” (Silver 1991, p. 115), it becomes clear that the degree of restrictiveness of the discussed works is rather high because they mostly support only two strategies out the fifteen available.

A first suggestion for designing IDAs that support a variety of different decision strategies was suggested by Pfeiffer et al. (2009b) and Pfeiffer et al. (2010) and will be explained in further detail in the next section. Their approach, however, was only presented in a first version which still included several pitfalls and missing functionalities as the usability test in their paper revealed. Thus, the next section will present an improved version of the system and show the advantages of this system over a maximally restricted one.

**A Modular Design of Interactive Decision Aids**

If all people were using the same decision strategy or if web designers knew which decision strategy a user likes to apply, the interface could easily be designed in a non-restrictive way, showing users exactly the aid that they want. For example, a user that likes to apply an EBA strategy could be supported by a range of filters where users can define the aspirational levels starting with the filter of the most important attribute, continuing with the second most important attribute, etc. Unfortunately, the decision for or against a strategy is highly contingent on the decision environment and the context which is unknown to the web designers. Furthermore, people might not exactly follow one particular strategy (Bettman and Park 1980; Gilbride and Allenby 2004; Pfeiffer et al. 2009a; Pfeiffer et al. 2014; Russo and Leclerc 1994). Therefore, online shop designers should assume that customers use different strategies during one particular shopping transaction and switch between them to screen out alternatives until the final choice is made.

As a result, one could argue that users should see one decision aid for each of the fifteen strategies such that users have highest flexibility. However, we think that this would lead to an information overload because of the high amount of provided decision aids. Our approach therefore is to design a modular
system where the same aids can be used for different decision strategies by combining them in different ways. The result is a minimally restrictive system that allows users to apply any strategy they want and to switch between different decision strategies whenever they want by reusing the same aids for different strategies.

In our approach we decompose different decision strategies into their component steps. First, we need an aid that allows to compare two alternatives next to each other, as some strategies assume that alternatives are compared in pairs (ADD, MCD). Other strategies assume an attribute-wise process, hence highlighting differences and similarities of products along one attribute should be provided (ADD, DOM, EBA, MAJ, MCD, LED, LEX). FRQ counts the number of good and bad attribute levels; other strategies, such as SAT, CONJ, and DIS, check whether attribute levels are above the aspiration level, so marking of attribute levels as either positive or negative should be provided. Another characteristic is the stepwise elimination of alternatives (ADD, COM, CONJ, DIS, MCD, LED, LEX, SAT, SAT+). Thus, users should be able to remove alternatives. As two strategies (SAT, CON) remove alternatives which do not meet the aspiration level of at least one attribute, a removal of alternatives with at least one negatively marked attribute level should be possible. Moreover, EBA eliminates alternatives which do not meet the aspiration level on an attribute. This can be supported by filters which remove all alternatives not fulfilling the filter criterion. Other, so-called compensatory strategies would not remove alternatives based on one filter criteria, but they allow alternatives to compensate a low attribute value with a high one. For these strategies, calculations of assigned attribute values (EQW, WADD) or of the number of positively marked attribute levels (FRQ, MAJ) are necessary. In addition to that, some strategies take the importance of attributes into account. WADD, for instance, multiplies attribute values with weights and LEX chooses the alternative with the highest attribute values on the most important attribute. Consequently, users must be able to assign attribute weights or sort attributes/alternatives.

As a result, we have decomposed the decision strategies into the following steps that need to be supported by IDAs: comparison of pairs (PAIRWISE COMPARISON), highlighting differences and similarities (HIGHLIGHT), marking attribute levels as either positive or negative (MARK), removal of alternatives (REMOVE ALTERNATIVE), automatic removal of alternatives with at least one negatively marked attribute level (REMOVE MARKED), filtering (FILTER), scoring attribute levels with attribute values (SCORE ATTRIBUTE LEVEL) and calculations with these assigned values (CALCULATE – SUM OF WEIGHTED STARS), summing up positively marked attribute levels (CALCULATE – SUM OF MARKS), assigning attribute weights (SCORE WEIGHT) and sorting (SORT). Figures 2, 3 and 4 show the design of the different IDAs in the prototype.

**Evaluation of the Decision Aids**

**Hypotheses**

Users might feel overwhelmed by being offered too many decision aids. This might increase the perceived effort for using the system because decision makers need additional effort for deciding on which decision aids to use (Reisen and Hoffrage 2010; Spiekermann and Paraschiv 2002). Simultaneously, IDAs should decrease the perceived effort, because they are able to reduce the decision maker’s cognitive effort by replacing cognitive steps with computer aided steps (Todd and Benbasat 1991, 1994a; Todd and Benbasat 1994b; Todd and Benbasat 2000). The maximally restrictive system supports a normative strategy that enforces the user to apply a more effortful strategy while the minimally restrictive system supports the usage of also simpler strategies with low effort. We argue that the increased effort of choosing which aid to use will be compensated by the latter two arguments and therefore suggest the following hypothesis.

