User Requirements and Design Guidelines for Digital Restaurant Menus

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ABSTRACT

Digital media have reached the domain of gastronomy, starting with printed restaurant menus being replaced by digital menus. While these allow for enriching a guest's stay in a restaurant, there is risk that the additional information offer might also overwhelm the guest. In this paper we present three studies on design aspects of digital restaurant menus. We conducted an online survey concerning guests' perceptions of paper-based menus and their expectations to digital menus. We conducted semi-structured interviews with employees of a restaurant to learn about their views and requirements and discussed with an owner of a fine dining restaurant potential uses of a digital menu. Subsequently, we built a prototype and evaluated it with a specific target audience. This study provided us with additional insights into user interface (UI) aspects. From our findings we distilled and contribute guidelines for designing digital restaurant menus.

Author Keywords

Digital restaurant menu; design guidelines; user requirements.

ACM Classification Keywords

H.5.2. User Interfaces: User-centered design, Evaluation; H.4.2. Types of Systems: Decision support

General Terms

Human Factors; Design.

INTRODUCTION

Restaurant menus have a long history: from paper-based menus in Ancient Rome to current digital applications for example on tablets or as projected surfaces. Their main function has always been to provide guests with an overview of available dishes and support their decision-making by presenting further information about these. Over time menus have not changed very much. They always consisted of dishes, often grouped by type or course; ingredients; prices; and sometimes pictures. However, the ongoing transition from printed to digital menus has introduced new options: Besides enriching the menu with multimedia content (e.g. video) and

adding further information (e.g. nutrition-related), personalization also became possible. One example for this is displaying health symbols for children [22]. Another one is the integration of a recommender system that shows only menu items that are really healthy or suitable for the guest, or arranging them according to the likes and dislikes of the guest. In the area of recipe and food recommendation much work has already been done (e.g. [3, 7, 8, 23]) that can also be integrated into digital restaurant menus. From the designer's or programmer's perspective, many different options are theoretically possible, but it is unclear which of them should be integrated into such a menu, as no systematic analysis was conducted beforehand that shows what restaurant guests would like to use and what employees or owners of restaurants need. Moreover, it is unclear whether such a digital version would be accepted as an alternative to the paper-based menu. For this aspect it would also be advantageous to know which problems it might have.

Some vendors have deployed digital restaurant menus using different form factors. Two examples are the *E-Table*[1] and the *eMenu*[2]. The former system can be used either on a table (with a projector mounted on the ceiling) or with portable devices (touch monitor). The latter is available for tablets, touch monitors at the table, or larger displays, typically found in waiting areas. Both systems enable features such as direct ordering (i.e. ordering without calling a waiter) or visualizing dishes with pictures. Although there are already commercial applications available in the field, this domain has not yet been thoroughly investigated from a scientific perspective.

Overall, several questions concerning digital menus remain unanswered, for instance: *Is a digital menu an alternative for guests? What is a proper form factor and technology (e.g. smartphones vs. touch monitors vs. tabletops vs. tablets)? Which pieces of additional information are not only possible but also worthwhile to show on a digital menu? Do digital menus introduce a drawback due to loss of communication?*

This paper analyzes stakeholders' needs and contributes design guidelines for digital menus. We distill them from three studies: First, we analyzed expectations of restaurant guests collected through an online survey to explore various design options. By not limiting the questions to a specific restaurant context we received an overview of this topic. Second, we conducted interviews with restaurant employees and discussed the topic with an innkeeper of a fine dining restaurant.

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[1]`http://www.e-table-interactive.com`, accessed 07/30/12
[2]`http://www.emenu-international.com`, accessed 07/30/12

These stakeholders are confronted with the system every day and can provide experts' insights. Third, we built a tablet-based prototype of a digital restaurant menu to evaluate open design options. Based on these three studies we distill guidelines for the design of digital restaurant menus, both from guests' and restaurants' perspectives.

RELATED WORK

Certain aspects of additional information that might be integrated into a restaurant menu have already been investigated, for example, the impact of nutrition information on the choice of dishes. Larson and Story [13] reason that most consumers (U.S.) would like to see nutrition information when they go out to eat. They emphasize that at least in the U.S., restaurants do not often provide this information. They also state that including this information alters the decision process, in that items with high calories or fat are less often purchased. On the contrary, there is evidence that this information might not be interesting for people in general: Sproul et al. [21] investigated the impact of nutrition labeling in an army cafeteria and reason that providing such information would have no impact. Their participants reported that taste and quality are more important in choosing dishes. Josiam and Foster [10] found that available nutrition information would more often be used by women, and in general seemed to be more interesting for older people. The authors provided an overview about different nutrition information that was reported as useful, and stated that this information should be included in a menu, but do not address how to avoid information overload. Further, Roberto et al. [20] indicate that nutrition information will not be noticed if not displayed prominently and therefore should be integrated into the menus directly. This research suggests that more information should be placed on the menu, but there is no general best way of presenting it due to personal differences. Since there is no optimal solution, this is not possible with printed menus; thus digital menus are required for adapting the menu to different circumstances. This is what our work investigates.

