DESIGNING AN AI-BASED ADVISORY PLATFORM FOR DESIGN TECHNIQUES

Xuanhui Liu  
*Karlsruhe Institute of Technology (KIT)*, xuanhui.liu@kit.edu

Simin He  
*Karlsruhe Institute of Technology (KIT)*, usdpb@student.kit.edu

Alexander Maedche  
*Karlsruhe Institute of Technology (KIT)*, alexander.maedche@kit.edu

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Research paper

Liu, Xuanhui, Karlsruhe Institute of Technology (KIT), Institute of Information Systems and Marketing (IISM), Karlsruhe, Germany, xuanhui.liu@kit.edu

He, Simin, Karlsruhe Institute of Technology (KIT), Institute of Information Systems and Marketing (IISM), Karlsruhe, Germany, simin.he@student.kit.edu

Maedche, Alexander, Karlsruhe Institute of Technology (KIT), Institute of Information Systems and Marketing (IISM), Karlsruhe, Germany, alexander.maedche@kit.edu

Abstract

The usage of design techniques in design processes is an important driver for the success of digital services. However, before using design techniques, suitable techniques need to be selected. With the continuous growth of the number of design techniques, the selection of appropriate ones becomes more difficult, especially for design novices with limited knowledge and expertise. In order to support the selection process, we propose design principles for the development of an advisory platform that interacts with design novices to suggest design techniques for different design situations using artificial intelligence (AI) techniques. Specifically, we leverage conversational agents, recommender techniques, and taxonomic background knowledge to conceptualize and implement an AI-based advisory platform. Following a design science research methodology, we contribute design knowledge for the class of advanced advisory platforms. Furthermore, from a practical point of view, we help design novices with our implemented advisory platform in the contextualized selection process of design techniques.

Keywords: Digital Service, Design Novice, Design Technique, Selection Support.
1 Introduction

The growing need of providing guidance for delivering user satisfied digital services leads to the continuous development of design techniques (Patricio et al., 2011). The fast development of design techniques provides designers a lot of options in the design process. For example, when generating ideas at the beginning of the design process, many design techniques can be used, such as shadowing, storyboarding, brainstorming, and behavioral mapping. However, too many alternatives increase the difficulty in the selection process (Greifeneder et al., 2010). As the selection of appropriate design techniques is mostly based on design expertise, design experts are well equipped with design knowledge. However, many organizations do lack specialized design experts (Bruun, 2010). Thus, design processes are often accomplished by design novices (Bonnardel et al., 2003). When conducting design activities, it is challenging for design novices who have little or no formal training and limited professional experiences to select appropriate techniques. As more and more design novices are encouraged to participate in design processes, there is a need to help design novices in making the right decisions of design techniques under consideration of various constraints such as time limitation, user participation etc. (Bonnardel et al., 2003).

Existing studies attempt to provide solutions by classifying design techniques to support the selection process (e.g., Sanders et al., 2010; Roschuni et al., 2015), developing algorithms to suggest design techniques (e.g., Jiang et al., 2008; Fuge et al., 2014), and designing web-based platforms to help with choosing suitable design techniques (e.g., allaboutux.org, theDesignExchange.org). These web-based platforms provide valuable support for exploring existing design techniques. However, design novices are still overwhelmed with a large number of available design techniques. And we believe that more advanced support for selecting design techniques is required. Hence, in this study, we propose to leverage artificial intelligence (AI) techniques to augment design novices in their decision-making processes. As a result, this research seeks to answer the following research question:

*Which design principles should an AI-based advisory platform follow in order to support design novices in the selection process of design techniques?*

This study follows design science research (DSR) methodology to answer the research question. As a result, we seek to contribute theoretically by proposing design knowledge to guide the development of systems for augmentation of design novices in their decision-making processes. Specifically, we focus on supporting design novices in the selection process of design techniques. Practically, our advisory platform (servicedesignkit.org) supports design novices to select suitable design techniques under consideration of different design situations.

This paper is organized as follows. The key concepts and related work are introduced in section 2. The research method is introduced in section 3. Section 4 presents meta-requirements, design principles, and design features. Section 5 presents the evaluation results as well as suggestions for improvement. Section 6 discusses the contribution, limitation, and future direction. Section 7 concludes this paper.

2 Conceptual Foundations and Related Work

2.1 Conceptual Foundations

The term technique is defined as “a procedure for accomplishing a desired outcome” (Brinkkemper, 1996). As design techniques include step-to-step instructions, which is easy for novices to understand and follow in the design process (Bonnardel et al., 2003). Compared with experts, novices have limited domain-specific knowledge (Kolodner, 1983). As a result, novices are not as skilled as experts to relate problems with their previous experiences (McKeithen et al., 1981; Schenk et al., 1998). Novices need more efforts than experts to access information and find suitable solutions (Schenk et al., 1998). The knowledge base of novices limits the abilities for problem-solving (Schoenefeld et al., 1982). Design novices in usability engineering are defined as “persons with less than one year of job experience and no formal training in usability engineering methods” (Bruun, 2010, P83). Thus, we define design novices
in this thesis as persons with less than one year of job experience and no formal training in digital service design activities.

