Probing Integrated Household Information Systems for Integrated Food Practices

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Abstract: Recent publications propose concepts of systems that integrate the various services and data sources of everyday food practices. However, this research does not go beyond the conceptualization of such systems. Therefore, there is a deficit in understanding how to combine different services and data sources and which design challenges arise from building integrated Household Information Systems. In this paper, we probed the design of an Integrated Household Information System with 13 participants. The results point towards more personalization, automatization of storage administration and enabling flexible artifact ecologies. Our paper contributes to understanding the design and usage of Integrated Household Information Systems, as a new class of information systems for HCI research.

1 INTRODUCTION

Food consumers face various challenges. On the one hand, they are expected to consume sustainably and reduce their food waste (Ganglbauer et al., 2013; Prost et al., 2018). On the other hand, they aim to reach their personal health or diet-related (Eikey and Reddy, 2017; Prost et al., 2018) goals, or just enjoy more hedonism and the positive aspects of food (Grimes and Harper, 2008). Therefore, some consumers are already using a variety of information systems, such as apps to track their diet, to check the ingredients of a product or just to use a digital shopping list (Lawo et al., 2020b, 2019).

Accordingly, the digitalization of food consumption practice offers new opportunitites to reduce effort and enable practices in line with the personal goals (Lawo et al., 2020b). At the same time, the flood of information (Stevens et al., 2017), the work of maintaining personal data (Eikey and Reddy, 2017) as well as planning and tracking the home inventory (Fuentes et al., 2019) adds new challenges for the consumers. Instead of adding the data just once or receiving data from the producers, consumers are burdened with connecting different apps and information by hand (Lawo et al., 2019).

This causes a mismatch with food practices which are acknowledged to be connected as integrated and dispersed (Ganglbauer et al., 2013), or entangled (Nicolini, 2009; Lawo et al., 2020a; Shove et al., 2012), while food data and applications (Lawo et al., 2019; Aspray et al., 2013) are not. To resolve this mismatch concepts of integrated Household Information Systems (IHIS) were proposed. Inspired by research on integrated business information systems (Becker and Schütte, 2004), these concepts attempt to overcome data silos and artificial separation of services, by integrating data, connecting consumers to the supply chain, and offering personalized services (Angara et al., 2017; Holmström et al., 1999; Stevens et al., 2017).

Although first concepts (Angara et al., 2017; Holmström et al., 1999; Stevens et al., 2017) and explorative research (Bossauer et al., 2018; Stevens et al., 2017) on added values exists, there is no design study that explores appropriation 'in-the-wild'. Therefore, we still miss a nuanced understanding of useful combinations of different services and data sources and which design challenges arise from integration. In short, the question whether integration of applications and data is the answer to support integrated practices remains unanswered.

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Therefore, in this paper we research the usage and design of IHIS with a 3-week design probe with 13 participants. While there is no complete system available, we searched for an app that covers a broad range of functions and is as close to this kind of hands-on experience. We decided for the app Foodoholic, as it already covers the integration of storage data, recipes, meal plans, and a shopping list. Still, a connection to the information of the supply-chain (Holmström et al., 1999) or a digital receipt (Stevens et al., 2017) are missing as a feature.

Our results emphasize the opportunities of aligning the various applications and data silos with the connectedness of practices. Thereby, we clearly see how such an integrated approch might resolve common issues with current food apps and enable a network of ICT artifacts that support consumers in their food practices.

Our work contributes to the relatively new field of IHIS, as it provides a first empirical account of the usage of design 'in-the-wild' showing how participants embed IHIS in their daily practices. Furthermore, we draw attention to automatization, personalization, and flexibility as essential features of future IHIS design to support food pracitces.

2 RELATED WORK

2.1 From Integrated Food Practices...

From a practice-based perspective, it is acknowledged that practices are interconnected, integrated and dispersed (Ganglbauer et al., 2013), entangled (Nicolini, 2009; Lawo et al., 2020a; Shove et al., 2012), or chronologically ordered (Ng et al., 2015). By following food along a chronological cycle, we see various practices from procurement to disposal and how they are accompanied by artifacts (see Figure 1).

