Future Chances of Software Customization: An Empirical Evaluation

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Abstract—Customization is an important market trend because companies can only survive when they focus on their customers’ needs. In order to offer demand-driven customization options, it is necessary to empirically analyze the benefit of the various adaptations from a customer’s point of view. In the software sector, only a few surveys have been conducted that exceed technical aspects. Moreover, existing studies are limited to the overall acceptance and benefits of customization, but draw no conclusions on different adaptation options. Thus, we present a large study that analyzes the starting points of software customization and deals with general questions of customization. The results indicate that software customization increases the willingness to pay (WTP) by about 15%. The survey points out that especially customization options, which adapt the functionality, increase the usability, and enable parental controls are of great importance for future software implementation. Hence, our results enable competitive advantages by implementing customization options that meet customer needs.

Keywords—customization; adaptability; tailoring; user study; human-computer interaction.

I. INTRODUCTION

Today, competitive pressure and customer empowerment change selling conditions. Customers are no longer willing to accept the customer sacrifice [1], [2], the gap between products offered and customer needs. That is why the long tail phenomenon [3], [4] starts to rule the market and a multitude of tiny niche markets replaces traditional mass markets. Hence, producers turn from selling off-the-shelf products to offering customization. Åhlström and Westbrook [5] have shown that the demand for non-standard products is even growing and producers plan to increase customization.

This trend can also be seen in the software sector. Software product lines (SPL) help to build software that satisfies a specific market segment on the basis of a common set of core assets [6]. However, accessibility movements and the regulation by law demand an even stronger focus on the individual (cf. Section 508 of the Rehabilitation Act [7] and the German Equality Law For Disabled People [8]). However, accessibility is not the only reason for software customization. The International Standard on Ergonomics of Human System Interaction (ISO 9241/110) indicates that customization is an important principle to design a dialog. The Technical Report on Software Engineering (ISO/IEC TR 9126-2) even says that customization is a requirement of software quality that helps to meet the user’s needs. Software customization could also enhance the customer experience [9]. Thus, customization is a crucial part in current software engineering.

There are various ways to customize software. The DUFS customization classification [10] organizes this richness and helps us to outline software customization. This categorization subdivides design customization, usability customization, functionality customization, and customization of service and communication. In this context, design customization means an adaptation of the appearance of the Graphical User Interface (GUI). As companies can only prosper if they focus on their customers, software developers need to know which customization features are in demand. A previous empirical study [5] cites this lack of knowledge of customer needs as the major difficulty in customization.

Nevertheless, existing studies often only focus on non-software vendors and software customization surveys are limited to technical aspects. Thus, we conduct a comprehensive survey. This paper elaborates on the small excerpt presented in a previous paper [10]. The detailed results on customization enable an in-depth analysis of customer evaluation. Hence, customer opinions of customization in the non-software sector as well as in the software sector are considered and future chances are identified. To our knowledge this survey is the largest one in terms of software customization and the only one that considers customization starting points. Thus, our study helps software developers to decide on customization implementation and provide adaptations that are valuable for their customers.

In the following, Section II summarizes previous surveys on customization and explains why analyses of non-software customization provide valuable insights that could be used for software customization. Section III introduces our study and illustrates the methods used. Afterwards, Section IV presents the non-software analysis and spotlights customization usage. The results of the software customization investigation are presented in Section V. Before concluding, Section VI critically examines the survey.
II. BACKGROUND AND RELATED WORK

The beginnings of customization go back to 1987, when Stanley Davis introduced a business strategy to implement customization called Mass Customization (MC) [11]. In 1993, Joseph Pine made this strategy popular [12]. From then on, the trend of customization spread. The following lists the most important studies on customization in the non-software sector as well as in the software sector. Additionally, the section shows why findings of non-software products could be valuable for software products.

