

Evaluating Design Alternatives for Feature Recommendations in Configuration Systems

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Abstract—Product configuration systems are an important instrument to implement mass customization, which is a production paradigm that supports the manufacturing of highly-variant products under pricing conditions similar to mass production. Previous research indicates that supporting users of product configuration systems with personalized feature recommendations (defaults) can lead to a higher satisfaction with the configuration process. Based on these findings, we investigate the influence of different representation styles of such defaults on users’ perception of the configuration system. Additionally, we explore if different representation styles of defaults have an influence on users’ selection behavior. For our user study we used RecoMobile, an environment which supports the configuration of mobile phones and corresponding subscription features. We found a strong relationship between the number of accepted default proposals and the perceived user interface quality. Our results further reveal that the different representation styles have a strong impact on users’ perceived overall quality of the system.

Keywords—Configuration Systems; Interactive Selling; Consumer Buying Behavior; Intelligent User Interfaces;

I. INTRODUCTION

Configuration systems, which have a long tradition as a successful application area of Artificial Intelligence [1], [2], [3], [4], [5], have been recognized as ideal tools to assist customers in configuring complex products according to their requirements. Example domains where product configurators are applied are computers, cars, financial services, and telecommunication switches.

Although configuration systems have many advantages such as a significantly lower amount of incorrect quotations and orders, shorter product delivery cycles, and higher productivity of sales representatives [1], customers (users) are often overwhelmed by the complexity of offered alternatives. This phenomenon is well known as mass confusion [6]. Another problem is that users typically do not know exactly which products or components they would like to have. As a consequence, users construct and adapt their preferences within the scope of a configuration process [7].

A possibility to help the user identifying meaningful alter-

natives is to provide defaults that are compatible with the user’s current preferences. Defaults in the context of interactive configuration dialogs are preselected answers to posed questions, for example, feature pre-selections. Defaults can be used to express personalized feature recommendations. For example, if the user is interested in reading/writing mails with the mobile phone, the recommended phone should support web access.

Felfernig et al. [9] conducted a study to investigate the impact of personalized feature recommendations on user satisfaction in a knowledge-based recommendation process. Nearest neighbors and Naive Bayes voter algorithms were applied for the calculation of default values. The results of their study suggest that supporting users with personalized defaults can lead to a higher satisfaction with the configuration process.

To increase the user satisfaction with the configuration process, it is not only important to implement algorithms that provide good recommendations, but also to establish an adequate format for presenting the recommendations. Research on consumer decision making has shown that consumers are influenced by the format of the information presented and as a consequence use different decision-making strategies in different contexts (see e.g. [8], [10], [11], [12]).

In this paper we discuss the impact of different styles to present default values in product configurators. We present results of a case study that investigated whether different ways to represent defaults have an influence on the users’ acceptance of proposed defaults as well as on evaluations of the product configurator. The evaluation criteria include one objective measure (number of accepted defaults) and subjective measures related to satisfaction, trust, confidence and intentions of behavior.

The remainder of the paper is organized as follows. In the next section we present background and related work. In Section 3 we introduce major functionalities of RecoMobile, an environment which supports the configuration of mobile phones and corresponding subscription features. In Section 4 we present the test design of our user study. In Section