Because of limited knowledge, design novices may have difficulties when selecting design techniques. In order to support the selection process, a taxonomy of design techniques can be used, which distinguishes the similarities and differences of design techniques (Liu et al., 2016). In addition, users can also benefit from the tags created by themselves (Golder and Huberman, 2006). Compared with taxonomy and tags, a more direct way to get suggestions of design techniques is to ask design experts. As there is a limitation of design experts in many companies (Bruun, 2010), a conversational agent for suggesting design techniques can be provided. As the suggestion of design techniques focuses on a specific domain, the conversational agent should be task-oriented, which provides desired information or helps users to complete the task (Chen et al., 2017). The conversation can be pre-defined based on different situations (Chen et al., 2017), which is used to estimate the goals of users according to the semantic representation during each turn of the conversation.

2.2 Related Work

Numerous studies attempt to find a solution to help with the selection of suitable design techniques for different design situations. For example, Fuge et al. (2014) provide a recommendation system to give advice on choosing appropriate methods for a particular project. In the study of Sanders et al. (2010), a framework was suggested to organize participatory design tools and techniques. Roschini et al. (2015) propose five key groups to classify the design thinking methods based on a common design process activity. Vermeeren et al. (2010) collect 96 user experience evaluation methods and identified six dimensions to categorize these methods. Liu et al. (2016) summarize the dimensions and characteristics of design techniques and proposed a taxonomy to give an overview and present the similarities and differences of design techniques.

From a practical perspective, there are web-based platforms with an objective of providing information about design techniques. For example, theDesignExchange explicitly articulates the objective of helping design participants to choose design techniques by providing five main categories. Under each main category, there are at least six sub-categories. And under each sub-category, there are more than three sub-sub-categories. However, for the purpose of supporting the selection process of design techniques, it is necessary to include a classification with a limited number of categories (Miller, 1956; Nickerson et al., 2013). ServiceDesignKIT includes a taxonomy with limited categories and combines with tags suggested by users (Liu et al., 2018). By using such platforms, users need to understand the meaning of the categories before using it, which may be challenging for design novices.

3 Research Method

We followed DSR methodology to identify design principles and implement the principles to develop an advisory platform by following Peffers et al. (2007). Figure 1 presents the overall DSR project. This research focuses on cycle 3 which is based on cycle 1 and 2.

![Figure 1. Overall DSR project adopted from Peffers et al. (2007)](image-url)
In cycle 1, in order to give an overview of design techniques and present the differences and similarities of design techniques, we rigorously developed a taxonomy by following a taxonomy development method (Nickerson et al., 2013). The developed taxonomy has five dimensions and 15 mutually exclusive and collectively exhaustive characteristics (Liu et al., 2016). As a taxonomy itself cannot be directly used to support the selection of design techniques, in cycle 2, a web-based platform which is based on the taxonomy for supporting the selection of design techniques was developed (Liu et al., 2018). Two design principles were proposed. One of them was to instantiate the taxonomy developed in cycle 1 and a tag cloud for collecting the categories created by the users. Another design principle was to enable users to add new techniques and save their favorite ones.

In cycle 3, after analyzing the problem in selecting and suggesting design techniques for different design situations, we derived four meta-requirements focusing on recommending and instructing the selection of design techniques. In order to address the meta-requirements, we proposed five refined design principles to address the meta-requirements focusing on suggesting and organizing design techniques. Among the five proposed design principles, two of them were adopted from cycle 2. Subsequently, design features that address the design principles were suggested and implemented, e.g., using a task-oriented conversational agent to suggest design techniques. The developed prototype was evaluated by in-depth interviews (Myers, 1997) and the system usability scale (SUS) questionnaire (Brooke, 1996).

4 Conceptualization

4.1 Problem Awareness & Meta-Requirements

The first meta-requirement (MR1) refers to offering users an organized design technique library with information on different dimensions and characteristics of design techniques. As the collection of design techniques is enriched by the absorption of techniques from other disciplines, the number of design techniques expands (Moritz, 2005). With a large number of design techniques, choosing the appropriate ones for a specific design situation is a challenge (Fuge et al., 2014; Sanders et al., 2010; Sharma et al., 2017). Design novices can ask experts for help, and the consultancy can give a customized and professional solution. However, consultancy service is costly. Alternatively, design novices can use a search engine with keywords to acquire design techniques, which has many weaknesses. The searching process by using keywords usually needs large amount of time and may result in low accuracy information because of the huge volume of information and irrelevance of keywords (Iqbal et al., 2017). People need to invest a lot of efforts to filter and synthesize the desired information. Moreover, as many firms and organizations have their own collections of design techniques and may use different names to describe the same design technique, confusion can be caused when searching for design techniques. As a clear overview of different design techniques with dimensions and characteristics can present the differences and similarities and narrow down the filtering scope, it is important to build a library for design techniques. This should enable users to distinguish and match design techniques with different design situations.