The HCI community began to investigate digital restaurant menus recently and only a few results are available so far. All created prototypes make the main functions (as stated before) of paper-based menus available. Igelmund et al. [9] present a digital menu on a tabletop for two guests to use at the same time. They implemented a recommendation feature for groups of people; i.e. the system recommends a suitable wine for peoples' individually chosen dishes. Additionally, their system allows to bookmark and compare menu items. An evaluation with twelve students indicates that these features in particular are perceived as useful. Chen et al. [6] tried to find design methods for interactive surfaces in restaurant environments. The authors conduct interviews with restaurant owners and found that they do not want to replace labor with technology, as they regard the contact between the staff and the guest as important. Chen et al. deploy a tabletop system (*Mojo iCuisine*) in a restaurant in Taiwan. Supplementary interviews and the review of blog posts of the restaurant's web page have shown that such an innovation is, at least in Taiwan, perceived as interesting and has positive commercial effects (as reported by the owner). Wallbank [24] presents a mobile

system focussing on privacy and personalization, including recommendation of menu items. The user can provide personal information about his eating habits and can rate menu items. This information is stored on users' smartphones and never exchanged with the restaurant. A small-scaled evaluation shows that the participants perceived the recommendation as the most useful feature and that the majority of the participants thought that a digital menu should not only replace a paper-based menu but introduce novel features. Aslan et al. [2] present a multilingual digital restaurant menu that allows the users to formulate multimodal queries (via speech or handwriting) in their language and to receive a translation in another language to communicate with the service staff.

None of these approaches reported a systematic survey that assesses users' needs. Nevertheless, when adapting a paper-based to a digital system, surveying users of the paper-based system may help since they might have expectations for a digital version. Our work addresses this gap by a systematic assessment without implementing a prototype beforehand. We extend our investigation to more stakeholders and take also restaurant employees and an innkeeper into account.

STUDY I: ONLINE STUDY

First, we conducted an online study to crowd-source a broad range of attitudes towards digital restaurant menus. We wanted to know how people use paper-based menus and the importance of different criteria for choosing a dish. In addition, we wanted to learn what problems paper-based menus have, if any. Most importantly, we wanted to assess peoples' views on features that could be integrated into a digital menu.

Setup

Our questionnaire consisted of 109 questions. Nine of them were open questions; the remaining 100 were multiple choice questions. For ratings of statements we used a 4-point scale with the labels "strongly disagree, disagree, agree, strongly agree", and for ratings for potential features of a menu a 4-point scale with the labels "not interesting, rather not interesting, rather interesting, interesting". To collect criteria people may apply when choosing a dish we conducted an informal pre-study (5 women, 11 men; aged 20-40). We collected 24 different criteria (5.99 criteria per person on average), out of which 17 were mentioned by at least three people. We added six additional aspects not mentioned (though maybe common, e.g. recommendation given by the waiter), summing up to 23 criteria for the dish decision part, and 27 questions on potential features that could theoretically be integrated into a digital restaurant menu were added. These features were inspired by the related work as well as aspects we found interesting for such a study and were only presented with their name (e.g. videos of dishes). After the assessment of these potential features (participants had also the option to state additional decision criteria and features), people should rate whether they think that a digital menu, containing such functions, is a reasonable innovation.

The questionnaire was distributed through several channels (e.g. notices on campus or mailing lists) and was available in German and English.

Results

379 participants completed the questionnaire. As only 5.3% had a nationality other than German, we decided to take only the remaining 359 participants (203 women, 156 men) into account. We had a high number of people younger than 31 (age <21: 49; 21-30: 139; 31-40: 43; 41-50: 67; 51-60: 25; 61-70: 25; >70: 11) which can be explained due to the way the link to the questionnaire was distributed. 84.4% of our participants reported that they visited a restaurant three or more times in the last six months. 15.6% reported visiting high-class restaurants and only 3.9% reported that they know of a restaurant using digital menus.

It turns out that there is a high level of satisfaction with the paper-based menu (only 15.9% reported to be unsatisfied with it). Nevertheless, 49.6% of the participants stated that they had already encountered the problem that the information about the dish was not precise enough to decide whether to order it or not. 14.8% reported in more detail which information was missing on paper-based menus. This was mostly related to ingredients: it might be unclear whether a dish really is healthy (e.g. with respect to allergies), suitable for personal values (e.g. being a vegetarian or vegan) or whether certain variations are possible (e.g. smaller portions). Another problem seems to be that the name and the description given are not sufficient to decide what to expect of a dish or drink.

Our participants seldom visit restaurants on their own (66.6% reported that they never go alone) and 84.2% reported that they are in a restaurant with at least two persons on average. It turns out that they like to talk about the menu (agreement[3]=67.9%) and the restaurant (agreement=72.1%) with their dining companions. Unsurprisingly, there is a tendency for clearly structured menus (agreement=89.2%) as well as a preference to read background information about the restaurant (agreement=62.1%). Participants disagreed with the statement that they visit a restaurant when short on time (agreement=9.7%). 15.1% stated that they already know what to eat when they visit a restaurant for the first time; in case a restaurant is visited subsequently, even more participants know what to order without looking at the menu (agreement=49.3%). Participants affirm that they appreciate the direct contact with the staff (agreement=81.0%).

Participants were asked to assess potential features of digital menus. Table 1 reports the results of these questions averaged over all participants. It contains a selection of features that might be integrated and the acceptance rates for these features. The table shows that features that are directly related to additional information about a dish are perceived as better than features that aim to make use of the digital medium (e.g. the live-stream from the kitchen or the recommendation of dishes). Interestingly, features that are related to social aspects that may add new topics to discussions at the table are not perceived well (e.g. comments from the staff or information about recommendations for others).

61.6% of all participants judged digital menus to be a good innovation. We checked whether younger people are more

[3]The percentage of people that gave a rating of three or four on the 4-point scale.