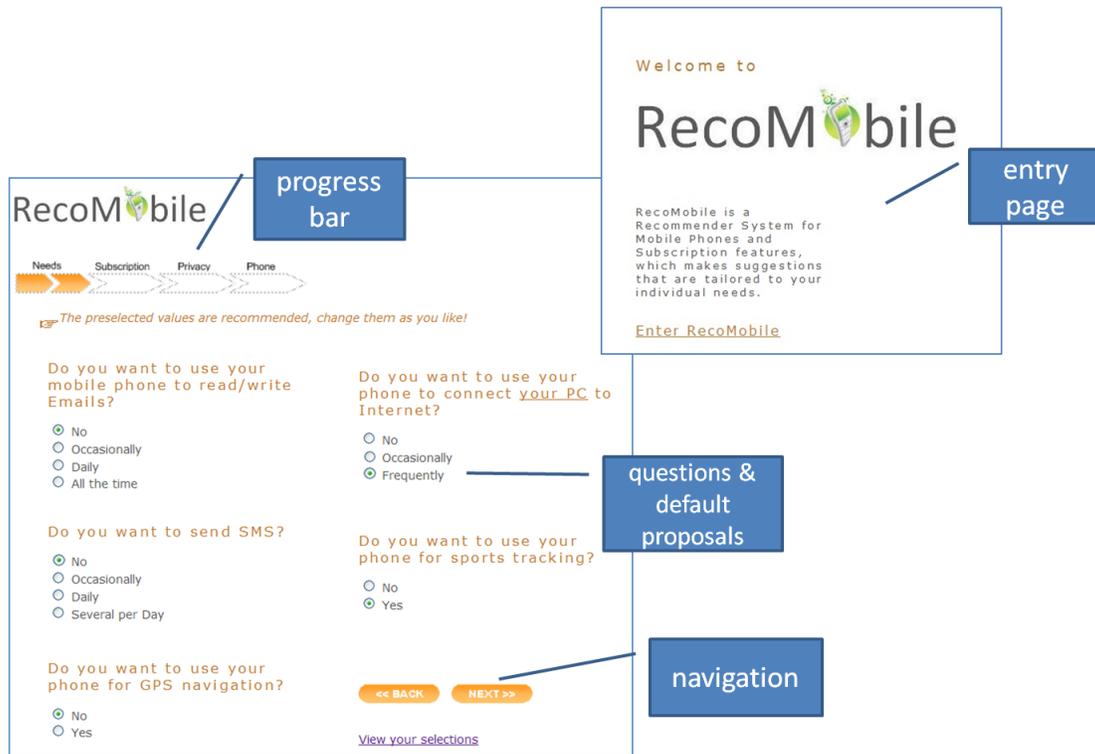


Figure 1: RecoMobile user interface – in the case of default proposal acceptance no further user interaction is needed (Version A).

5 we discuss the results of our study with the goal to point out to which extent the presentation style of defaults have an impact on users' perception of the configuration system as well as on the users' willingness to accept defaults. Finally, we conclude the paper in Section 6.

II. BACKGROUND AND RELATED WORK

Product configuration systems are increasingly being used by manufacturing companies to assist customers in specifying their requirements and to find a product that matches their preferences. One major problem of configuration systems is the high diversity of offered products and product attributes. Previous research has shown that consumers are often overwhelmed in high variety categories because of the large amount of options to evaluate [15]. Since humans have limited processing capacity [16], [17], confronting consumers with too much information can lead to an information overload and therefore can result in decreased quality of decision performance [18]. A possibility to overcome this problem in configuration systems is to personalize the system's user interface by providing feature recommendations matched to customer preferences [9]. The results of a study conducted by Felfernig et al. [9] show a higher user satisfaction with the configuration process

when personalized defaults are provided compared to a non-personalized configurator version.

Although product configuration systems support interactive decision processes with the goal to identify configurations that are useful for the customer, the integration of human decision psychology aspects has been ignored with only a few exceptions. Kurniawan, So, and Tseng [25] investigated human choice processes within a product configuration task. Their results of their study suggest that configuring products (choice of product attributes) instead of selecting product (choice of product alternatives) can increase customer satisfaction with the shopping process.

The research of [6] and [26] was aimed at investigating the influences on consumer satisfaction in a configuration environment. Huffman and Kahn [6] conducted a study to explore the relationship between the number of choices during product configuration and the user satisfaction with the configuration process. Their results showed that both the way the information is presented and the type of customer input to the information gathering process influence customer satisfaction when being confronted with many choice alternatives.

Kamali and Loker [26] explored consumer involvement in the customization process by creating three levels of interactive design involvement. The results of their research revealed a higher consumer satisfaction with the website's

navigation as user involvement increased.

McNee et al. [27] explored user interfaces that integrate users in the selection of items that are used to develop the initial user model. From their results they conclude that such interfaces can affect user loyalty to the system in a positive way.