**MR1:** When users need to find design techniques, the system should be able to search them from a design technique library based on different dimensions and characteristics.

The second meta-requirement (MR2) refers to providing the recommendation of comparable and complementary design techniques. Comparable design techniques mean design techniques with similar design purposes (Jiang et al., 2008). When users find a suitable design technique, comparable design techniques can be recommended to help with further comparison and understanding of similar design techniques. In addition, the comparison of similar design techniques can lead to a better selection of the most suitable design techniques. Complementary design techniques are techniques that can be used for different purposes or constraints (Jiang et al., 2008). With comparable and complementary design techniques, a set of design techniques for a specific design situation can be built. For example, in the early stage of the design process, design techniques for idea generation can be used, whereas, before release, design techniques for measuring user behavior can be applied. Thus, comparable and complementary design techniques need to be suggested.
**MR2:** When users select a particular design technique, the system should recommend comparable and complementary design techniques.

The third meta-rerequirement (MR3) refers to reducing the cognitive effort of design novices when selecting design techniques. When comparing with design experts, design novices have a different cognitive process and viewpoints of design processes. For example, when designing a webpage, design novices who are given full described requirements spend less time on reviewing and decision-making than design novices who are given incomplete requirements (Bonnardel et al., 2003). A reason for this result is the lack of professional knowledge. A detailed and concrete description of design situations can help design novices in planning design activities. Furthermore, design novices are usually not motivated enough to invest much time in studying design knowledge or training design practices which is occasional or infrequent for them (Bonnardel et al., 2003). Thus, if the platform can help design novices in constructing and describing their requirements clearly, they will gain a deeper insight into the required design techniques. Therefore, step-to-step instructions for design novices during the selection process of design techniques need to be provided.

**MR3:** When users have less experience in design processes, the system should guide them in selecting design techniques step-to-step.

The fourth meta-rerequirement (MR4) refers to the customization of the suggested sets of design techniques. Personalization can influence the usage of the information system and the loyalty of users (Kim and Son, 2009). When working on a design project, different techniques are needed in different phases of the design process. People have their own preferred and frequently-used design techniques. If a group of techniques can be organized with the corresponding design project and recorded as search history, design novices can build their own technique sets. A user interface for each design novice to access the frequently-used techniques by saving them along with the suggestion history can be provided. This personalization feature allows the novices to tailor specific sets of design techniques for specific projects or design situations. Thus, spaces for saving suggested design techniques should be provided. In addition, users should be enabled to submit new design techniques or give advice to the existing design techniques in the system.

**MR4:** When users find appropriate techniques, the system should provide users a space to store the suggested results. Additionally, the system should allow users to submit new design techniques.

### 4.2 Design Principles

In order to address the derived meta-requirements, we suggest several design principles (DPs). The proposed design principles do not map one-to-one to the meta-requirements. A meta-requirement can be addressed by multiple design principles and vice versa.

We have identified that design techniques need to be selected based on their different characteristics and design situations (MR1). To address this meta-rerequirement, the system needs to provide insights into different characteristics of design techniques. As classifications can reduce the complexity and enable the systematical comparison of data, using classifications brings cognitive benefits (Gorlenko and Englefield, 2006; Parsons and Wand, 2008). Classification is widely used in information system development such as data management, objected-oriented system design, and ontological engineering (Parsons and Wand, 2008). The process of using classification is also a learning process, and it helps people to understand how information is organized and sought out (Roschuni et al., 2015). With a classification of design techniques, people can decide which design techniques are most relevant to a specific design situation (Sanders et al., 2010). The top-down taxonomy includes five dimensions which present the critical factors which influence the choice of digital service design techniques (Liu et al., 2016). Under each dimension, there are at least two mutually exclusive and collective exhaustive characteristics. With this taxonomy, novices can narrow down the scope of design techniques based on the design situation. Except for the top-down taxonomy, a bottom-up tag cloud is provided, which is proposed by design novices in the form of tags without a hierarchical structure. 72 design techniques are provided. The basic information (i.e., name, description, instruction, and reference) and the corresponding attributes (i.e., characteristics and dimensions in the top-down taxonomy as well as
bottom-up suggested tags) of techniques are stored in the database. The collection of techniques can be seen as a basic library for the application.

