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Situation awareness for recommender systems

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Place, date

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Signature

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IS Information system

1 Summary of the given task

Within the scope of the lecture "Management Research" of the 1st semester of the M. Sc. IT Management berufintegrierend in the summer semester 2019 the students have to analyse one research paper according to the guidelines of Hevner et al. (2004).

Hevner et al. describe the design science research as a paradigm in the field of information systems and defined seven guidelines (see chapter 3) which need to be considered in the design science approach.

The article is checked systematically after each guideline (Figure 1).

Table 1. Design-Science Research Guidelines	
Guideline	Description
Guideline 1: Design as an Artifact	Design-science research must produce a viable artifact in the form of a construct, a model, a method, or an instantiation.
Guideline 2: Problem Relevance	The objective of design-science research is to develop technology-based solutions to important and relevant business problems.
Guideline 3: Design Evaluation	The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods.
Guideline 4: Research Contributions	Effective design-science research must provide clear and verifiable contributions in the areas of the design artifact, design foundations, and/or design methodologies.
Guideline 5: Research Rigor	Design-science research relies upon the application of rigorous methods in both the construction and evaluation of the design artifact.
Guideline 6: Design as a Search Process	The search for an effective artifact requires utilizing available means to reach desired ends while satisfying laws in the problem environment.
Guideline 7: Communication of Research	Design-science research must be presented effectively both to technology-oriented as well as management-oriented audiences.

Source: Hevner et al. (2004, p. 83)

Figure 1: Design-Science research guidelines

The objective of this work is to investigate the chosen article on the compliance of these guidelines. First, the content of the article will be summarized and the theory of design science research explained. Based on this, the article will be checked according to the design science guidelines. Finally, the implementation of the article will be rated by the authors of this paper.

The students have the free choice between an A to D ranked article at <https://vhbonline.org/> of the department business informatics. The following analysis deals with the paper "Situation awareness for recommender systems" published in the year 2018.

2 Summary of the research project

The authors deal with a recommender system, which automatically makes a recommendation depending on the current situation. As an example, they create a system which suggests suitable music depending on the current situation of the user. Different contextual dimensions are combined to an overall situation. A context is for example movement, hearth rate, place and the weather (Richthammer et al., 2018, S. 9). For example, an increased heart rate on a monday morning at work may mean that you are preparing for an important presentation and want to listen to relaxing music (Richthammer et al., 2018, S. 2). In the course of this paper, a prototype app for android smartphones was created that has exactly these features (Richthammer et al., 2018, S. 14).

With previous comparable systems, such as Spotify, an explicit mood in order to hear a corresponding playlist has to been chosen. In contrast to the current situation, the proposed approach automatically recommends music (Richthammer et al., 2018, S. 5).

The paper is divided into 7 chapters:

1. Introduction → A brief overview of why the authors will deal with the topic is shown.
2. Background and related work → This chapter presents the current state of research as well as work already implemented.
3. Situation-aware recommender systems → A framework for the creation of an app is developed, adapted scientific publications.
4. Music recommender system for everyday situations → The procedure of a survey, the contexts as well as their weighting for the determination of a situation are explained.
5. Implementation → The technical implementation of the app is described here.
6. Evaluation → The evaluation will take a closer look at the study design and the results.
7. Conclusion → In the last chapter, the authors take a critical look at the procedure.

During the course of the paper, a prototypical model is developed based on a generic model. From this, a study is then used to deduce that respondents are 16% more satisfied with a situation-based solution than without taking the situation into account (Richthammer et al., 2018, S. 2).