The format of information presentation as well as elements of user interface design can have a significant impact on user attitudes and perceptions of the trustworthiness of a system (see e. g. [19], [20], [23], [24]). Eroglu et al. [23], [24] examined the impact of task-relevant cues as well as system design elements, such as color, background, and fonts, on the outcomes of online shopping. They suggest that both environmental cues and design elements influence a consumer's willingness to make a buying decision. The results of a study conducted by Kim and Moon [19] showed that the manipulation of user interface design elements, such as title, menu, main clipart and color, can have an impact on users' trust in an electronic commerce system. Roy et al. [20] revealed a strong relationship between quality or usability of a system and the level of trust of customers in the system. Trust has been demonstrated as key factor to the success of e-commerce [22]. Empirical research has shown that the perceived trustworthiness of a system can have an influence on consumers's purchase intention as well as on the intention to use the system again [21].

Another phenomenon that influences the selection behavior of consumers is known as *Decoy effect*. According to this theory consumers show a preference change between two options when a third asymmetrically dominating option is added to the consideration set. An asymmetrically dominated option is completely dominated by (i.e., inferior to) one item in the consideration set but not by another. The insertion of such an alternative into the consideration set can increase the percentage of consumers who choose the dominating option compared to a situation where the asymmetrically dominated option is absent [28]. Decoy effects have been intensively investigated in different application contexts, see, for example [28], [29], [30], [31].

The *Framing effect* describes the fact that presenting the same decision alternative in different variants can lead to the selection of different alternatives. Tversky and Kahnemann [32] showed the effect in a series of studies where they confronted participants with choice problems using variations in the framing of decision outcomes. They reported that "seemingly inconsequential changes in the formulation of choice problems caused significant shifts of preference" [32]. Frame analysis has been applied to different application contexts, such as social movement, political opinion formation, or in the behavioral finance domain.

III. THE RECOMOBILE PROTOTYPE

RecoMobile is a knowledge-based configuration system for mobile phones and services enriched with recommendation functionalities to recommend useful feature settings for the user [9]. Example pages of RecoMobile are depicted in Figure 1. First, the user has to answer a few questions concerning some general attributes of the configuration domain (e.g., the preferred phone style). For the following questions regarding mobile subscription details, privacy settings, and the phone, the recommender proposes personalized feature settings (default proposals) that are determined on the basis of user interactions of past configuration sessions. After the specification of a set of requirements, the configuration system checks whether a solution (configuration) exists. In the case that no solution could be found, the system activates a diagnosis and repair component [33], [34].

Figure 2 depicts a simple example for the RecoMobile diagnosis and repair mode: the configurator detects that no solution could be found, i.e., the defined set of customer requirements is inconsistent with the underlying configuration knowledge base. In such a situation, the system activates a diagnosis and repair component [33], [34] that identifies minimal sets of changes such that the retrieval of at least one solution is possible. If the user selects a repair proposal, for example, *change the desired phone style to slider*, the system is able to find a solution.

After the specification of all user requirements, a phone selection page is presented to the user, which enlists the set of phones that fulfill the given set of customer requirements (see Figure 3). For each mobile phone the user can activate a product fact sheet that is implemented as a direct link to the supplier's web page. Finally, the user can select the preferred mobile phone and finish the session.

In the context of this paper we present a study where we used the RecoMobile prototype to explore whether different *representation styles of feature recommendations* have an impact on users' perception of the configuration system. In the following sections we focus on a discussion of our experiment.

IV. EXPERIMENT: USER STUDY

We conducted a user study with the goal to compare different presentation styles for feature recommendations (defaults) in a product configuration system. For this purpose we implemented three different versions of the RecoMobile User Interface (see Table I). These three versions differ in the way the defaults are displayed to the user as well as in the extent to which user interaction is required to select/reject the provided default suggestions. In Version A the recommended feature alternative is preselected by the system (see Figure 1). User interaction is only required to select a different alternative than the recommended one.