A. Non-Software Products vs. Software Products

Kotler and Armstrong described a product as "anything that can be offered to a market for attention, acquisition, use, or consumption that might satisfy a want or need" [13]. Additionally, Peter Drucker stated that a company can only prosper if it focuses on its customers and their needs [14]. Consequently, the customer’s perception of the product and its value determines the company’s success.

According to Kittlaus and Clough [15], the value that comes out of the intangible product software can only be realized in its functionality. However, the emergence of appearance customization in software, e.g., the tailoring of forum appearances, shows that software is more than something to get things done. Thus, there are similarities in customer perception between non-software and software products, even though they differ greatly in characteristics.

Due to the importance of customer perception, we believe that findings from the non-software area in terms of perceived customization could be valuable for the software sector. This practice is useful since the non-software sector has a much longer history and many people see software as incomprehensible "black magic" [16]. Thus, non-software products are well-known to a wider audience whereas software knowledge could still be limited.

In contrast to non-software products, many software characteristics support its customizability. Software has no physical form and belongs to the economic factor of knowledge [15], [16]. This makes later adaptations easier and enables repeated customization. As Frederick Brooks said, this easy adaptability obliges software vendors to offer adaptation options [17]. Besides, the delivery of software is simple, fast and could be made on an individual basis. These facts facilitate software customization.

B. Previous Studies on Non-Software Customization

To address customer needs it is important to know which product features create value from a customer’s point of view. As only customers can answer this question properly, many surveys have been conducted. Unfortunately, many of them only consider non-software products [18], [19], [20]. Piller et al. [21] listed existing studies of MC and highlighted especially the additional contribution that could be achieved with the help of customization. By offering shoes that are adapted in terms of fit, function and design, the sporting goods producer Adidas, e.g., achieved 30 to 50% higher prices [21], [22]. However, in 1998 Huffman and Kahn [23] empirically documented problems in information retrieval.

C. Previous Studies on Software Customization

Despite the fitness of software for customization few studies analyze general aspects of software customization. The most important one was made in 1991 by Mackay [24]. She observed the triggers and barriers of software customization. According to her, the main triggers are the reusing of repeated patterns, the retrofitting after a system change, and the avoidance of annoying behavior. In contrast, barriers are a lack of time and knowledge. In 1996, these results were proven by Page et al. [25].

Most existing studies on software customization only consider technical aspects. Many authors compared the three methods of software customization. Adaptable initiatives are based on the self-customization of the user. Moreover, in the non-software area it is also quite common for manufacturers to adapt the product to the customer’s needs. In the software sector this can be done by the software itself. This method is known as adaptive initiative. Additionally, software could use a mixed initiative which combines both aspects. Thus, several studies tried to identify the best practices for designing menus [26], [27] or GUIs [28], [29], [30]. Furthermore, research is done to analyze accessibility aspects [31], [32]. These studies verified the benefits of software customization. With regard to quantitative aspects, an increase in performance and decrease in error rates could be measured. Moreover, improvements in qualitative aspects, such as usability, stress in usage, and individual preferences, became visible. The increase in user satisfaction, a software quality requirement (cf. ISO/IEC 25051:2006), was empirically verified in a study on Apache Security Software [33]. However, its validity was limited by only interviewing skilled users.

The financial effects of software customization have been studied by Oliver et al. [34]. They found that 5 to 10% higher profit margins and doubled revenues could be realized.

All existing surveys on the subjective advantages of software customization focused on overall feelings but no conclusions on the acceptance and benefit of particular customization features could be drawn. Thus, we conducted a large study that used the DUF5 customization classification [10] to analyze customer perception on different customization options. DUF5 sub-divides software customization into four categories. Design customization sums up all options that help adapt the interface’s appearance according to the customer’s preferences. Usability customization refers to adaptations which make the software more effective, efficient and task satisfying (cf. DIN EN ISO 9241 Part 11). All customization options that help close the gap between offered and needed functionalities belong to the category of
functionality customization. Customized auxiliary services and customized software messages and greetings are part of service and communication customization. By using this categorization and involving heterogeneous user groups our survey gives detailed insights into the appraisal of software customization. Additionally, it deals with general questions on customization to form a basis for in-depth research.