Feature	Agreement (%)
Variation possibilities for dishes	86.0
Variation possibilities for course menus	83.0
List of all ingredients	80.8
Pictures of the dish	78.0
Which dishes or drinks are sold out	75.0
List of additives	68.3
Regional characteristics of the dish	62.1
Direct ordering via the digital menu	59.9
Information on the origin of ingredients	59.1
Nutrition content and calories	51.8
Other guests' comments on the dish	50.2
Warnings in case of ordering something the guest should not eat or drink (e.g. because of allergies)	47.3
Interactive browsing method to find a suitable meal (e.g. filtering options)	44.6
Explanation of why a recommendation was given	43.5
Estimated preparation time	43.5
Chefs' comments on the dish	40.4
Recommendation of dishes and drinks	37.8
Information on the history of a dish	36.5
Live-stream from the kitchen	31.7
Statistics for the dish	28.9
Waiters' comments on the dish	25.6
Variations chosen by other guests	22.8
Information about recommendations made for dining companions	20.6
Information about the staff	17.9
Videos of the dish	13.1
How often the dish was chosen during the last hour	11.4
Information about which page of the digital menu the other guests at the table are currently looking at	5.8

Table 1. Potential features and their agreement rates

open to the idea of a digital menu, by comparing the group of people younger than 31 with the remaining participants: 68.6% of people younger than 31 think that this is a good innovation, but only 53.8% of the other participants think so (a Chi-square test revealed this age effect to be significant, $\chi^2(1, N = 359) = 8.3, p < 0.01, \omega = 0.15$). A similar effect can be observed for smartphone owners. They are significantly more likely to consider digital menus to be a good innovation: 70.2% of smartphone owners vs. 55.5% of non-smartphone owners ($\chi^2(1, N = 359) = 10.24, p < 0.01, \omega = 0.17$). An explanation could be that people using smartphone or tablet apps in their daily life may be less reluctant to browse through a digital menu, or they assume they can use such a menu easily. This effect still holds even if only smartphone owners older than 30 are taken into account ($\chi^2(1, N = 179) = 9.41, p < 0.01, \omega = 0.23$). Interestingly, people who visit mostly high-class restaurants are less likely to think that a digital menu is a good innovation: only 44.6% of participants reporting visiting mostly high-class restaurants think so vs. 64.7% that reported mostly not visiting such restaurants ($\chi^2(1, N = 359) = 8.02, p < 0.01, \omega = 0.15$).

Participants who declared that they are not satisfied with the paper-based menu do not necessarily like a digital menu; however, 66.7% of them do think that it is a good innovation. Moreover, among those who do not think that a digital menu is a good innovation, 70.0% provided free-text answers as to why they do not like the idea. Table 2 presents the answers and how often each reason was mentioned, as well as a classification into four categories. The table shows that people are concerned about the potential loss of social interaction

Reason	Times mentioned
Social issues	
- Contact with the staff will be lost	34
- Potential loss of employment of the service staff	7
- If a digital menu is used, guests will focus more on the menu than on communication	5
Traditional issues	
- The atmosphere in a restaurant will be disturbed because it is a place that should not be digitized	20
- The paper-based menu is a tradition	14
- It does not make any sense to use a digital menu	11
- The paper-based menu is sufficient	10
Technical issues	
- Interaction with the menu is expected to be difficult, especially for older people	12
- No interest in recommendation of dishes as the guest wants to decide on his own	3
- Privacy concerns about the recording of interactions with the digital menu	3
- Special requests cannot be articulated	3
- Malfunctions of the digital menu are expected	2
Other issues	
- Ecological concerns	1
- Higher probability that expectations are raised that cannot be met by the restaurant (e.g. through pictures of dishes)	1

Table 2. Reasons why people think that a digital menu is not useful

Criterion	Agreement (%)
What the guest would currently like (e.g. hearty or spicy)	97.4
The guest's preferences and dislikes for ingredients	91.4
The guest's level of hunger	89.7
Dishes the guest cannot cook himself or only infrequently	73.8
Dishes the guest has already eaten in the restaurant	73.3
The price of the dish	65.7
Special offers (e.g. "dish of the day")	64.1
Dishes not yet eaten in the restaurant but tried elsewhere	63.2
Ingredients that the guest has eaten a short time before (e.g. "Not pasta again.")	57.7
The reason for visiting the restaurant	52.0
The recommendation of people other than the staff	51.6
Dishes the guest has not yet eaten	49.0
The dining companions in the restaurant	44.0
The recommendation of the waiter	42.9
The current season	41.0
The guest's remaining time to eat	32.4
The time of the day	29.8
The dishes people around are currently eating	26.4
The "eating effort" (e.g. eating gyros makes less effort than eating something with a chopstick)	23.9
The ingredients' accordance with diets	22.4
The ingredients' accordance with intolerances	20.6
The weather	19.5
The ingredients' accordance with religious beliefs	5.0

Table 3. Criteria applied when deciding for dishes and agreement rates

between staff and guests, but also about the contact among the dining companions. Additionally, the tradition of paper-based menus seems to make it difficult to appraise digital menus.

Guests seem to be interested about dining companions' dish choices (agreement=79.4%). Moreover, if a guest does not have a specific idea what she or he should order, this information can influence the decision and help to find a dish (agreement=64.9%). But even in cases where guests already know what to order, a small percentage reported that this decision may still be influenced by their dining companions' choices (agreement=27.6%). Depending on the relationship between companions, common dishes for several persons can be an option. This is mainly the case if visiting the restaurant with friends (agreement=29.5%), but not if visiting with distantly related people (agreement=5%). Some participants consider not ordering a dish if they know that one of the dining companions dislikes it (agreement=17.2%). Interestingly, the price of the dishes and drinks seems to matter always, even if someone else will pay the bill (agreement=81.9%).