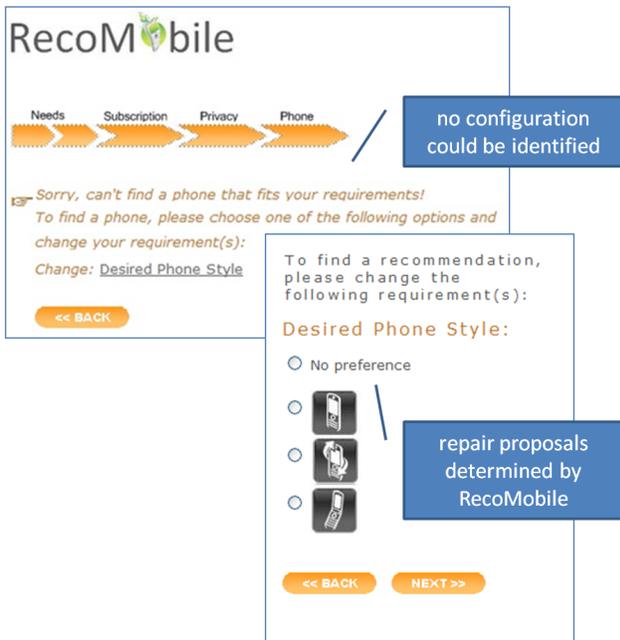


Figure 2: RecoMobile user interface – repairing inconsistent requirements.

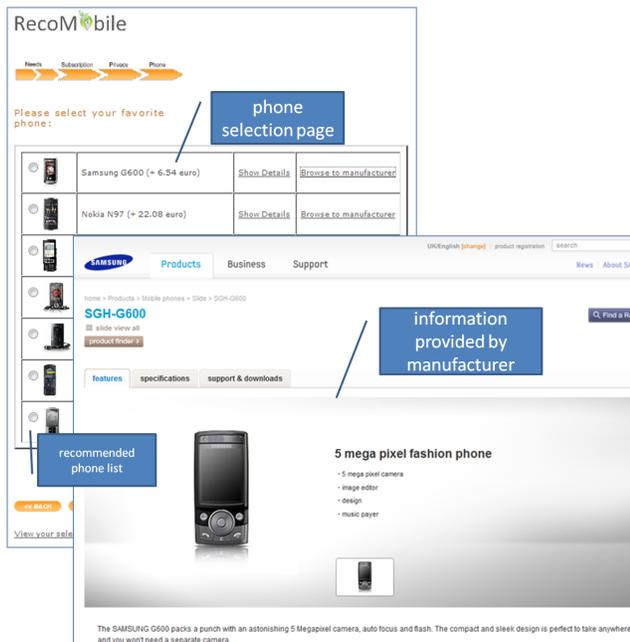


Figure 3: RecoMobile user interface – selecting a phone.

Table I: RecoMobile - Configurator versions in user study.

Version	Default Presentation	Explanation
A	Defaults without confirmation	Defaults are preselected by the system – acceptance of defaults does not require additional interaction (see Figure 1)
B	Defaults with confirmation	Defaults are preselected by the system – acceptance of defaults requires additional interaction in terms of a confirmation (see Figure 4)
C	Defaults to select	Defaults are displayed with a hint – acceptance of defaults requires additional interaction in terms of a selection (see Figure 5)

In Version B the preselected feature recommendations are endowed with an “Accept-Button” so that both, acceptance and changing the alternative require user interaction (see Figure 4). In Version C the recommended feature alternative is displayed with a hint (see Figure 5) and the user has to select the desired feature alternative - even if the user wants to accept the recommendation.

Versions B and C are derived from the research work of Ritov and Baron [35]. They indicate that people have a strong tendency to accept preset values (known as *status quo bias*) compared to other alternatives. A previous user study of our research group revealed a strong biasing effect even if uncommon values are presented as default options [36]. Therefore, a major risk of this status quo effect is that defaults could be exploited for misleading users and making them to choose options that are, for example, not really needed to fulfill their requirements. Ritov and Baron [35] suggest to present the options in such a way, that keeping as well as changing the status quo needs user input. They argue that “when both keeping and changing the status quo require action, people will be less inclined to err by favoring the status quo when it is worse” [35].