III. METHODS

Our empirical study analyzes customization from a customer’s point of view. All values in the text are rounded off to two digits after the decimal point.

A. Data Collection and Sample

As previously outlined [10], the study was conducted in 2010 in South Germany. The answers of ten interviewees could not be used because of missing data. Thus, the study includes the answers of 274 participants. 43.43% of them are female. The sample includes heterogeneous participants (cf. Fig. 1 and Table I). The survey could be completed either electronically (20.44%) or in paper form (79.65%).

The sample is slightly different to the whole German population because of the proximity to the University of Ulm. It includes comparatively many young, well-educated participants and male opinions are somewhat overrated. However, the large and heterogeneous sample allows conclusions to be drawn on perceived customization.

B. Participant Grouping

Two participants had never used a computer before, so the sample size for the computer-related questions is 272. For analysis purposes these participants were divided into frequent users that use their computer daily and perform at least five different tasks and non-frequent users. The study contains data of 175 frequent and 97 non-frequent users.

IV. CUSTOMIZATION USAGE AND REASONS

The survey started with non-software customization to facilitate access and ensure the quality of the given answers. Additionally, it helps to get elementary insights into customization. These results are pointed out in the following.

A. Customization Usage

In order to analyze customization usage we subdivided non-software products into the categories clothing and shoes, vehicles and bikes, grocery and beverages, stationery, souvenirs, jewelry, health care, as well as electronic articles. The survey gave examples of customization in the different categories. This helped to ensure that all participants could properly answer if they had ever used customization in these categories. Fig. 2 illustrates the results.

![Table I. Professional Distribution](image)

<table>
<thead>
<tr>
<th>Profession</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job Applicant</td>
<td>8</td>
</tr>
<tr>
<td>Scholar</td>
<td>26</td>
</tr>
<tr>
<td>Trainee</td>
<td>12</td>
</tr>
<tr>
<td>Student</td>
<td>59</td>
</tr>
<tr>
<td>Employee</td>
<td>94</td>
</tr>
<tr>
<td>Operative</td>
<td>12</td>
</tr>
<tr>
<td>Executive</td>
<td>36</td>
</tr>
<tr>
<td>Self-employed</td>
<td>20</td>
</tr>
<tr>
<td>Senior Citizen</td>
<td>7</td>
</tr>
<tr>
<td><strong>Sum</strong></td>
<td><strong>274</strong></td>
</tr>
</tbody>
</table>

The overall usage rate of 51.19% supports customization research. Besides of adaptations of electronic articles, grocery and beverage, customization usage is quite common.

Analyses of the adaptation starting points with the help of the DEFS customization categories design, ergonomics and fitting, functionality, as well as services [10] show that in most of the product categories adaptations are generally minor variations in design. These adaptations are used with clothing and shoes, vehicles and bikes, grocery and beverage, stationery, souvenirs, jewelry, and electronics. Nevertheless, products with adaptations to increase the ergonomics and fitting are also available. In the health sector these adaptations are necessary to cope with the customer-specific body. However, even clothes or shoes are adaptable in terms of ergonomics. Thus, e.g., the sporting goods producer Adidas offers ergonomically adaptable shoes. Above all, the categories vehicles and bikes as well as electronic articles offer ways of adapting the functionalities by adding adequate modules. In contrast, service customization is only rarely available in the Business-to-Consumer (B2C) sector.
B. Reasons for Customization Usage

The survey tried to get an insight into the reasons for the named customization usage. The participants had to state if they use customization to adapt the functionality, adapt the design, highlight individuality aspects, or participate in a future trend. They also got the chance to say they see no benefit in customization. This question was semi-open and multiple answers were allowed. Fig. 3 lists the results.