**Hypothesis 1**: Compared to the maximally restrictive system supporting a normative decision strategy, the minimally restrictive system decreases perceived effort.
Figure 2. Interactive Decision Aids (1)

Figure 3. Interactive Decision Aids (2)
On the one hand, Nakatsu and Benbasat (2006) found that for structured tasks a system with high restrictiveness is more beneficial in terms of improved performance than a system with low restrictiveness. Assuming that choosing a product in a product-comparison matrix is a well-structured task, one might expect a more restricted system to also be more useful. Furthermore, when a normative strategy such as utility-maximizing is supported by the system, the normative strategy should improve the user’s performance in solving the task since the strategy has high decision accuracy (Johnson and Payne 1985; Bettman et al. 1990). However, decision makers might feel that the DSS is not useful if they are confronted with a maximally restricted system that supports a strategy they do not intend to use. Indeed, the fit between task and technology (Goodhue 1995) positively influences the perceived usefulness, also in the context of consumer e-commerce (Klopping and McKinney 2004). The task-technology fit is defined as the “degree to which a technology assists an individual in performing his or her portfolio of tasks” (Goodhue 1995, p. 218) and consists of the fit between the task, the technology and the individual. Thus, the functionality offered by IDAs should fit the individual’s ability to use a strategy and should fit the decision (task) environment. The highest task-technology fit is not necessarily synonymous with offering support for a normative, utility-maximizing strategy. Indeed, support of strategy that is easy to use might be necessary when, for example, the decision environment is complex (such as a tied decision between very similar products) and the individual is not willing or capable to use a more complicated utility-maximizing strategy. In sum, there are both arguments for and against a higher perceived usefulness of a minimally restrictive system as compared to a maximally restrictive system. We suggest that the positive effects of the minimally restrictive system far outweigh the positive effects of the maximally restrictive system and therefore suggest the following hypothesis:

Hypothesis 2: Compared to the maximally restrictive system supporting a normative decision strategy, the minimally restrictive system increases perceived usefulness.

West et al. (1999) compare the customers’ interaction with IDAs with the interaction with traditional retailers and conclude that – like traditional retailers influence consumer’s satisfaction in brick and mortar business – IDAs influence satisfaction. In case of online shopping, possibilities of personalizing the web interface as well as controlling the interaction with the web interface should have a positive effect on users’ satisfaction. Bechwati and Xia (2003) find that users’ satisfaction is the higher, the more they perceive the effort-reduction provided by IDA. Thus, we suggest that the lower perceived effort achieved by our prototype also increases satisfaction. Murray and Häubl (2008) argue that limiting the monotonous or menial tasks associated with making a purchase decision online can increase both satisfaction and enjoyment. Several studies have shown that IDAs are capable of automating parts of the
decision-making process that consumers prefer to avoid, because they are tedious or unpleasant (Häubl and Trifts 2000; Maes et al. 1999; West et al. 1999). This should also hold for minimally restrictive systems, which support effortful, tiring and error-prone tasks, such as calculating scores or filtering. Urban and Hauser (2004) provided further empirical evidence that consumers enjoy the interaction with IDAs. Based on their literature research, Murray and Häubl (2008) conclude that, “a well designed interactive consumer decision aid […] makes the process of deciding a more pleasurable one” (p. 14).

Perceived Usefulness, effort, enjoyment and satisfaction are main drivers of the intention to re-use a system. Indeed, it was shown by Wang and Benbasat (2009) that strategy restrictiveness decreases the intention to re-use a system. Consequently, we argue that the minimally restrictive decision aids should increase the intention to re-use the system.

Hypothesis 3: Compared to the maximally restrictive system supporting a normative decision strategy, the minimally restrictive system increases the user's shopping enjoyment.

Hypothesis 4: Compared to the maximally restrictive system supporting a normative decision strategy, the minimally restrictive system increases the user’s intention to re-use the system.