DP1: Provide the system with a top-down taxonomy and bottom-up suggested tags for users to select design techniques, given that users with the knowledge of different dimensions and characteristics of design techniques can select suitable design techniques appropriately.

The second meta-requirement describes that a set of design techniques may be required in specific design situations (MR2). Except for providing design novices classifications which enable them to search the technique based on dimensions and characteristics, the platform should recommend possible design techniques which design novices may need in the same or different design situation. In addition, some design techniques are always used together in design practices. These techniques may have similar characteristics or design purposes (Jiang et al., 2008). The relationship of design techniques is described by comparable and complementary design techniques (Jiang et al., 2008). The recommended comparable design techniques should have similar characteristics and purposes and can be used in the same design situation. Whereas, the complementary design techniques should have different characteristics and purposes and need to be used in different design situations. Therefore, the system should include a recommendation function.

DP2: Provide the system with a recommendation function for users to view and choose comparable and complementary design techniques, given that a set of design techniques for specific design situations can be built.

We have identified that the system should instruct design novices when selecting design techniques (MR3). As using natural language dialog is easy to understand and provides an intuitive way to access information, using a conversational agent is more interactive and effective for untrained users (Maes, 1994) when compared with using classifications with abstract dimensions and characteristics to select design techniques. The conversational agent plays a key role as digital assistants to help people when performing different tasks. It is already applied in many fields such as filtering information, retrieving information, managing emails, scheduling meetings, etc. (Maes, 1994). A conversational agent can bring design novices benefits by reducing the information overload and offering an intuitive insight into the problem (Sharma et al., 2017). With this intuitive conversation-like approach (i.e., a process of questions and answers), design novices will construct their needs clearer and have a look at the critical factors of choosing digital service design techniques (Carayannopoulos, 2018). Additionally, the conversational agent can be used to collect users’ inputs when users are communicating with the agent (Denecke et al., 2018). Moreover, the conversational agent offers a playful user interface which can engage users in the interaction (Allison, 2012). When comparing with consultancy, the conversational agent can provide 24 hours, seven days a week service (Allison, 2012). Thus, with a well-structured conversational agent, design novices can spend less effort when selecting design techniques.

DP3: Provide the system with a conversational agent for users to select design techniques with instruction, given that even if users are not familiar with the dimensions and characteristics in the taxonomy, they can find appropriate design techniques for a project in a specific design situation.

We have identified that the advisory platform should have an individual management user interface to record the preferred techniques and the suggestion history of the conversational agent (MR4). In a particular phase of a design process, the designer may use a set of specific design techniques. When users find some techniques which meet their objectives, they may consider saving the selected technique for retrieving. For example, we usually put some useful and frequently-visit websites into a favorite folder. In many web-based applications, the personal page is associated with improving the user experience (Dumais et al., 2014). Thus, we offer each user a favorite list to store the design techniques which they like. Besides, the suggestion history of design techniques by the conversational agent can be recorded in a timeline which includes the project information and the suggested design techniques. Users can view such information to track the suggestion history for specific design projects and design situations.
DP4: Provide the system with a personal page for users to store the suggested results, given that users can review the suggestion history and track the design techniques used for different design projects and design situations.

We have identified that the design novices should be encouraged to participate in design activities (MR4). As an emerging field, service design adopts techniques and knowledge from different disciplines, which enriches the design technique library for different design activities (Mager, 2009). People with different knowledge backgrounds should have the possibility to engage in digital service design practices. Some web-based applications are developed aiming to build a design community such as the web portal theDesignExchange focusing on sharing design knowledge and experiences (Roschuni et al., 2011). Thus, the advisory platform should provide the function enabling users to suggest new design techniques to the technique library. Because the technique library is constructed based on classifications, the user interface for suggesting new design techniques should not only include the input of basic information of a technique such as a name, description, and instruction, but also allow users to assign the appropriate dimensions, characteristics, and tags to each suggested design technique. This enables the system to directly associate a design technique with the classifications of the design technique library. However, the suggested techniques may be varied in content and quality, which influences the quality of the advisory platform, which can further impact the loyalty of users (Xu et al., 2011). Thus, the suggested design techniques should be at first stored in a temporary database which enables the administrator to review and edit the suggested design techniques. And then, the suggested techniques with high quality will be added into the technique library.

DP5: Provide the system with a submission function for users to suggest new design techniques with dimensions and characteristics to the technique library, given that the technique library can be enriched by collaborating the submissions from users.

The five design principles are proposed for addressing the derived meta-requirements. Table 1 presents a short summary of design principles and the associated meta-requirements.