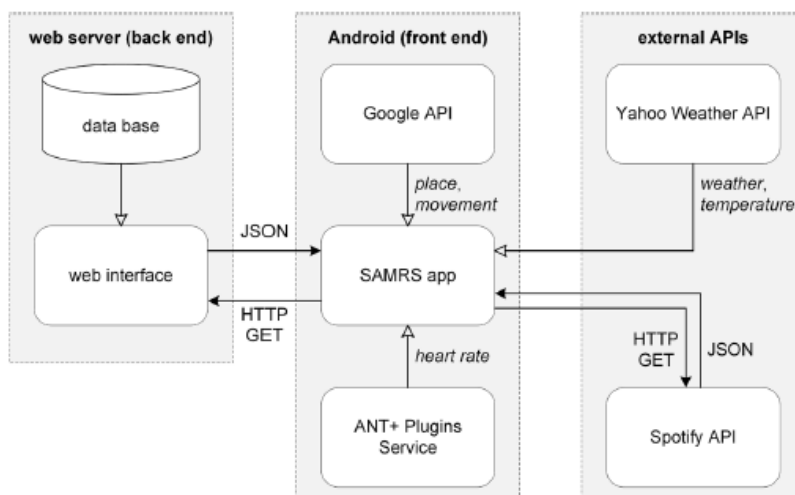
3 Description and evaluation of the presented work according to the guidelines of Hevner et al.

Subsequent chapters describe the article “Situation awareness for recommender systems” based on each of the seven guidelines according to Hevner et al..

3.1 Design as an Artifact

Hevner et al. (2004, pp. 82-83) describe design as an artifact as follows: The “[d]esign-science research must produce a viable artifact in the form of a construct, a model, a method, or an instantiation” and it must be an “[...] innovative, purposeful [...] artifact for a specific problem domain [...].”

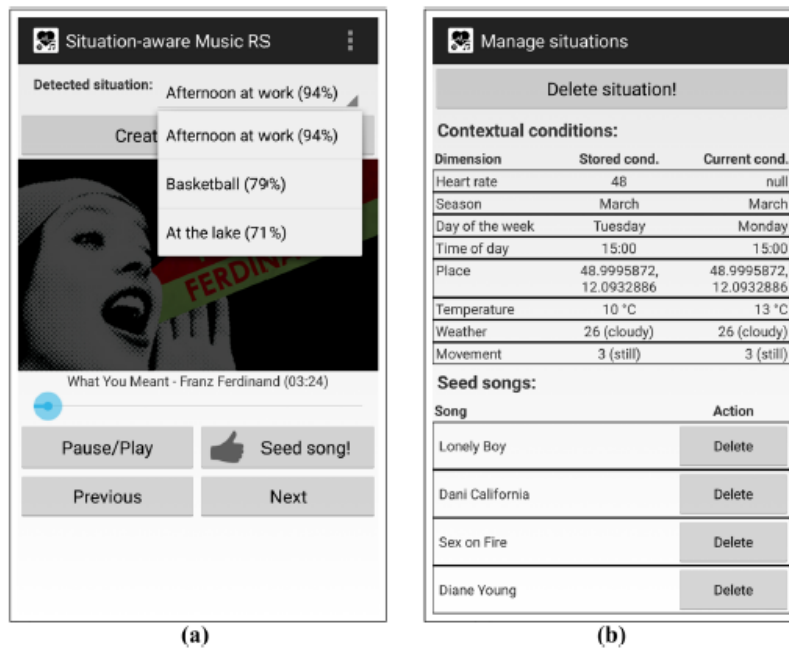
The artifact that emerged from the article is a prototypical app that recommends suitable music depending on the situation. An already existing situation awareness theoretical model was adapted to be suitable for situations (Richthammer et al., 2018, S. 6). From this, the authors have derived a UML activity diagram. Using logical explanations, the authors designed an architecture that takes into account many of the contexts mentioned (Figure 2):



Source: Richthammer et al. (2018, S. 15)

Figure 2: Architecture of the situation-aware music recommender system

After everything was created correctly and the contexts were weighted by mathematical formulas, the authors were able to implement an app, which finally also represents the artifact of the article (Figure 3):



Source: Richthammer et al. (2018, S. 16)

Figure 3: Screenshots of the prototypical software application. a) Music player with situation selection. b) Management of situations

It is an innovative artifact, since such a prototype does not yet exist after research of the authors (Richthammer et al., 2018, S. 3-5). According to the authors, machine-driven decisions are becoming more and more present today (Richthammer et al., 2018, S. 4), which is the reason why they choose this topic. The exact relevance of the problem will be discussed in more detail in the next subchapter.