**Design**

We conducted a laboratory experiment with 73 students from a German university which were randomly assigned to one of the two groups: maximally restrictive decision aids (see Figure 5) and minimally restrictive decision aids (see Figure 6). The experiment consisted of three parts. In the first part the participants had to indicate their interest and their product knowledge about cell phones on a scale from 1 to 5, (mean for interest was 3.18 and for knowledge 3.00). In order to ensure that participants were familiar with the decision aids, in the first part, we also showed them an introductory video that explained the differences decision aids that they would see in their group. In the second part, they had to make three decisions with the same interface because we wanted to ensure that that would have enough opportunity to familiarize with the interface. Furthermore, all IDAs were explained by tooltips as shown in Figure 6 for the decision aid CALCULATE. All tooltips could be assessed any time by the user. For each of the three choices they had to select one out of six cell phones. In each screen, they saw a new set of cell phones. In the third and final part, they answered a questionnaire.

For measuring the four constructs concerning respondents’ evaluation (perceived ease of use, perceived usefulness, enjoyment and intention to re-use), we developed a questionnaire based on well-validated items from the literature (Kamis and Davern 2005; Pereira 2001). These are found in the appendix in Table 2. All questions had to be answered on a 5-point Likert scale (1: I strongly disagree to 5: I strongly agree). Cronbach’s alpha showed adequate reliability of the items with levels above 0.7 for all constructs as recommended by Nunnally (1967) and Kline (2000).

![Figure 5: Interface for the maximally restrictive decision aids group.](image)
Results

As manipulation check we asked all respondents to indicate on a 5-point likert-scale whether they found the interface to be restrictive (“There was only a restricted number of possibilities to compare cell phones with one another.”, “I find the possibilities to compare products with another limited.”, ”The webstore enables me to be flexible in my cell phone choice.”, Cronbach’s α=0.78). The manipulation check indicated that the participants in the maximally restrictive group perceived higher restrictiveness (Mdn=3.95) than the participants in the minimally restrictive group (Mdn=3.24, U=365, z=2.321, p<0.01).

For testing the hypotheses, we use Mann-Whitney-U tests because the data was non-normally distributed. The results are shown in Table 3. Hypotheses 1, 3 and 4 are supported while for usefulness there is no significant difference between minimally restrictive and maximally restrictive systems. Yet, the trend for the influence on perceived usefulness follows the predicted direction.

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Median of maximally restrictive system (N=34)</th>
<th>Median of minimally restrictive system (our prototype) (N=39)</th>
<th>Z</th>
<th>effect size</th>
<th>p (one-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1: Perceived effort</td>
<td>3.60</td>
<td>3.20</td>
<td>-2.077</td>
<td>-0.24</td>
<td>.019*</td>
</tr>
<tr>
<td>H2: Perceived usefulness</td>
<td>3.67</td>
<td>4.00</td>
<td>-0.685</td>
<td>-</td>
<td>.25</td>
</tr>
<tr>
<td>H3: Perceived enjoyment</td>
<td>3.50</td>
<td>4.00</td>
<td>-1.826</td>
<td>-0.21</td>
<td>.034*</td>
</tr>
<tr>
<td>H4: Intention to re-use the system</td>
<td>3.00</td>
<td>4.00</td>
<td>-2.132</td>
<td>-0.25</td>
<td>.017*</td>
</tr>
</tbody>
</table>
Conclusions

We have observed that maximally restrictive DSSs that support a normative strategy have been the focus of research, while there is little known about (1) how to design a minimally restrictive and (2) how users react to such a minimally restrictive system. We have argued that minimally restrictive systems are important because they support the adaptive way of decision-making behavior: users prefer using different strategies in different environments and they prefer to mix several strategies when making a decision. This adaptive way of decision-making behavior calls for a highly flexible system of IDAs that does not restrict the user to apply exactly one strategy but rather allow the user to (1) choose one out of many strategies and (2) to mix several strategies with another.

In our prototype, we have exemplified how IDAs can be designed that fulfill these two requirements. The key idea is to modularize the system such that the same IDAs can be combined in different ways in order to support different decision strategies. When designing such a more complex interface, the question arises whether the advantage of a more flexible system is counterbalanced by a low usability and a high user effort because user have to choose which decision aids to apply. Therefore, in an empirical study with 73 respondents, we have analyzed how users evaluate a minimally restrictive DSS. We have compared our prototype with a maximally restrictive system that supports the use of a normative, utility maximizing strategy.

Our prototype of minimally restrictive system is evaluated very positively. Users perceive lower effort, more enjoyment and have a higher intention to re-use the minimally restrictive system compared to a maximally restrictive system that supports only a normative utility-maximizing strategy. To conclude, web designers should consider implementing minimally restrictive systems because the results suggest that it improves several dimensions of the user’s evaluation of the system.