<table>
<thead>
<tr>
<th>DPs</th>
<th>Description</th>
<th>Addressed MRs</th>
</tr>
</thead>
<tbody>
<tr>
<td>DP1</td>
<td>Provide the system with a top-down taxonomy and bottom-up suggested tags</td>
<td>MR1, MR3</td>
</tr>
<tr>
<td>DP2</td>
<td>Provide the system with a recommendation system to suggest comparable and complement techniques</td>
<td>MR2</td>
</tr>
<tr>
<td>DP3</td>
<td>Provide the system with a conversational agent for users to instruct the selection process of design techniques</td>
<td>MR3</td>
</tr>
<tr>
<td>DP4</td>
<td>Provide the system with a personal page to store the favorite design techniques and the suggestion history</td>
<td>MR4</td>
</tr>
<tr>
<td>DP5</td>
<td>Provide the system with a submission function for users to suggest new design techniques</td>
<td>MR4</td>
</tr>
</tbody>
</table>

Table 1. A summary of design principles and the addressed meta-requirements

4.3 Prototype Implementation

In order to develop a prototype of the system, design features (DFs) are provided based on the meta-requirements and design principles. Design features are specific capabilities of the system to satisfy design principles (Meth et al., 2015).

To satisfy DP1, a design technique card gallery with a filter can be used to visualize the classified design techniques. Each design technique is presented as a card which contains the technique name and an image. The filter is constructed based on the dimensions and characteristics of a taxonomy (Liu et al., 2016) and bottom-up suggested tags by design novices.

DF1: Use a card gallery to visually depict design techniques with the combination of taxonomy and tags to enable filtering

Figure 2 presents a screenshot of the advisory platform based on DF1. Design techniques are visualized as a set of cards (1 in Figure 2). Users can click on each design technique card to open a webpage which includes detailed information of the design technique. The characteristics under each dimension can be
selected exclusively, and all the five dimensions can be selected collectively (2 in Figure 2). On the right side, a tag cloud is depicted (3 in Figure 2), which includes bottom-up suggested tags from design novices. Users can also filter design techniques by using these tags. Every time the user changes the selected characteristics or tags, the cards gallery will be refreshed and show corresponding design technique cards. In order to instruct the selection process, the conversational agent (4 in Figure 2) shows up at the same position on each webpage. Details on the conversational agent are described in DF3.

Figure 2. A card gallery of design techniques with a filter

To satisfy DP2, a group of comparable and complementary design techniques for the user-selected one should be recommended to users. For example, if a user selects closed card sorting, techniques such as open card sorting will be recommended as comparable design techniques because of the high similarity of the characteristics between these two techniques.

**DF2: Recommend comparable and complementary design techniques for each selected design technique**

In order to recommend comparable and complementary design techniques to a user-selected design technique, the similarity between the user-selected design technique and the recommended design technique needs to be calculated. Because the basis for recommending is the taxonomy of design techniques which includes mutually exclusive and collective exhaustive characteristics under each dimension of design techniques (Liu et al., 2016) and each design technique is stored in the database with their own characteristics, we can adopt the overlap measure to calculate the similarity of two design techniques (Boriah et al., 2008).

\[
    r = \frac{n(t(j), t'(j))}{N} \quad \text{for } j=1...5 \quad (1)
\]

where \( r \) represents the similarity between two design techniques, \( t \) represents the user-selected design technique, \( t' \) represents the recommended design technique, \( j \) is the dimension of a design technique, \( n \) is the number of the same characteristics in the dimensions between the user-selected design technique and recommended design technique, \( N \) is the number of all dimensions in the taxonomy.

The value of the similarity \( r \) is between 0 to 1, in which 1 means two techniques have totally same characteristics, while 0 means the two techniques have no common characteristics. In order to recommend design techniques based on the similarity between the two techniques, we need to define a threshold of \( r \). With the consideration of the current amount of design techniques in the database, we recommend a technique as a comparable one when \( 0.6 \leq r \leq 1 \), which means the recommended design
technique and the selected one have at least three same characteristics. Whereas, when $0 \leq r \leq 0.2$, which means the technique will be recommended as a complementary technique to the selected one when they have no same characteristic or only one same characteristic.

To satisfy DP2 and DP3, a conversational agent is used to interact with users and guide them to find appropriated design techniques. The user interface is designed as a chat frame. Users can send a text to the conversational agent, then the agent answers with text or graphics.

**DF3: Embed a conversational agent in a chat frame in order to guide users to find appropriate design techniques for specific design situations**

Di Prospero et al. (2017) suggest an architecture framework for conversational agents. This architecture divides a conversational agent into four important components: user interface, application core, external data sources, and personality processing. The four components are applied to identify the architecture of the conversational agent (Figure 3). To make the access convenient and easy for users, the conversational agent interacts with users based on the browser as the user interface. To provide design novices appropriate design techniques, a technique library which includes the necessary information of techniques is associated as an external data source. The suggested techniques will be stored in the suggestion history for users to retrieve. The application core is the component which monitors and controls the conversation (Di Prospero et al., 2017). After the result of recommendation arrived, the application core visualizes the result and presents to users. In personality processing, the conversational agent matches the needs of users with the taxonomy of design techniques and the rules for recommending comparable and complementary design techniques to suggest suitable design techniques to users.