By analyzing the ratings of various criteria (cf. Table 3) it turns out that many of them are not restricted to the moment of choosing the dish. Guests might take into account what they can cook by themselves, what they have already eaten in restaurants and what they just ate before the visit. Additionally, the table shows that classical contextual information (e.g. the weather) seems not to be as important as other criteria directly related to the preferences and the background of the guest. Furthermore, the low scores concerning intolerances, religious beliefs and diets can be explained with the small number of subjects that are affected by such limitations: Only 24.5% of the participants stated that they are restricted in their decision because of personal reasons.

Discussion

The online survey revealed that there is no necessity for introducing digital menus into restaurants. However, it also indicates that a digital menu may be an asset a restaurant may employ to attract, for instance, younger people with a positive attitude towards such innvoation. This can be correlated with their affinity to smartphones[4]. But even people older than 30 years do not categorically reject the idea of introducing digital menus. Moreover, we showed that age is not the only aspect that indicates whether a guest is likely to prefer a digital restaurant menu.

Furthermore, our online survey showed that a visit to a restaurant is a social event which is attended by a group of people and for which in general a sufficient time span is scheduled. This has two important impacts on the design of a digital restaurant menu. First, if a digital menu restricts the social interaction between the dining companions, it is expected to be perceived as annoying. The menu should rather provide the possibility to improve the social interaction. As people apparently like to talk about the menu and the restaurant itself, this could be achieved by including more information in the digital menu. The loss of social interactions with the service staff is another problem that is contrary to the high rating of the direct ordering feature in which a guest orders without calling a waiter. One way of addressing this issue is to allow both concepts in a restaurant, e.g. to automatically transmit the order, but having the waiter acknowledge it. Second, as people are generally not in a hurry when visiting a restaurant, they have time to elaborately check the menu and use additional features. Nevertheless, the main functions of a paper-based menu have to be retained in the first place and

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[4]The study "Our Mobile Planet" found that people between 18-29 years are the largest group of smartphone users in Germany, `http://www.ourmobileplanet.com`, accessed 07/30/12

potentially further improved to reduce the problems reported about the paper-based menu. Consequently, features that hinder this basic task should be avoided. The results shown in Table 1 indicate that features considered to be most important are the ones that help guests to find the most suitable dish by providing additional information. Surprisingly, recommendations and the interactive browsing feature are not highly rated. An explanation could be that people who like to explore the restaurant menu by themselves do not want to share their private information to receive a recommendation, or do not trust such a system. Hence, these features should be optional and not placed prominently in such a menu.

In order to enhance the perception of a potential recommendation for dishes, we investigated the criteria people take into account while deciding on a dish. We want to stress that we focused on personal criteria and not on group decision [14] criteria, which might also have an impact on the final choice (e.g. children might have an influence [12]). Nevertheless, our results indicate that there are already many other different criteria people might use actively. Criteria related to the user's situation are difficult to include in a recommendation process, as the user has to provide them for each recommendation cycle himself (e.g. current level of hunger), or they have to be logged as they occur (e.g. ingredients eaten a short time before). It can also be assumed that guests would not invest much effort in enhancing a user model with such information, as the recommendation feature was poorly rated.

STUDY II: EXPERT INTERVIEWS
We also wanted to explore the restaurants' perspective to gain more insights into the topic. Therefore, we conducted a second study with expert interviews of restaurant employees and presented the idea of a digital menu to an innkeeper of a fine dining restaurant and discussed it afterwards. Taking into account these stakeholders is important as they are confronted with restaurant menus every day and they might have specific views on the topic depending on the restaurant's philosophy.

Method
We conducted semi-structured interviews with employees of a restaurant. Each interviewee received an explanation of the purpose of the interview and a short introduction into the topic of digital restaurant menus. Afterwards, we asked personal questions (area of work in the restaurant, time working in gastronomy and time working in this restaurant). We also inquired about the employees' perception of paper-based menus, as well as typical questions asked by the guests which are not covered in the menu. In the next step, specific questions concerning a potential digital restaurant menu were asked: e.g. which functions and information should be included to add additional value in comparison to a paper-based menu and to improve the guests' dining experience. Further, we wanted to know which functions might support them during daily work, and which potential problems a digital menu might introduce, e.g. if they fear that it will harm the working atmosphere. Additionally, we asked them whether they consider digital menus to be a good innovation. Finally, we collected additional thoughts and comments.

Five employees (3 women, 2 men) of a fine dining restaurant working in different areas were interviewed (2 chefs, 2 service employees and 1 management assistant). They had gastronomy experience of 5-31 years (mean=15.4, SD=10.92). Only one chef had experience with ordering systems,[5] but no employee had experience with digital menus.

Results
Paper-based menus have drawbacks.
Each interviewee had suggestions on how to improve paper-based menus. There were two problems mentioned specifically related to their restaurant. On the one hand, the content of the menu changes frequently and hence, the menu itself has to be changed as well; this leads to high effort and costs. On the other hand, because of the location of the restaurant, menus in different languages are desirable, but this is not realizable because of the high frequency of changes. A more general problem concerns missing pictures of dishes, as the menu should be kept compact and inexpensive to print. The chefs identified additional problems with the lack of information due to compactness: more information about the ingredients (e.g. origin and nutrition information) would be helpful in deciding on a dish. The absence of this information makes it especially difficult for guests to consider health aspects.

A digital menu is perceived as a reasonable innovation.
Each interviewee considered digital menus to be a reasonable and positive innovation. Nevertheless, one of the chefs mentioned that he likes the idea but is unsure whether such a innovation is suitable for the atmosphere of their restaurant.