3.2 Problem Relevance

The project has "[...] to develop technology-based solutions to important and relevant business problems" (Hevner et al., 2004, p. 83). Hevner et al. describe two problem situations, one is the difference between the goal status and the current status, the other as a search process to perform actions to reduce or eliminate the differences (Hevner et al., 2004, p. 85).

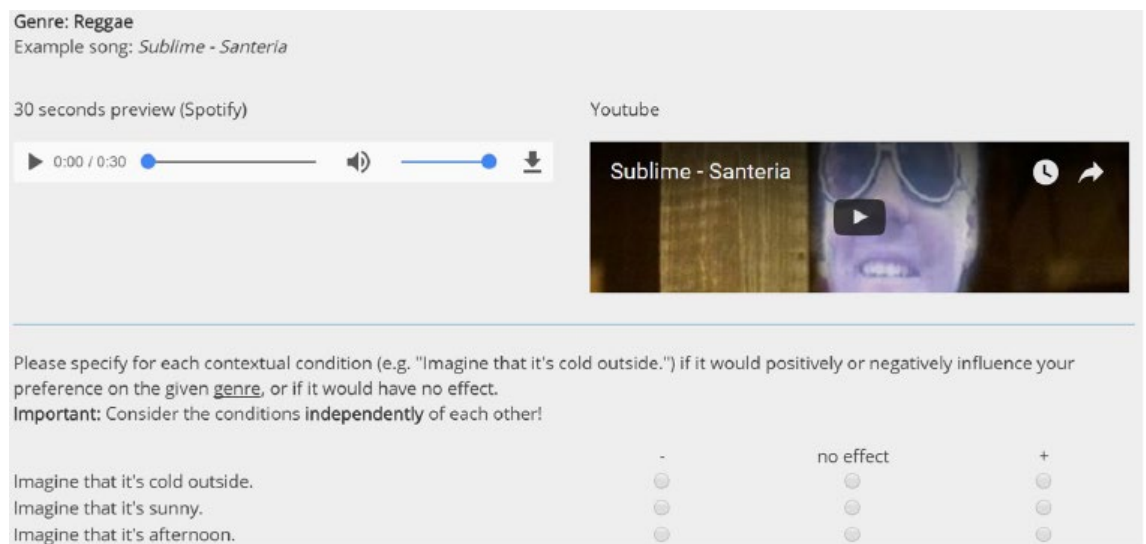
The authors argue that, as a result of technological progress, machines are increasingly making decisions autonomously (Richthammer et al., 2018, S. 4). Previous mechanisms require input from the respective user in order to be able to suggest something to him. In addition, these mechanisms only use a certain context and not several contexts (Richthammer et al., 2018, S. 2). A generic recommender system does not yet exist in this respect. It can be said with certainty

that if such a technology comes onto the market, the demand from the providers will be enormous. As an example, this was shown with a music app, but the advertising industry, for example, would generate a lot of profit if it could play out situation-related advertising per user.

3.3 Design Evaluation

The guideline design evaluation needs to show the “[...] utility, quality, and efficacy of a design artifact and must be rigorously demonstrated via well executed evaluation methods” (Hevner et al., 2004, p. 83). Methods of design evaluation are observational, analytical, experimental, testing and descriptive (Hevner et al., 2004, p. 86).

A prototype was created, which shows the implementability of the created architecture. The authors use the prototype to show its usefulness in the form of qualitative information. To show that a situational recommender system increases satisfaction, two surveys were created. The first survey aims to give weight to different contexts such as time, movement, temperature or heartbeat. A piece of music was played to the participants. The 158 participants now had to decide whether the situation had a positive or negative influence on the music title (Figure 4).



Source: Richthammer et al. (2018, S. 10)

Figure 4: Web survey to determine the practical relevance of different contextual dimensions

A number of mathematical functions were then used to calculate a numerical weighting for each context.

In the second survey, 25 situations were suggested to the participants from which they could choose five that they could most easily mentally adapt to (Richthammer et al., 2018, S. 19). The

participants were then asked to select two to six songs that they could imagine listening to the most in each situation. The songs were freely selectable.

In the subsequent evaluation phase, 35 participants were played random songs per situation, which were to be evaluated. 32 participants were suggested songs similar to those they had selected before. They also had to be evaluated.