![Figure 3. The architecture of the conversational agent, based on Di Prospero et al. (2017)](image)

The conversational agent is developed for suggesting design techniques. In order to make sure the user requests match the database, a pre-defined conversation structure need to be applied in the task-oriented conversational agent to guide the process of conversation (Allison, 2012). The conversation should guide users to the topics that relevant to the suggestion of design techniques. The conversation logic is presented in Figure 4. The conversational agent can guide users step-by-step to the two main functions: searching or recommending design techniques. If a user chooses “Let me recommend,” the agent will at first ask the user several pre-defined questions on the user’ design situations, and then map the answers to the dimensions and characteristics in the taxonomy to calculate the similarities to recommend suitable design techniques.
Finally, to satisfy DP4 and DP5, a personal page should provide the function of saving a favorite list as well as the suggestion history from the conversational agent, and a form to submit new design techniques. These functions will be associated with a personal page including different panes which can be switched by using a navigation list.

**DF4:** Enable users to save favorite design techniques, to capture the history of suggested design techniques, and to submit new design techniques by providing a personal page

By clicking “My techniques” on the top right of the navigation bar (5 in Figure 2), the individual model will appear. The individual model includes three panes: a favorite list, suggestion history, and submission of new techniques. The favorite list stores the technique cards which are marked as liked by users. In the suggestion history, the suggested design techniques by the conversational agent are stored in a timeline, and grouped by projects with the project name, design situations. In the pane of submission of new techniques, there is a form which enables users to submit new design techniques to the system for enriching the database.

Table 2 presents a short summary of design features and addressed design principles.

<table>
<thead>
<tr>
<th>DFs</th>
<th>Description</th>
<th>Addressed DPs</th>
</tr>
</thead>
<tbody>
<tr>
<td>DF1</td>
<td>A card gallery of design techniques with taxonomy and tags to enable filtering</td>
<td>DP1</td>
</tr>
<tr>
<td>DF2</td>
<td>Recommend comparable and complementary design techniques for each selected design technique</td>
<td>DP2</td>
</tr>
<tr>
<td>DF3</td>
<td>A conversational agent to guide users to find appropriate design techniques</td>
<td>DP2, DP3</td>
</tr>
<tr>
<td>DF4</td>
<td>A personal page to save favorite design techniques, to capture the history of suggested design techniques, and to enable the submission of new design techniques</td>
<td>DP4, DP5</td>
</tr>
</tbody>
</table>

Table 2. A summary of design features and addressed design principles

### 5 Evaluation

To evaluate the design principles and the instantiated advisory platform, we combined a semi-structured interview (Myers, 1997) with a SUS questionnaire (Brooke, 1996). The semi-structured interview focuses on collecting in-depth feedback from the participants. The SUS questionnaire seeks to measure the perceived usability with a ten-item scale (Brooke, 1996). The five-point scale ranging from “strongly agree” to “strongly disagree” was used (Brooke, 1996). Each participant was asked to rate the ten statements (i.e., items). In the analysis, the SUS questionnaire yields a single number ranging from 0 to 100 (Brooke, 1996). Eight students with education background of information systems are invited to take part in the evaluation. The students were recruited from the attendees of a colloquium which we presented the basic function of the advisory platform. We asked the attendees whether they were interested in the advisory platform and whether they could participate in the evaluation. We set up an appointment with each of them who agreed to participate in the evaluation. The evaluation then started a week after the colloquium. The eight participants included three females and five males with age range from 24 to 30. Three were doctoral students, three were bachelor students, and the other two were master
students. Two of them evaluated themselves as experts in the digital service design field, and six of them evaluated themselves as novices in this field. The participants were considered as an appropriate target group for this evaluation as they could be potential users of our advisory platform.

Figure 5 presents the evaluation (first four steps) and analysis approach (the last step). Each of the participants of the evaluation went through the first four steps in Figure 5. At first, we gave each participant the same task. Here was the task scenario: “please imagine you were a developer in a company which runs a supermarket. Recently, your company decided to build an online shop. In order to provide customer satisfied services, you were assigned to conduct user research in a short-term period.” The participants were told to select design techniques based on this task scenario and save the favorite ones by using the taxonomy and tags (DF1), the recommendation list (DF2), the conversational agent (DF3), and the individual page (DF4). After introducing the task scenario, the participant started to use the advisory platform.