A digital menu may ease restaurant employees' work.
The inclusion of more information about dishes and drinks in the menu may be a relief for the service employees and chefs. As an example, allergies and intolerances (e.g. lactose intolerance) were mentioned as causing problems in the restaurant's work flow. Currently, specific information about the ingredients is missing. If a guest has an allergy or intolerance, she or he has to ask the waiter whether dishes are problematic for her or him. The employee then might have to forward the question to the kitchen. Furthermore, the chefs think that digital ordering has the advantage that the orders are sent electronically to the kitchen in a clearly structured format without potential problems with the handwriting of the service staff.

The working atmosphere might be improved by digital menus.
None of the interviewees thought that a digital menu would be a problem for the working atmosphere in general. Only one service employee had concerns about the direct ordering feature because he fears that his job could become less important or even unnecessary. But without such a feature he would assess the innovation as reasonable. Two other interviewees assumed that the working atmosphere would be improved because of the availability of more information and the possibility of taking the order electronically. They hoped this would resolve problems between service and kitchen (e.g. unreadable order coupons).

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[5]Systems in which the waiter takes the order with a mobile device and the order is subsequently sent to the kitchen electronically.

Functions providing additional information are perceived as added value if they do not put pressure on the staff.
It turned out that the following functions that add supplementary information which is not yet provided in paper-based menus are perceived as valuable by every interviewee: pictures of dishes, the origin of ingredients, the list of all ingredients and additives, the calories and nutrition values as well as regional and historical information about dishes or drinks. They think that this information should be accessible for the guests. One of the chefs mentioned an additional advantage: If the guest reads more interesting facts, being more engaged in the menu possibly results in more time for the staff to process orders. A possibility to directly display what is currently sold out is seen as a clear advantage. Furthermore, one of the interviewees who judges the recommendation system for dishes or drinks as a good feature, notes that with such a system, the guests can find a suitable dish more easily. He expects that this will help to improve guests' perception of the restaurant. In contrast, functions that put more pressure on the staff are considered problematic (e.g. displaying the approximate time until the dish will be served).

Not all functions that are desirable for the guest can be realized easily by the restaurant.
Showing pictures of dishes or presenting all additives, nutrition contents and calories means more effort for the restaurant. Although the chefs agree that this additional effort is worthwhile, not every restaurant will be capable of doing this because of insufficient expertise of the staff. Additionally, there are other features that might not be directly realizable due to the restaurant's circumstances (e.g. refurbishment of the kitchen before a live-stream can be shown).

Information on the staff and staff's comments on dishes or drinks are perceived as a good possibility to leverage engagement with the guest.
All interviewees mentioned that making comments on dishes or drinks which can be read by every guest is a good opportunity to forge links with the guests. For the same reasons, including additional information on the staff in the menu (e.g. full name, short description) is also perceived as helpful. However, for both functions, they raised concerns about privacy aspects and stated that each employee needs to have control over the presented data.

In addition, we distilled two results from the discussion with the innkeeper of a fine dining restaurant. These are:

More transparency should be provided by the digital menu.
The innkeeper stated that more transparency in the menu is necessary, i.e. more information on the menu items should be provided helping guests to decide on really suitable meals. This matches up with the results gathered in our online study.

Gastronomic concepts can be supported with a digital menu.
The innkeeper mentioned two concepts, the "Strategie Orange" [11] and "LOHAS" [16], which he would like to use in his restaurant. He stated that a digital menu can support these concepts, whereas different aspects of these concepts are hard to realize with a paper-based menu. For instance, he mentioned that "food-moduling" (part of the "Strategie Or-

ange") cannot be done with a paper-based menu in a comfortable way. "Food-moduling" means that a guest can adjust all parts of a dish, i.e. she or he could decide which ingredients should be included and which not, as well as the amount of each in a dish. If a restaurant wants to realize this concept currently, such options have to be noted by the waiter, which is seen as a time-consuming process.

Discussion
As restaurants have different philosophies and target audiences, their needs for a digital menu might also vary. Although only employees and an innkeeper of one restaurant were asked, several important aspects of a digital menu can be derived that are presumably suitable for a broad range of traditional restaurants. It turns out that there are problems with the paper-based menu, for instance the lack of information due to the compactness of a printed menu, in order not to overwhelm a guest with too many pages. Other problems with the paper-based menu appear if the restaurant has specific requirements, e.g. frequent updates of their offerings. The question is whether other restaurants do not have such requirements because of the inflexibility of paper-based menus or the corresponding costs. Another inflexibility inherent to a paper-based menu is the lack of multi-language support. If a restaurant wants to provide the menu in another language, there are basically two options. Translations can be included in the menu line-by-line or as translated distinct copies. The first option might be problematic due to the compactness aspect of menus, and the second option might also be costly as more menus have to be printed. Again, such inflexibility can be overcome by using a digital menu.

Paper-based menus differ strongly between restaurants. It can be assumed that the requirements for a digital menu will also vary depending on the type and the size of the restaurant. This is not only restricted to graphical design decisions, but also concerns the functionality offered (e.g. a live-stream from the kitchen may not be an option for every restaurant). Hence, a digital menu system that should be used by a broad range of restaurants has to provide an easy option to enable and disable features depending on the concept and requirements of the restaurant.

The fact that a digital menu is perceived as a good innovation that has the potential to improve the working atmosphere is promising, although the results show that there are different perspectives among employees regarding functionalities. That is problematic because the innkeeper will decide on the functionality that a menu should have. Therefore a general guideline is that the restaurant staff should be considered in the process of implementing a digital restaurant menu.

STUDY III: EVALUATION OF A PROTOTYPE
Studies I and II were used to analyze expectations without the usage of a specific system and informed the functional requirements of a prototype of a digital restaurant menu. For Study III, we created a prototype based on these results and conducted a user study for investigating questions related to HCI aspects of digital restaurant menus with it, but also to reassess aspects of the former studies with a specific system.