According to the Mann-Whitney-U-Test, the t-test shows that the group's evaluations, which were based on situation-related suggestions, are 16% higher than those of the control group.

The survey was conducted in a comprehensible manner and the evaluation methods are also very accurate.

3.4 Research Contribution

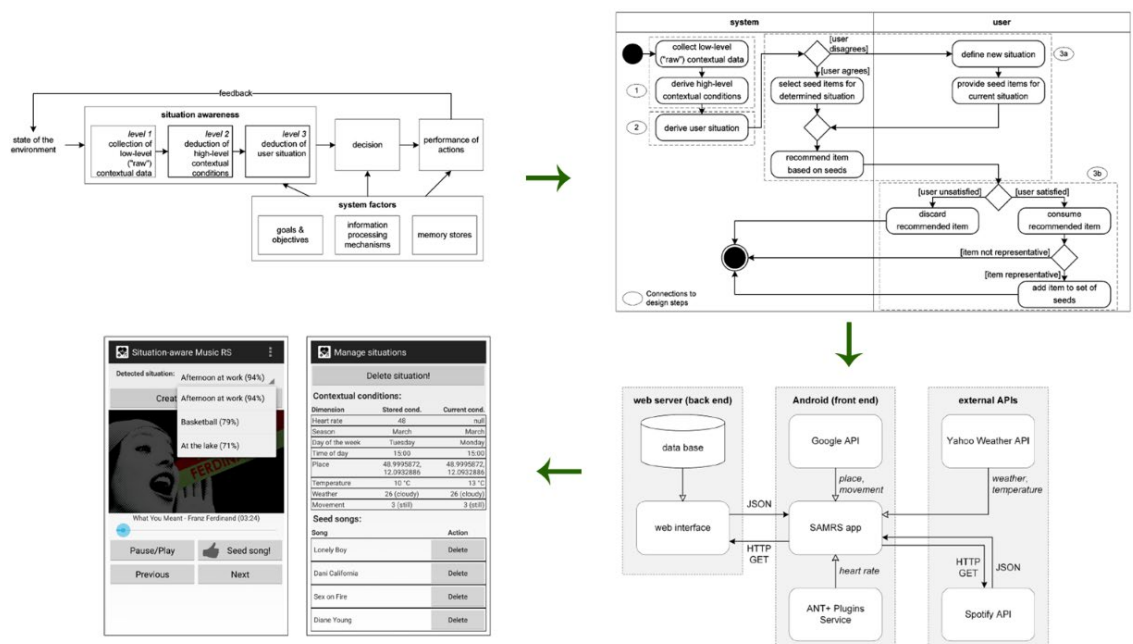
In this guideline step there must be an effective design-science research and the project “[...] must provide clear and verifiable contributions in the areas of the design artifact, design foundations, and/or design methodologies” (Hevner et al., 2004, p. 83). There are three types of research contribution, according to Hevner et al., which are the “design artifact” (solution for unsolved issues, using knowledge or existing data base in new and innovative ways and produce significant value to the IS community) , “foundations” (creative development that extend/improve the existing foundations) and “methodologies” (creative development and use of evaluation methods and new evaluation metrics provide design-science research contributions) in a research project (Hevner et al., 2004, p. 87). “One or more of these contributions must be found in a given research project” (Hevner et al., 2004, p. 87). Following are the contributions of the research project:

- Design Artifact: A situation aware recommender system does not exist but is desirable for many industries. In addition, they combine basic research also from other authors to implement a prototype.
- Foundations: By proving that a situation-based recommender system generates greater satisfaction, the authors have broadened the foundations clearly.
- Methodologies: No unique method was used that could be identified. The usual quantitative and statistical analyses were used.

3.5 Research Rigor

The main part of this guideline step is that “[...] design-science research relies upon the application of rigorous methods in both the construction and evaluation of the design artifact” (Hevner et al., 2004, p. 83).