![Figure 5](Image)

**Figure 5. Evaluation and analysis approach**

After completing the task, we at first gave each participant a questionnaire with SUS questions and demographic questions. Subsequently, we interviewed them about their feedback on the system. The interview questions were designed based on the provided design features of the advisory platform. Some of the questions were pre-defined for appreciative and laddering interview (Schultze and Avital, 2011). Each participant used 20-30 minutes for the task, questionnaire, and interview. Each interview lasted about 10-20 minutes and was conducted face-to-face. All interviews were recorded and transcribed for the analysis. The interview transcript was analyzed by using QDA Miner which is a qualitative data analysis tool to achieve reliable coding of sentences or paragraphs. In order to match the feedback with the design features and evaluate each design feature, we used open coding to analyze the transcript of the interviews (Myers, 1997). Table 3 presents two examples of our coding approach.

<table>
<thead>
<tr>
<th>Design Feature</th>
<th>Coding</th>
<th>Quote</th>
</tr>
</thead>
<tbody>
<tr>
<td>DF3: Conversational agent</td>
<td>Structured decision making</td>
<td>“He can advise user, it helps me with finding and structuring my decision making. [...] the structure of the question helps me to categorize and know what do I really want in the situation.” (P2)</td>
</tr>
<tr>
<td></td>
<td>Don’t require expertise</td>
<td>“It really helps me, it is very quick, you have just a few questions and you can answer even you don’t have any background knowledge.” (P6)</td>
</tr>
</tbody>
</table>

**Table 3. Examples of analyzing the interview transcript**

The analysis of the SUS results from the eight participants of the evaluation presented that the average SUS score of the system was 75.31 (SD = 10.11). A product is passable when the SUS score is above 70 (Bangor et al., 2008). Furthermore, existing studies show that the total average SUS score of the web-based application is 68.2 (Bangor et al., 2009). Thus, the advisory platform is in the acceptable range. In general, our advisory platform seems to be evaluated positively with regard to usability.

In the semi-structured interviews, the evaluation result demonstrated that there was both positive and negative feedback. Furthermore, some possibilities for optimization were also suggested. Table 4 presents a short summary of the evaluation along the four key design features. As the participants were allowed to mention more than one positive and negative point or no feedback to each design feature, the percentage numbers in Table 4 don’t total to 100%.

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<table>
<thead>
<tr>
<th>DFs</th>
<th>Positive feedback</th>
<th>Negative feedback</th>
<th>Suggested improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>DF1: card gallery</td>
<td>• Efficient to select (50.0%)</td>
<td>• Require understanding of categories (87.5%)</td>
<td>• Introduction and instruction video (12.5%)</td>
</tr>
<tr>
<td></td>
<td>• Easy to understand (25.0%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DF2: technique</td>
<td>• The recommendation is inspiring (62.5%)</td>
<td>• Not quite sure about the meaning (25.0%)</td>
<td>• The recommendation should be more visible (25.0%)</td>
</tr>
<tr>
<td>recommendation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DF3: conversational</td>
<td>• Structured decision making (62.5%)</td>
<td>• More serious (12.5%)</td>
<td>• Offer using examples (37.5%)</td>
</tr>
<tr>
<td>agent</td>
<td>• Don’t require expertise (62.5%)</td>
<td>• More annoying (25.0%)</td>
<td>• Reduce the number of suggestion (25.0%)</td>
</tr>
<tr>
<td>DF4: personal page</td>
<td>• Techniques associated with projects (25.0%)</td>
<td>• Need evaluation of new added techniques (37.5%)</td>
<td>• Export the suggestion result (12.5%)</td>
</tr>
<tr>
<td></td>
<td>• Convenient to use (87.5%)</td>
<td>• Need checking the existence of suggested techniques (25.0%)</td>
<td>• Add comment section (37.5%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Share with group members (12.5%)</td>
</tr>
</tbody>
</table>

Table 4. A summary of evaluation with the percentage of interviewees mentioning each point.

All of the interviewees expressed their willingness to use this application in the future because the platform provided “a collection of different kinds of techniques” (P7). P2 and P3 told us that they haven’t seen other similar tools. P1 said it was useful because it really helped him to find design techniques. Half of the participants pointed out that the platform was well designed.

The evaluation of DF1 presented that the card gallery of design techniques with the taxonomy and tags was efficient for people to search design techniques, but the dimensions and characteristics of the taxonomy were considered to be not easy to understand. Here are some quotes from the interviews. P2 gave us positive feedback “I think it is useful. [...] I can just click the options.” For supporting the understanding of the content of the taxonomy, P5 suggested: “It will be also nice to have an explanation of what are the categories, and what is the difference between characteristics.”

The evaluation of DF2 presented that the recommendation of comparable and complementary design techniques gave participants a lot of inspirations. But the term comparable and complementary required explanation. For example, P7 mentioned the merit, “The complementary can give me inspiration maybe I will know it forward what kind of techniques I will use in the future.” But P8 mentioned the unclear explanation of the term complementary technique “I am not quite sure about what is the use case of complementary technique.”