A. Study Design

Our experiment addressed two relevant questions. (1) *Does the manipulation of the presentation style of defaults have an impact on users’ perception of the configuration system?* (2) *Do different default representation styles have an influence on users’ willingness to accept/select defaults?* To address these questions, we conducted an online survey at the University of Klagenfurt. N=129 subjects participated in the study. Each participant was assigned to one of the three user interface versions of the configurator (see Table I). The experiment was based on a scenario where the participants had to decide which mobile phone (including

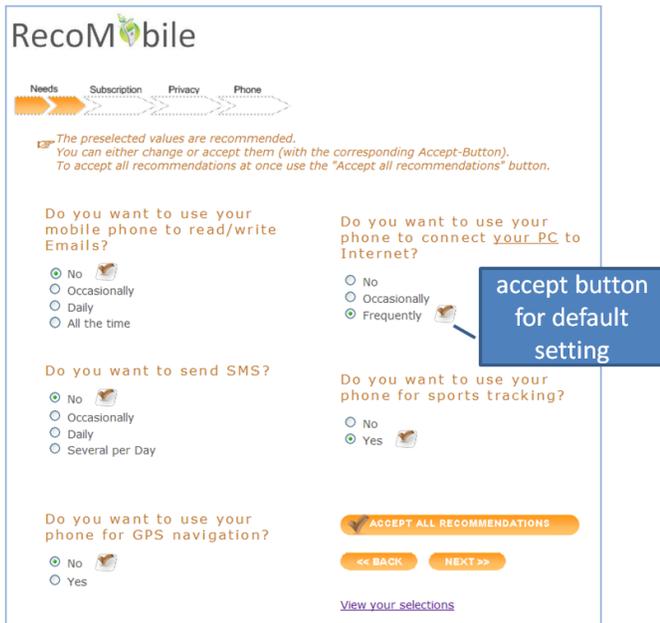


Figure 4: Version B of the RecoMobile user interface – in the case of default proposal acceptance users have to explicitly confirm their selection (Accept-Button).

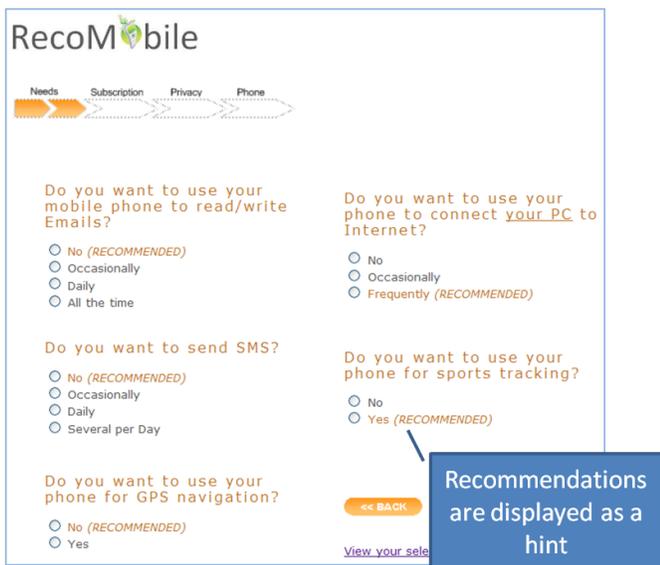


Figure 5: Version C of the RecoMobile user interface – the user selects the desired alternative - also in the case of accepting the default proposal.

Table II: Evaluation questions.

Measurements	Questions
Satisfaction with quality	How satisfied were you with the overall quality of the selection process?
Confidence	How confident are you in having selected the most suitable phone and subscription?
Trust	How high is your degree of trust in the recommendations given by the system?
Use intention	How high is the probability that you would use the system again?
Reference intention	How high is the probability that you would recommend the system to another user?
Purchase intention	Assume that you need a new phone. How high is the probability that you would purchase the selected mobile phone?
Satisfaction with user interface	How satisfied were you with the presentation of feature recommendations?

Table III: Comparison of default selection behavior in different configurator versions.