Also, Hevner et al. claim that research must show a certain stringency (Hevner et al., 2004, p. 83). The search for existing concepts, models and literature is indispensable for successful research projects. In the construction of the design artifact, the authors first highlight the differences to conventional recommender systems and fall back on definitions of different authors (Richthammer et al., 2018, S. 3-5). For a first model, the authors adapt a draft of a veritable source. In the adaptation, they incorporate their own findings from basic research (Richthammer et al., 2018, S. 6). From other sources they then develop a UML activity diagram, which contains the view of human and machine. From the UML diagram, a suitable information technology architecture was designed.



Source: Own presentation according to Richthammer et al. (2018)

Figure 5: Evolution from an adapted model, over an UML diagram, over an IS architecture to a prototype

When selecting relevant contexts such as weather, movement and time, the authors rely on various sources but select, in their opinion, the relevant ones from them. The result of the weighting of the contexts and the UML diagram elaborated are transformed into a usable prototype.

For the evaluation of the prototype, i.e. the design artifact, a survey was carried out with a control group. A stringency can be observed with regard to the statistical evaluation. The authors describe in detail which method they used and why.

In summary it can be stated that both the construction of the design artifact and the subsequent evaluation follow an unambiguous stringency.

3.6 Design as a Search Process

“The search of an effective artifact requires utilizing available means to reach desired ends while satisfying laws in the problem environment” (Hevner et al., 2004, p. 83). This guideline should find an effective solution to the issue (e.g. as an iterative process) and “[e]ffective design requires knowledge of both the application domain [...] and the solution domain [...]” (Hevner et al., 2004, p. 88).

In the paper, the theories and objectives were not changed during the research process. An iteration and change did not take place. Instead, the research project was performed linearly.

3.7 Communication of Research

This guideline checks how the results of the project have been communicated. The authors have published the article in the journal "Electronic Commerce Research". Furthermore, it can be viewed online in various research portals. It is not clear from the article whether a discussion or lectures have taken place at scientific events.

Moreover, the research was funded by the Bavarian State Ministry of Education, Science and the Arts within the FORSEC research group (Richthammer et al., 2018, S. 22). It can therefore assume that the results have been communicated to the Ministry of Education.

It can be said that the project is very technical and less managerial. This is supported on the one hand by the implementation of an app, on the other hand by the mathematical weighting of the contextual dimensions and the statistical evaluation of the survey.

4 Overall evaluation of the research approach

After analyzing the article systematically, it can be stated that the two authors followed the guidelines of Hevner et al. very closely. In particular, the guidelines "Design as an Artifact", "Design evaluation" and "Research Rigor" were followed very strong. There is a clear stringency that makes it simple to understand why and how this step or method is applied. Each chapter successively expands the construction of the design artifact. At the end, there is an evaluation of the project by suitable and appropriate methods.

Guideline	Description	Article
Design as an Artifact	Innovative and viable artifact (construct, model, method, installation)	A situation aware recommender system was created
Problem relevance	Develop technology-based solutions to important and relevant business problems	Machines decide more and more autonomously, which is why it is important to let them make a situation-aware decision
Design evaluation	Utility, quality, and efficacy of a design artifact and this must be rigorously demonstrated via well executed evaluations methods	A quantitative analysis with a control group were made
Research contribution	Effective design-science research; three types of research contribution	Design Artifact: It is desirable, moreover it produces a significant value to the IS community Foundations: they have proven that such a system makes more satisfied, so it has expanded the foundations of research Methodologies: No unique method but well estimated were used
Research rigor	Design-science research relies upon the application of rigorous methods in both the construction and evaluation of the design artifact, show a certain stringency	Each chapter expands the construction of the design artifact. In the final part, a survey is conducted on the suitability of the design artifact.
Design as a search process	Find an effective solution to the issue	No change in the research question occurred during the project. An iterative process did not take place
Communication of research	Presented effectively both to technology- /management-oriented	The article was published in a veritable journal. Furthermore, the results were handed over to the Bavarian Ministry. The article is very technical due to its circumstances, but the technology itself is also very interesting from a management point of view.

Table 1: Overall evaluation of the individual guidelines

List of references

Hevner, A., March, S., Park, J., & Ram, S. (2004, March). Design Science in information systems research. *MIS Quarterly*, pp. 75-105.

Richthammer, C., & Pernul, G. (2018, October 24). Situation awareness for recommender systems. *Electronic Commerce Research*, pp. 1-24.