The evaluation of DF3 presented that the conversational agent was well received by the participants because it could help with structuring the decision-making process which was easy to understand. But there was still room for improvement. The conversation agent could be more intelligent. The positive feedback includes: “it doesn’t require any expertise” (P5); “It can help. Especially the agent, [...] it helps me with finding and structuring my decision-making” (P7). P7 also mentioned the improvement, “maybe some general question that I can ask him like not only about the conditions, like if I have some keywords that I want to ask him. He should be a little more intelligent.” Further suggestions mentioned by P2 and P6 included reducing the number of the suggested design techniques and providing examples of using the design techniques.

The evaluation of DF4 presented that the personal page was considered to be useful because participants could store and organize design techniques with specific projects. Some improvements were also mentioned, for example, providing a comment section for each selected technique, enabling the sharing of favorite design techniques, and checking the existence of the suggested design techniques in the database. Here are some representative quotes. P7 mentioned the advantages, “I think it is very good. I can see what techniques I have viewed before and I liked.” The mentioned improvements are as follows. P7 suggested, “there may be some functions like I can make some notes on each technique here. Add some comments to each technique.” P6 mentioned, “my suggestion is maybe you can add a different project with different techniques.” P5 suggested checking if the suggested techniques were already existing in the database. P1 talked about the sharing function, “like sharing social network, or at least team working, some people can be added to this group, and people in this group can share examples.”
Discussion
In this research, an AI-based advisory platform for suggesting design techniques is presented. The proposed design principles contribute to design knowledge theoretically by guiding the development of a class of advisory systems with the specific purpose of suggesting design techniques (Gregor, 2006). The advisory platform uses a taxonomy and tags as a basis for suggesting design techniques, which contributes to the theoretical understanding of instantiating the taxonomy and tags for supporting the selection of design techniques. Compared with the design principles in design cycle 2, newly added design principles such as the conversational agent received positive feedback in the evaluation. Thus, our research extends existing solutions to solve the problem of suggesting appropriate design techniques for specific design situations. In addition, the implementation of a conversational agent is an attempt to use the task-oriented conversation in the suggestion of design techniques. The advisory platform also has practical contributions. First, our platform is a useful tool for design novices to select suitable design techniques for different design situations. The design technique library enables users to have an overview of design techniques and select design techniques. For each user-selected design technique, comparable and complementary design techniques are recommended, which gives users inspirations in finding a group of design techniques for a specific project. In addition, the task-oriented conversational agent is provided to help design novices with limited background knowledge to select design techniques step-by-step. After using the advisory platform several times, design novices can have some impressions on the situations that need to be considered when selecting design techniques. Furthermore, the platform provides users with an individual page that allow users to manage their personal design technique sets.

There are also limitations which need further research. The implementation of the AI-based conversational agent for addressing design principles is an attempt to instantiate the taxonomy and tags by using natural language dialog, which received positive feedback in the evaluation. But the feedback was based on the usability which did not reflect the actual performance of selection by using the conversational agent. It is obvious that the natural language-based conversation is easier to understand than the abstract terms in the hierarchy. However, the process of suggesting design techniques by using a conversational agent is not as transparent as using a taxonomy. Because when using a conversation agent, the suggested design techniques will appear at the end of the conversation. Whereas, when using a taxonomy, the design techniques included by different categories will appear step-by-step by choosing one category after another. In the future research, a comparison between using a taxonomy and a conversational agent can be conducted, which will also compare the differences between the advisory platform in design cycle 3 and the web-based platform in design cycle 2. Moreover, the instantiation of suggesting complementary and comparable techniques is still at an early stage. The suggested design techniques are based on the similarities and differences of the dimensions and characteristics in the taxonomy, which need further test on whether the suggested design techniques are related to each other. Another future research direction is to analyze whether the gap between experts and novices can be narrowed. The proposed advisory platform includes taxonomy and tags, which is an initial attempt to combine the categorizes of design techniques from both experts’ and novices’ perspectives. Further analysis of reducing the gap between experts and novices can be conducted.

Conclusion
In this research, we first analyzed the motivation and background of supporting design novices to select design techniques. By using the DSR approach, four meta-requirements were derived, and five design principles to address the meta-requirements were proposed. In order to satisfy design principles, four design features were provided and implemented in an AI-based advisory platform. We evaluated the platform based on the design features and identified several areas of improvements. With this study, we contribute theoretically by identifying design knowledge for the development of advanced advisory platforms which support the selection of design technique. From a practical point of view, we contribute by helping design novices in the practice with our AI-based advisory platform in the selection process of suitable design techniques.
References