Interestingly, the perceived usefulness of the two systems did not differ. This indifference could be caused by both positive and negative effects of the maximally restrictive system cancelling each other out. On the one hand, the maximally restrictive system might have encouraged decision makers to apply a strategy that leads to decisions of higher accuracy and, in turn, a higher performance than the strategy they would have applied. An interesting avenue of future research would be to analyze whether decision accuracy actually increases with the maximally restrictive system, and if this, in turn, could lead to a higher perceived usefulness. This is particularly interesting because recent research has shown that users “of technology fitted to them as an individual can perceive it as more useful than it actually is, in terms of improving task performance” (Parkes 2013, p. 997). Hence, the usefulness of the minimally restricted system might be overestimated by the users. On the other hand, the maximally restrictive system might have a steeper learning curve than the minimally restrictive system because of the smaller number of different decision aids. This might influence how useful the system is perceived and would support an increased perceived usefulness of the minimally restrictive system once the user is used to applying the aids. Further experiments with users applying the system over a longer period of time are needed to verify this conjecture. In sum, we think that the usefulness of the minimally restrictive system will further increase over time and outweigh the arguments for a higher usefulness of the maximally restrictive system. This result would further speak in favor of offering minimally restrictive systems to users.

Our proposed minimally restrictive system might be used as a process-tracing approach by inferring the applied decision strategies from clickstreams on decision aids. The applied decision strategies can be inferred, for example, by using state-machines (Pfeiffer et al. 2012). Consequently, the here proposed system could be used for studying decision-making behavior both in industry as well as in research.

References


Appendix

<table>
<thead>
<tr>
<th>Table 1. Decision Strategies</th>
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<tbody>
<tr>
<td><strong>EQW:</strong> Equal Weight Heuristic (Einhorn and Hogarth 1975)</td>
</tr>
<tr>
<td><strong>WADD:</strong> Weighted Additive Rule (Tversky 1969)</td>
</tr>
<tr>
<td><strong>ADD:</strong> Additive Difference Model (Payne 1976)</td>
</tr>
<tr>
<td><strong>MCD:</strong> Majority of Confirming Dimensions Heuristic (Wright and Barbour 1977),</td>
</tr>
<tr>
<td><strong>FRQ:</strong> Frequency of Good and/or Bad Features Heuristic (Alba and Marmorstein 1987)</td>
</tr>
<tr>
<td><strong>COM:</strong> Compatibility Test (Beach 1990)</td>
</tr>
<tr>
<td><strong>CONJ:</strong> Conjunctive Strategy (Coombs and Kao 1955)</td>
</tr>
<tr>
<td><strong>SAT:</strong> Satisficing Heuristic (Simon 1955)</td>
</tr>
<tr>
<td><strong>SAT+:</strong> Satisficing-Plus Strategy (Park 1978)</td>
</tr>
<tr>
<td><strong>DIS:</strong> Disjunctive Strategy (Coombs and Kao 1955)</td>
</tr>
<tr>
<td><strong>DOM:</strong> Dominance Strategy (Lee 1971)</td>
</tr>
<tr>
<td><strong>MAJ:</strong> Simple Majority Decision Rule (Arrow 1951)</td>
</tr>
<tr>
<td><strong>EBA:</strong> Elimination-by-Aspects Strategy (Tversky 1972, Payne et al. 1988)</td>
</tr>
<tr>
<td><strong>LEX:</strong> Lexicographic Heuristic (Tversky 1969)</td>
</tr>
</tbody>
</table>
**LED: Minimum Difference**  
**Lexicographic Strategy**  
(Montgomery and Svenson 1976)  
Similar to LEX but with a relaxed condition of what a “tie” is. Alternatives can differ slightly on the considered attribute and still be considered to be tied.

### Table 2. Measurements

<table>
<thead>
<tr>
<th>Construct</th>
<th>Items</th>
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</table>
| Perceived Effort (Pereira 2001), α=0.73 | The task of selecting a cell phone using this webstore took too much time.  
Selecting my preferred cell phone was too complex.  
I easily found the information that was important for my choice of the cell phone. (recoded)  
The task of finding the preferred cell phone took too much effort.  
The task of selecting a cell phone using this system was too complex. |
| Perceived Usefulness (Kamis and Davern 2005), α=0.77 | Using the webstore improved my decision making.  
The webstore is useful.  
After using the webstore, I had the feeling to efficiently have made my decision. |
| Perceived Enjoyment (Kamis and Davern 2005), α=0.86 | I found my visit of the webstore interesting.  
I found my visit of the webstore exciting.  
I found my visit of the webstore fun. |
| Intention to Re-Use                | If I had to select a cell phone again, I would use the webstore again. |