According to the participants, the main reason for customization is to adapt the functionality. Another frequently named reason is design adaptation. The enhancement of one’s individuality which rests on a human basic need was also seen as a major factor. Moreover, only 13.14% of the participants see no benefit in customization. In contrast, 18.08% judge customization as an important future trend. This justifies the importance of this paper’s topic.

The free-text answers showed that customization is used to possess something unique, increase the imaginary value, differ from the mass, and give presents. The participants also revealed the importance of value for money aspects.

Since the female and male answers differ, we did a Chi-Square Test ($\alpha = 0.05$) to analyze this. Table II shows that only the fact that the women use customization more often to highlight their individuality (41.18% vs. 28.39%) could be traced back to gender.

![Figure 3. Reasons for Customization Usage.](image)

<table>
<thead>
<tr>
<th>Reason</th>
<th>Pearson’s Chi-Square</th>
<th>Degrees of Freedom</th>
<th>Asymptotic Significance (2-sided)</th>
<th>Fisher’s Significance (2-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Benefit</td>
<td>3.538</td>
<td>1</td>
<td>0.060</td>
<td>0.063</td>
</tr>
<tr>
<td>Future Trend</td>
<td>0.254</td>
<td>1</td>
<td>0.615</td>
<td>0.628</td>
</tr>
<tr>
<td>Individuality</td>
<td>4.911</td>
<td>1</td>
<td>0.027</td>
<td>0.029</td>
</tr>
<tr>
<td>Design</td>
<td>0.526</td>
<td>1</td>
<td>0.468</td>
<td>0.526</td>
</tr>
<tr>
<td>Functionality</td>
<td>0.017</td>
<td>1</td>
<td>0.985</td>
<td>1.000</td>
</tr>
</tbody>
</table>

V. SOFTWARE CUSTOMIZATION

The second part of the survey examined the usage of existing software customization options, financial benefits for software vendors, and future chances.

A. Usage of Software Customization

In order to get meaningful results on the perception of existing software customization options, we chose features that are well-known to participants of all age categories. The participants rated 15 adaptation options in the areas of operating systems, Office products and world wide web. All but one are adaptable options because users take more notice of self-made changes than of automatic ones. This increases the reliability of the findings. With regard to usability, we listed the creation of links, creation of bookmarks, the quick launch bar of the operating system, and the tool bars of Office programs which all help to get quick access. Usability aspects can also be customized by tailoring the update handling and choosing one’s native language. Existing software offers many features to adapt the design, i.e. the GUI appearance. We chose the adaptation of fonts, colors and contrasts, icon size, desktop background, mouse pointer, and the screen saver. Furthermore, the participants judged the functional customization offered by iGoogle and Windows gadgets. Since service customization is only rarely available in the B2C sector, we limited our survey to adaptive purchase proposals in online shops.

The survey explained each feature to ensure that all participants understood the questions. Afterwards, the participants stated if they knew the customization option and if they had ever used this adaptation. Additionally, they rated the benefit of each option. According to Schwarz et al. scales with zero-to-positive-values should be used to measure the intensity of a single attribute [35]. Thus, we used a scale from 0 to 5 to evaluate the feature’s benefit. A value of 5 indicates that it is very useful. In contrast, a benefit of 0 shows that this feature has no benefit at all. Fig. 4 illustrates the results and maps them to the DDFS software customization categorization. It also shows the usage of the customization options. Even though most of the options are well known, some participants did not know several features. We excluded these participants to calculate a meaningful percentage of usage. The strong correlation (Pearson’s $r = 0.87$) between benefit values and usage highlights that the customer’s view is of crucial importance in terms of customization research.

![Figure 4. Benefit and Usage of Software Customization.](image)
ticular achieved high benefit values. Design customization options are rated with high benefit values, too. In contrast, functionality adaptations as well as adaptations of service and communication are rated particularly low. This might be based on some external factors. In contrast to the long-established examples in the categories usability and design, the specified functionality adaptations are quite new. This negatively influences the knowledge, acceptance and also the perceived benefit. The results of customization usage in the non-software sector verify this argumentation. Functionality adaptations are the main reason named for customization. Furthermore, it has to be pointed out that service adaptations have only been rarely available to date in the B2C sector.