Prototype

Previously, we found that people are satisfied with paper-based menus. Since tablets have a similar format as traditional menus and each guest could have an own tablet, as with printed menus, we decided to design the prototype as a tablet application. We populate it with 46 different items in ten different categories, inspired by a menu of a local Italian restaurant. We integrate nearly all (24 of 27) features asked about in Study I, with the goal to reassess them in a given context and after they had been used. We put a special focus on the recommendation part: We use a hybrid recommender strategy (content and critique-based [19]), taking into account preferences for and aversions to ingredients in menu items. In addition, we allow filtering options to refine the recommendation: filtering by price, calories, category (e.g. appetizers), type (e.g. vegetarian) and ingredients to enable assisted browsing inspired by the Entree system of Burke et al. [5].

Since people have been quite contented with paper-based menus, we wanted to know whether a digital menu application should make full use of available UI elements and widgets provided by common frameworks, or whether the visual layout should stay close to that of a printed menu. Therefore, we evaluated two versions of digital menus: the *paper-style*, in which we designed the UI to reflect a paper-based menu (e.g. using the concept of pages with listed menu items), and the *app-style*, in which we designed the menu like common tablet apps (e.g. using the Master/Detail pattern [15] and separate views for different information). For both styles, the interactions have been kept simple in order to not overwhelm the users. In most cases, it is sufficient to click on items to receive details. To navigate in the *paper-style* a swiping gesture can be used leading to pages with different categories of items (similar to turning pages in a paper-based menu). In the *app-style* we used a three-level hierarchy for the navigation: In the detail area, menu types (e.g. appetizers) and categories (e.g. soups) are shown and by selecting a category the corresponding menu items are displayed in the master area. In the *paper-style*, details to menu items are shown in-place, by expanding the list, while in the *app-style* a new view is shown. Figure 1 shows the main and detail views of each style.

Method

To assess usability problems, we used the Expectation Measure of Albert and Dixon [1]. For that, the participants were asked to state what level of difficulty they *expect* of certain tasks that can be solved with a digital menu, prior to any interaction with our prototype (e.g. "How difficult do you think is it to order a dish with another side order via the menu?"). Subsequently, each participant was assigned to either the conditions "*app-style* first" or "*paper-style* first" and had to interact with the corresponding style and find a suitable appetizer. Afterwards, an interaction with the other style, and the task to find a main dish, was provided. After each part, a System Usability Scale (SUS) [4] had to be filled out. For both tasks, we had restricted the functionality of the prototype in order to not overwhelm participants. The next step was to solve 35 small tasks (e.g. finding a specific menu item) in the *app-style*, but with all functions enabled. After each task, the subject had to state how difficult the task was (second part of
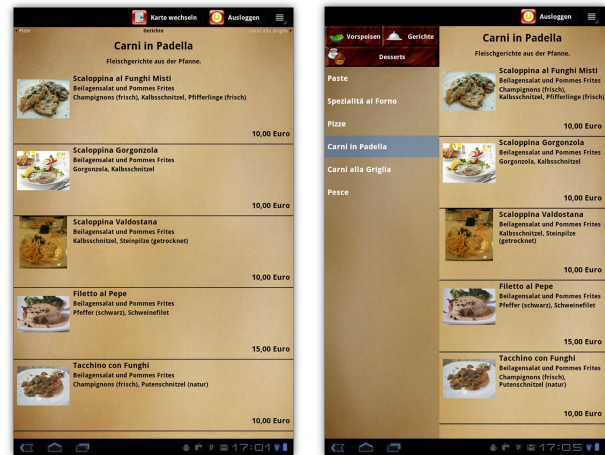
(a) *Paper-style* main view   (b) *App-style* main view
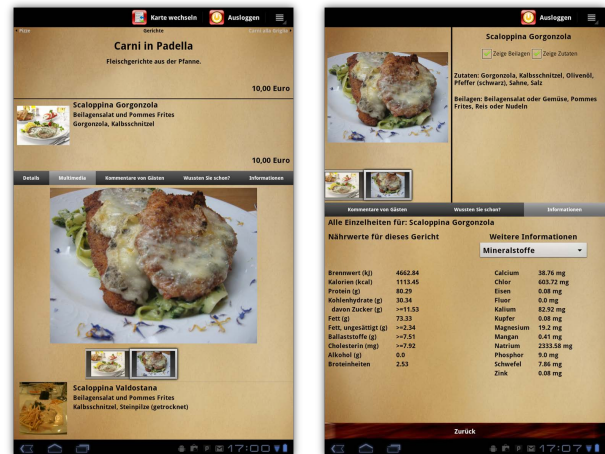
(c) *Paper-style* detail view   (d) *App-style* detail view

Figure 1. Screenshots of the main and detail views of both styles

the Expectation Measure; the answer can be compared with the expected task difficulty). The tasks were chosen to guide a participant through all features integrated into our prototype for a reliable assessment later on. In a short follow-up interview we asked what the three best features in the prototype were. A post-session questionnaire asked participants to rate features (as in the online survey), and answer questions specific to the recommendation and general questions concerning digital restaurant menus, requiring either a rating on a 4-point scale or a free-text answer. During the evaluation the experimenter observed the situation, took notes and encouraged the participants to think aloud [18].

Results

We conducted this evaluation with 20 German-speaking participants (8 women, 12 men; average age=20.15, SD=2.72). In general, our participants' experiences with smartphones and tablets were quite widespread and all of them had at least used a personal computer. 85% of our participants reported that they visited a restaurant three or more times in the last

six months. 25% have already visited restaurants that provide digital menus (mostly tablets). Advantages of those devices mentioned by the participants are the possibility to order directly and to view pictures of dishes.