Version	Mean	Std. Deviation
A	8.02	4.078
B	7.91	3.676
C	6.43	3.749

the corresponding services) they would select. A post-study questionnaire was designed covering 8 subjective measures (see Table II). Each question had to be answered on a 11-point Likert scale.

V. RESULTS

In the following we discuss the influence of different representation styles of defaults on users perception of the configuration system as well as on users selection behavior.

A. Objective Measure

The objective measure aims at analyzing the default selection behavior in the different product configurator versions. The average number of defaults selected or accepted by users of different configurator versions are shown in Table III. The results show that there is no significant difference between the configurator versions. Users of versions A and B accepted on average roughly 8 out of the 15 recommended feature options (Version A - mean=8.02, Version B - mean=7.91). Users of Version C selected on average roughly 6 default proposals (Version C - mean=6.43).

Table IV: Subjective Measures - Evaluation results.

Measurement	Version A		Version B		Version C	
	Mean	SD	Mean	SD	Mean	SD
Satisfaction with Quality	6.30	1.896	6.03	2.467	4.41	3.135
Confidence	5.70	2.322	6.08	2.882	4.68	2.857
Trust	5.47	2.063	4.94	2.366	3.94	2.628
Use intention	4.30	3.344	5.11	3.328	4.12	3.121
Reference intention	4.47	2.980	5.08	3.255	4.06	3.219
Purchase intention	5.17	3.485	3.72	3.177	3.85	3.076
Satisfaction with User Interface	5.23	3.081	4.50	3.185	4.18	3.451

B. Subjective Measures

The results of the evaluation of the subjective measures are shown in Tables IV and V.

The average scores of user evaluations of the subjective measurements are shown in Figure 6. An independent t-test was conducted to find significant differences between the configurator versions. Table V presents a comparison of users' evaluations of configurator versions with different styles of presenting defaults (significant differences are highlighted with bold typeface). The different methods of presenting recommendations have a significant impact on perceived quality of the system. Users of configurator Version C gave significantly lower scores (mean=4.41, Standard Deviation SD=3.135) than users of Version A (mean=6.30, SD=1.896) and B (mean=6.03, SD=2.467). The comparison on confidence shows significant differences ($t=2.050$, $p=0.044$) between users of Version B (mean=6.08, SD=2.882), who rated highest, and users of Version C (rated lowest - mean=4.68, SD=2.857). As for trust in the recommendations given by the system, there is a significant difference ($t=2.558$, $p=0.013$) between the rating of Version A (mean=5.47, SD=2.063) and Version C (mean=3.94, SD=2.628).

The comparison of the other measures (use intention, reference intention, purchase intention and satisfaction with user interface) revealed no further significant differences between the different user interface versions.

Version C was rated lowest in almost all subjective measures, except the *Purchase intention*. Version B has a slightly lower mean value in this case (mean=3.72, SD=3.177) compared to Version C (mean=3.85, SD=3.076).

C. Relationships between objective and subjective variables

We wanted to identify potential correlations between the number of selected/accepted defaults and users' subjective perceptions of the configurator. Therefore we calculated correlation between the objective measure and each subjective measure. Table VI shows the coefficient values by

Table V: Comparison of evaluation results of different configurator versions - Independent t-test. Significant differences are highlighted with bold typeface.

Measurement	Version A compared with Version B	Version A compared with Version C	Version B compared with Version C
Satisfaction with Quality	$p=0.623$	$p=0.005$	$p=0.020$
Confidence	$p=0.559$	$p=0.119$	$p=0.044$
Trust	$p=0.348$	$p=0.013$	$p=0.097$
Use intention	$p=0.329$	$p=0.822$	$p=0.203$
Reference intention	$p=0.429$	$p=0.602$	$p=0.190$
Purchase intention	$p=0.083$	$p=0.114$	$p=0.862$
Satisfaction with User Interface	$p=0.348$	$p=0.204$	$p=0.685$

Table VI: Correlations between objective and subjective variables - Pearsons Correlation.