Additionally, our findings show that all evaluated design customization options achieved lower benefit values than usability adaptations. All functionality customization options achieved lower benefit values than design adaptations and service and communication customization options are left far behind. This proves that the DUFs classification categories reflect customer perception adequately.

B. Willingness To Pay

We differ between non-software and software products to examine the Willingness To Pay (WTP) and evaluated the additional contribution in comparison to an off-the-shelf product. As our goal was to analyze the general WTP rather than the WTP for a specific product, we chose an hypothetical approach. The analyses of Miller et al. [36] showed that hypothetical approaches could generate mean WTP estimations that do not significantly differ from the actual WTP and could be used to make meaningful management decisions. Our participants had to state if they would pay not more, 10%, 25%, 50% more, double the price, or more than double the price to get a customized product. The latter was quantified by a contribution of 150%. Table III summarizes the results – specified by age and user-group. The WTP of the participants younger than 15 years and older than 69 years are not representative but are listed for completeness.

<table>
<thead>
<tr>
<th>Age (in Years)</th>
<th>Non-Software</th>
<th>Software</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>frequent users</td>
<td>non-overall</td>
</tr>
<tr>
<td>11-14 Years</td>
<td>10.00%</td>
<td>10.00%</td>
</tr>
<tr>
<td>15-19 Years</td>
<td>9.55%</td>
<td>26.88%</td>
</tr>
<tr>
<td>20-24 Years</td>
<td>15.76%</td>
<td>24.29%</td>
</tr>
<tr>
<td>25-29 Years</td>
<td>20.24%</td>
<td>13.08%</td>
</tr>
<tr>
<td>30-39 Years</td>
<td>13.64%</td>
<td>13.06%</td>
</tr>
<tr>
<td>40-49 Years</td>
<td>11.00%</td>
<td>11.75%</td>
</tr>
<tr>
<td>50-59 Years</td>
<td>13.53%</td>
<td>17.22%</td>
</tr>
<tr>
<td>60-69 Years</td>
<td>27.50%</td>
<td>15.50%</td>
</tr>
<tr>
<td>&gt; 69 Years</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Average</td>
<td>15.69%</td>
<td>15.52%</td>
</tr>
</tbody>
</table>

The overall average willingness for an additional contribution in the non-software sector is 15.22% and indicates that there is a broad-mindedness for customization. Other surveys in the mass customization area document an even higher WTP of about 30% and partly 100% [21], [37].

The average contribution of 14.97% in the software sector is lower. The reason for this could be that software is not a daily product for everybody and could seem to be less important. This argumentation is verified by the fact that the average contribution of non-frequent users is 14.90% in terms of non-software products but 13.79% with regard to software. In contrast, the average contribution of the participants with frequent computer usage is in both product categories exactly the same (15.46%). These findings could encourage the assumption that in a world where computer usage becomes increasingly common the WTP for software customization will become more similar to non-software products. Thus, the analysis of non-software products could be valuable for software vendors.

C. Future Chances

In order to evaluate the potential of software customization, the survey contained an appraisal of the perceived future chances. We used the DUFs classification to make a distinction. By adding the subcategory parental controls we extended the DUFs category functionality. The category usability was also further divided by using the subcategories intuitiveness and language. This enables detailed analyses.

In every category the participants rated the future chances of software customization by evaluating their need for future implementation. The survey highlighted that participants should incorporate adaptable and adaptive adaptations. Once again we used a 0-to-5 scale to achieve consistency and support the reliability of the results. A value of 0 marks no future requirements whereas a value of 5 characterizes great future requirements. Fig. 5 illustrates the mean future requirements and their variances in a simplified Software Customization Chart (SCC) [10]. In contrast to a full SCC, we make no distinction between adaptable, adaptive or mixed initiatives.