We learned that for the majority of this sample the contact with restaurant staff is unimportant or only less important (10% and 50% respectively). In addition, 60% never asked the waiter before to recommend a drink or dish. First, they reported a lack of trust in these recommendations (33.33% of the participants used this explanation). Second, participants stated that they usually know what they want to eat. Only one reported asking for recommendations frequently. We asked about their satifaction with the paper-based menu; 10% seemed to be dissatisfied, while 90% were satisfied.

Concerning the SUS [4] we learned that the *app-style* has a better usability than the *paper-style* (87.38 vs 73.5 on average[6]). Together with our observations one issue may serve as explanation: 65% of the participants had problems with switching through "pages" (by a swiping gesture) as no prior instruction was given and indicators at the top corners seemed not to convey enough information to explain this feature. As soon as the experimenter realized that a participant would not find this feature on his own, he provided the hint that this menu can be used like a paper-based menu. Interestingly, in all cases, this was sufficient for the participants to start using this feature. Concerning the Expectation Measure of Albert and Dixon [1] we learned that only very few features have usability issues; mostly they were related to the arrangement of our recommendation view, as it integrates a lot of functionality that overwhelmed participants in the first place.

We aggregated the results on the features assessment and compared them with the values derived from the online study (only considering participants younger than 31) to see whether features were rated significantly differently. Only in six cases we found significant differences (all were better-perceived): the recommendation, the interactive search, health warnings, nutrition information, videos and direct ordering. A reason for this might be that these features were hard to imagine for the participants of Study I, as the questionnaire provided only the names of features. In the short interview, the recommendation feature was mentioned most often as the best feature (40%), followed by the possibility to customize a dish directly via the menu (25%). Also often mentioned was the navigation option of the *app-style* (20%).

More specific questions were asked concerning the recommendation and filtering feature. Just 15% of the participants stated that they would rather not use the recommendation feature. Checking their former answers, two out of these three participants had reported that they usually do not need a recommendation of the staff as they always know what they want to eat. This could serve as an explanation for their answer. Together with the aforementioned results, this is evidence that our participants perceived the recommendation as useful. 85% think that providing the system with ingredient preferences or dislikes is reasonable for improving the recommen-

dations. Concerning implicit feedback (e.g. [17]), 30% think that it should rather not be used, but 95% like the option to inspect and correct the assumptions made by the system if it is integrated into a recommendation.

We asked whether more filtering possibilities should be included. Only 15% responded positively, but only one participant had a specific idea for another option: a filter for dishes mostly concerned with the origin of the ingredients.

Concerning the question of whether the participant prefers the *app-style* or *paper-style* it turns out that no participant prefers the *paper-style*. Only 10% of the participants were indifferent in their preference concerning these two styles; the remaining 90% preferred the *app-style*. The main reason for this (mentioned by 94.4% of the subjects that favored the *app-style*) is the better overview provided by the *app-style* because of the clear structure in menu types, categories and menu items.

Regarding the general acceptance, all participants think that a digital menu is a reasonable innovation (50% agreed, 50% strongly agreed). This may serve as an explanation for the fact that 95% of the subjects would prefer the digital menu to the paper-based one in case they could choose. Moreover, when confronted with the statement that a digital menu is superior to a paper-based one in helping people find a suitable dish, 40% of the participants strongly agreed and 60% agreed. Additionally, we asked all participants whether they think that a digital menu should be used in all restaurants. 45% answered this question positively. The remaining 55% were asked to list restaurant types for which they would consider a digital menu appropriate: fine dining restaurants, as well as restaurants in which ordering is time-critical (e.g. fast food restaurants) or done often (e.g. sushi bars).

Several questions concerning the preferred mode in case a digital restaurant menu is used were asked. Regarding the question whether the device should be owned by the restaurant or by the guest, there is no clear result, although a tendency is visible towards restaurant-owned devices (15% user-owned, 40% restaurant-owned, 45% undecided), analogously to the classic situation in a restaurant where the paper-based menu is also owned by the restaurant. Unsurprisingly, because they have only interacted with a tablet during the evaluation, many participants prefer a tablet that displays the menu, but a tabletop also seemed to be an alternative for some of the participants (0% for smartphone, 0% for regular screen, 30% for tabletop, 70% for tablet). We also assessed the participants' preferences regarding the duration the menu should be available: 85% of the participants would like to use the menu during their complete visit. 10% prefer to use it only for the time of the ordering. One participant proposed a variation: a menu that is integrated into the table but can be closed if not needed. Concerning whether they favor a "shared medium" (one for all dining companions) or a "personal medium", 75% want a "personal medium" and 20% a "shared medium". Again, one participant was undecided and provided the answer that this should be variable depending on the kind of the group (e.g. during a business lunch, each guest should receive a separate menu but in case of a family lunch, one menu might be shared).

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[6]The SUS score ranges from 0 to 100; the higher, the better.

Discussion

All of the participants liked the digital restaurant menu and their answers to the questionnaires provided further insights into what should be integrated into a digital menu. Nevertheless and most interestingly, the personalization aspect, integrated into our prototype by using a recommender system, was not perceived as useful by the participants of the online survey. In contrast, the assessment of this feature in the evaluation was significantly better. This result is especially interesting as most participants stated that they do not need any recommendation in a restaurant but affirmed that they would use this feature if it was integrated into a menu.