	Number of selected defaults
Satisfaction with Quality	-0.054 ($p=0.591$)
Confidence	0.027 ($p=0.793$)
Trust	-0.079 ($p=0.437$)
Use intention	-0.148 ($p=0.142$)
Reference intention	-0.066 ($p=0.512$)
Purchase intention	-0.050 ($p=0.620$)
Satisfaction with User Interface	0.265 ($p=0.008$)

Pearsons Correlation. The results show that the number of selected/accepted defaults is significantly positively correlated with the perceived user interface quality. This suggests that users' willingness to accept defaults depends not only on the quality of the recommendation but also on the *presentation style of defaults*.

D. Discussion

Regarding the subjective evaluation, Version C, where system users had to select the recommended feature alternatives on their own, was rated lowest by almost all evaluation criteria. Users' evaluations of system versions with different ways of presenting defaults showed significant differences concerning the perceived quality of the selection process, the confidence in the system and the trustworthiness of the system. The scores on behavior intentions (intention to use the system, purchase the configured solution, and recommend the system) and users' satisfaction with the user interface revealed no significant differences between the compared configurator versions.

The results also show a strong relationship between satisfaction with the presentation of feature recommendations and the willingness to accept/select defaults.

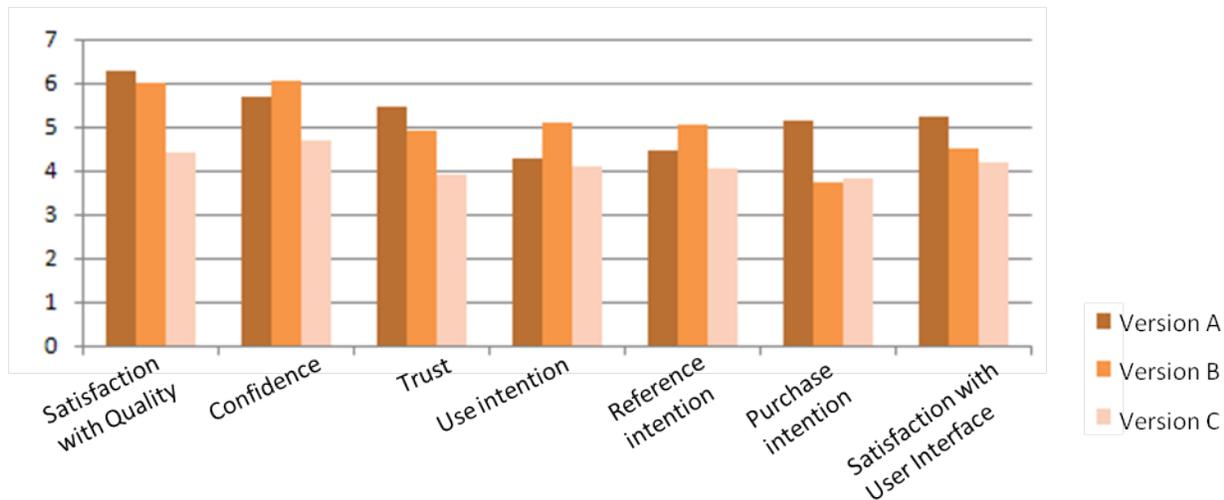


Figure 6: Comparison of evaluation results between different RecoMobile versions - Mean Values.

VI. CONCLUSION AND FUTURE WORK

We presented the results of an empirical study that analyzed the impact of different presentation styles of personalized recommendations in product configuration scenarios. For this purpose we implemented three different user interface versions of a mobile phone and subscription configurator. The versions differed in the way the recommendations were displayed to the user and in the extent of user interaction required to accept/reject the suggestions. The results show that the method of presenting feature recommendations can have a significant impact on users' satisfaction with the overall perceived quality of the selection process, as well as on users' confidence and trust in the product configurator. Furthermore, we found a strong correlation between the number of selected or accepted recommendations and users' satisfaction with the presentation of feature recommendations. Our results suggest that the method of presenting personalized defaults is an important factor that influences users' satisfaction with the configuration process. Our future work will include the investigation of additional decision phenomena in the context of knowledge-based configuration scenarios (e.g., framing or decoy effects).

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