The results show that functionality customization in particular achieves high rates and should be increasingly implemented in future software. The participants also highlighted
great future chances in usability customization. Customization options which enable parental control by limiting the available functionality achieved high support, too. Moreover, the results support the importance of adapting the language of the GUI. The participants also called for an improvement in design adaptations and the intuitive software handling. In terms of service and communication customization the estimations were only moderate. This might be based on the fact that the participants could not evaluate the benefits of service customization because of the low availability in the B2C sector. In summary, an overall value of 3.49 emphasizes the future chances of software customization and highlights the need for further research. Furthermore, the differences in the starting-point evaluation support the DUFS classification.

We performed t-tests to verify the differences in evaluations of female and male participants. The results (cf. Table IV) indicate that the differences in the categories design, communication, and parental controls depend on gender. With regard to parental controls the female rated the future requirement very high (4.10) in comparison to a moderate rate in the male group (3.58). The women also rated the future chances of design adaptations (3.89) as well as adaptations in services and communication (2.61) higher than the men did (3.23 resp. 1.90). In all other categories the differences could not be tracked back to gender.

Further t-tests analyzed the higher valuation of the frequent computer users. Table IV illustrates that the differences in the rating of intuitiveness, design, and language depend on the frequency of computer usage. Fig. 6 shows these differences.

VI. Discussion

In the following, some threats to validity are considered and the importance of this paper’s topic is proved.

A. Threats to Validity

The chosen questions could have an impact on the results and be a threat to internal validity. However, we controlled this by carefully designing the questionnaire, avoiding ambiguous questions, keeping consistency, and using well known examples within the survey. Moreover, we checked the survey in a pretest with five persons.

A potential threat to external validity might be the representativeness. However, the age, the profession, and the expertise of the participants differ significantly and the data set is sufficiently large. To our knowledge, this is actually the largest study of customer acceptance and benefits of software customization. Moreover, it is the only one that evaluates software customization starting-points. Hence, we judge the reported results to be meaningful.

The large sample size also supports the validity of the Chi-Square Test in Section IV. Although, there is only one degree of freedom, the minimal expected frequencies (15.64 to 59.07) are far away from the critical border of ten.

B. Validation of the Need for Customization

The results show that some answers are related to being part of a specific user group, e.g., men or women or frequent or non-frequent users. Yet, many evaluations are based on the user’s experience, characteristics, and preferences. This diversity can be seen in the listed variances (cf. Fig. 5). Only customization could cope with these individual aspects.

VII. Conclusion and Future Work

In this paper, we analyzed the acceptance and benefits of customization in the non-software as well as in the software sector. For this reason, we conducted a comprehensive study with 284 participants. Our results showed that customers want customization and are willing to pay a contribution of about 15% for adaptable or adaptive software. The results revealed an overwhelming approval of software customization but indicated unused capabilities in existing systems. The participants use the existing software customization options which enable parental control by limiting the available functionality achieved high support, too. Moreover, the results support the importance of adapting the language of the GUI. The participants also called for an improvement in design adaptations and the intuitive software handling. In terms of service and communication customization the estimations were only moderate. This might be based on the fact that the participants could not evaluate the benefits of service customization because of the low availability in the B2C sector. In summary, an overall value of 3.49 emphasizes the future chances of software customization and highlights the need for further research. Furthermore, the differences in the starting-point evaluation support the DUFS classification.

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options. However, they highlighted that the importance of the adaptation depends on the starting point of the customization. The participants especially emphasized the benefits of adaptations to increase the usability. With regard to future software engineering, the participants called for the improvement of functionality and usability customization options. Moreover, they requested further adaptations in parental controls. Additionally, the findings supported the DUFS customization classification. In summary, the study gave insight into the perception of software customization from a customer’s point of view. This could help software developers to detect valuable software customization and provide software that exactly meets customer-specific needs.

For future work, the enlargement of the study could identify cultural impacts on customization perception.

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