Despite the outcome that every participant likes the innovation, the majority does not consider a digital menu to be appropriate for every restaurant. There is a clear notion of where to use it. Fine dining restaurants were often mentioned as examples for restaurants where digital menus could be applicable. This is an interesting result, as we saw in Study I that people who reported visiting fine dining restaurants are less likely to approve the use of digital menus. We learned that our participants prefer that the menu should stay at the table for the entire visit, and each person should have an own menu.

DESIGN GUIDELINES

Besides the results on specific aspects of the topic (e.g. decision criteria), we were able to derive the following guidelines for the design of digital restaurant menus from our studies.

1) Keep the information that is available in the paper-based menu also in the digital menu.

Most participants of our online survey reported being satisfied with the paper-based menu. The only problems seemed to occur because of missing information. Hence, it seems reasonable to keep the information that is already available in paper-based menus for digital menus. As our prototype followed this guideline, we can confirm this: None of the participants recognized the information we display in the main views as annoying.

2) Include the capability to navigate quickly through different menu categories.

Study III showed that a prototype that does not mimic a paper-based menu's navigation features is perceived as advantageous: The navigation capability we included in our *app-style* was often described as beneficial in contrast to the *paper-style* digital menu as well as the paper-based menu.

3) Social interactions should not be restricted by the menu.

Although the participants of our evaluation reported no contact with the staff is needed, it should be emphasized that this was a clear result of the online survey. This has two implications: First, features that attract too much attention during the course of dining might hinder the social interaction and should only be integrated carefully. In addition, if the menu allows use of other features of the device (e.g. other installed apps), this could also restrict interaction. Hence, the menu should be restricted to the menu app. Second, using a direct ordering feature would restrict the contact to the staff even

more. This trade-off should be examined carefully with respect to the restaurant in which a digital menu should be used.

4) Additional information about the menu items should be integrated fundamentally and placed prominently.

The discussion with the innkeeper showed that there are restaurant concepts that would profit by the integration of more information into the menu items (e.g. a list of all additives). Pieces of information that are related to the menu item itself were also perceived as most interesting by the participants of the online survey, and this is also supported by the main objective of the menu to help a guest in his choice what to order. Hence, it follows that this information should be readily visible and easily accessible. In contrast, information not related to the menu items (e.g. description of the staff) can be integrated, but should not be placed too prominently.

5) Novel features should be placed in the menu with respect to the target audience.

Especially those features using the capabilities of a digital device were not perceived well by the participants of the online survey (e.g. recommendation feature or video). Nevertheless, the evaluation with a prototype showed that a few of these features were positively perceived. Hence, we reason that they might be integrated, but should also not be placed too prominently in the menu: on the one hand, to not overwhelm guests with novel functionality, and on the other hand, to not distract guests not interested in such features.

6) Avoid features that put pressure on the staff or let employees become redundant.

Some features might be interesting for guests, but might put pressure on the staff. The employees reported that they expect a digital menu to be a reasonable innovation that could improve the working atmosphere, but only if such features are not integrated. An innkeeper who decides on the features that she or he wants to use in a digital menu should consider this.

7) If a restaurant has a younger audience, the digital menu should be available during the complete restaurant stay.

The participants of the evaluation reported that they want to use a menu during the complete visit and that they want to have one device per guest. This has two implications: First, if an innkeeper wants to follow this guideline and wants to provide devices to display the menu, she or he has to keep in mind that the combination of these two aspects results in the highest costs. Second, this combination allows the broadest range of possible features. For instance, a recommendation feature for menu items seems to be more beneficial if each guest has an device to her- or himself.

Limitations

Our studies were conducted with German participants. Since eating habits vary among different cultures and nationalities, (e.g. [25]) this is a threat to external validity. Another limitation is the selection of the participants for Studies II and III: We had to restrict ourselves to only a few employees and an owner of one restaurant. In the next step a systematic survey of different types of restaurants would be beneficial to learn

which specific needs arise depending on different restaurant philosophies. For Study III, we evaluated the prototype with only 20 people that were younger than 31. Our reasons for that were mostly motivated through the subgoal of a first usability assessment of our prototype. First, it seems reasonable for this evaluation to work with participants that are less likely to have problems with the device itself, as many of them own a smartphone (as stated before) or tablet. As a consequence, the perception of the digital menu will not be biased due to insufficient experience, and the problems which are reported will mostly be related to design issues. Second, usability problems reported by people that already have experience with other mobile applications are especially useful, as they probably have certain expectations of such applications.

CONCLUSION

For different reasons, restaurants began to implement digital menus without scientific grounding of design choices. In this paper we presented results from three different studies on digital restaurant menus. The online survey showed that, albeit most people are satisfied with paper-based menus, a lot of information and functionalities could enrich restaurant menus from guests' perspective. Currently these features are not integrated into paper-based menus due to space limits. At the same time, restaurant employees stated that additional functionality could help guests to choose a dish, especially for health-related decision making. As a recommender system could be a viable option for digital menus to assist the guest further, we also started to explore what criteria people reported using actively when deciding on a dish and learned that different criteria are used, not only related to the moment of choosing the dish (e.g. current level of hunger) but also extending to criteria with a longer duration (e.g. dishes eaten days before). Our studies informed the design of a prototype to further investigate digital menus. Its evaluation revealed that nearly all participants preferred digital over paper-based menus. Even more, participants preferred the prototype designed as full application (*app-style*, making use of all UI widgets) over a page-based navigation structure (*paper-style*, adopting the paper-based concept). Finally, we derived design guidelines based on our studies. They comprise what we have learned for the design of digital restaurant menus.

For future work, we plan to conduct a field study with our prototype to study menus in natural settings; we are especially keen on investigating further HCI-related as well as social aspects of replacing paper-based menus with their digital counterparts.

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