Thereby, consumption is accompanied by keeping track. For example, household budgets are used to keep track of finances (Comber et al., 2013) and diet and nutrition are tracked with diet trackers and food diaries (Achananuparp et al., 2018; Ahmad et al., 2016; Comber et al., 2013; Graf et al., 2015). Buying food products is usually done in supermarkets but also on farmers markets or through online delivery (Ng et al., 2015). Within shopping, lists are commonly used to prevent over-buying and ensure completeness of the basket (Ganglbauer et al., 2013, 2012; Ng et al., 2015). Thereby, shopping lists are often created in front of the fridge, ensuring to buy only necessary products (Ng et al., 2015). Besides, shopping is sometimes aligned to offers or vouchers (Ng et al., 2015). There are also 'wild' procurement practices, where consumers use gardens to grow vegetables (Ganglbauer et al., 2013; Heitlinger et al., 2018), forage (Chamberlain and Griffiths, 2013) or do food sharing (Burton et al., 2017; Comber et al., 2012; Ganglbauer et al., 2014). "Most food brought into the home was not consumed immediately but was instead stored for later use" (Ganglbauer et al., 2013). Consumers attempt to keep an overview (Ganglbauer et al., 2013) or record the expiry dates (Comber et al., 2013). The preparation of food includes cooking (Ganglbauer et al., 2013; Ng et al., 2015) or grilling (Chamberlain and Griffiths, 2013), as well as alternative modes like fermentation (Dolejšová and Kera, 2016). Recipes are used for inspiration or learning new dishes (Ng et al., 2015). Eating includes practices of in-home eating, but also eating-out (Ng et al., 2015; Warde, 2018). Consumers tend to share their eating experiences on social media or schedule with meal planners (Ng et al., 2015). Food exits the household in multiple ways, e.g. through composting (Ng et al., 2015) or the trash bin (Ganglbauer et al., 2013, 2012). But, disposal also merges to procurement again, e.g. through food sharing (Ganglbauer et al., 2014). Overall, disposal itself is hardly accompanied by artefacts as interventions focus on the earlier stages.

Figure 1: Food Lifecycle.

2.2 ... to Integrated Household Information Systems

To account for the entangled nature of practices by breaking data silos and offering personalized services, concepts of IHIS were proposed (Angara et al., 2017; Holmström et al., 1999; Stevens et al., 2017). Based on the idea of integrated data storage and business to customers data exchange, those concepts try to transfer the idea of Integrated Business Information Sys-

tems (Becker and Schütte, 2004) into private households. What they have in common, is the data transfer through digital receipts and the idea of a shared data storage. They differ, however, in their concepts of integration of services. Explorative research found the provision of additional product information, comparing products and identifying product alternatives warnings about allergy/diet relevant products and best before date reminder, food information sharing, budget accounting, and historical data as well as inventory-based recipe recommendation to be necessary features of such systems (Bossauer et al., 2018). While Foodie Fooderson (Angara et al., 2017) combines various services in one application, the household resource management approach of Stevens et al. (2017) is open for integrated as well as third party services. Still, none of the concepts have been deployed nor evaluated.

3 METHOD

3.1 Design Probe & Interview Study

To investigate the use of IHIS-like systems as support for daily practices, we conducted a design probe study (Arnold, 2004) with 'Foodoholic', which is further described and motivated in section 3.2. For this purpose, we recruited a qualitative sample of 13 participants. The main criteria for inclusion in the sample was that they were mainly in charge of their household's food practices. Moreover, we aimed for a sample that covers a broad range of demographic characteristics, such as age and education. The sample is aged between 22 and 54, covering a range of educational backgrounds from apprenticeship to a university degree. Due to the focus on the main responsibility in the household, our sample reflects the unevenly distributed work in households and includes 11 female and only 2 male participants. The living situation is diverse as well. We selected participants that live alone, in a shared-flat as well as families with children to consider their different food practices.

After a first meeting where the app was introduced to the participants, we asked them to use it for the next 3 to 4 weeks until the session of the post-interview. There we conducted semi-structured interviews (Ayres, 2007) including a reflection on their current food practices and the role of ICT, the appropriation of the Foodaholic app and the IHIS-Pracitce alignment as well as exploring future design and usage scenarios. The interviews were transcribed and coded using MaxQDA[1]. The interview data were analyzed using inductive thematic analysis (Braun and Clarke, 2006).

Table 1: Participants of our Study.

#	Gender	Age	Education	Living
P1	male	36	Univ. Degree	alone
P2	female	49	Sec. School	w/ family
P3	female	23	High School	w/ family
P4	female	24	High School	alone
P5	female	23	High School	w/ partner
P6	female	52	High School	w/ family
P7	female	22	High School	shared flat
P8	female	22	High School	shared flat
P9	female	34	High School	w/ child
P10	female	24	Univ. Degree	shared flat
P11	male	24	High School	shared flat
P12	female	54	Apprenticeship	w/ partner
P13	female	46	Sec. School	w/ partner

3.2 Foodoholic

For the probe, we selected the app Foodoholic as this is freely available and already covers various functions along the food lifecycle (see Figure 2).[2] This includes a shopping list, a virtual fridge, recipe recommendations, a meal planner, and health and budget information. The fridge and the shopping list are connected so that procured items are shown in the fridge. All services share an integrated database.

Related to the food lifecycle, the shopping list and the budget and health information support the consumer primarily in the procurement phase, especially in the context of planning and executing shopping. The integrated database enables the exchange between the shopping list and the virtual fridge, which displays the products purchased and thus supports the storage phase. Based on the available products in the virtual fridge, recipe recommendations and a meal planning function are offered to support the preparation, taking into account the respective food in stock. By knowing the stock in the virtual fridge as well as their own consumption, the consumer can draw conclusions about possible remaining stocks that are no longer being used. Moreover the system provides health and budget information to support the personal goals of consumers. Additionally, the recipes and the meal plan are adaptable towards sustainable diets such as vegetarian.

[1] MAXQDA is the world-leading software for qualitative and mixed methods research. (https://www.maxqda.com)

[2] https://apps.apple.com/de/app/foodoholic/id13293755

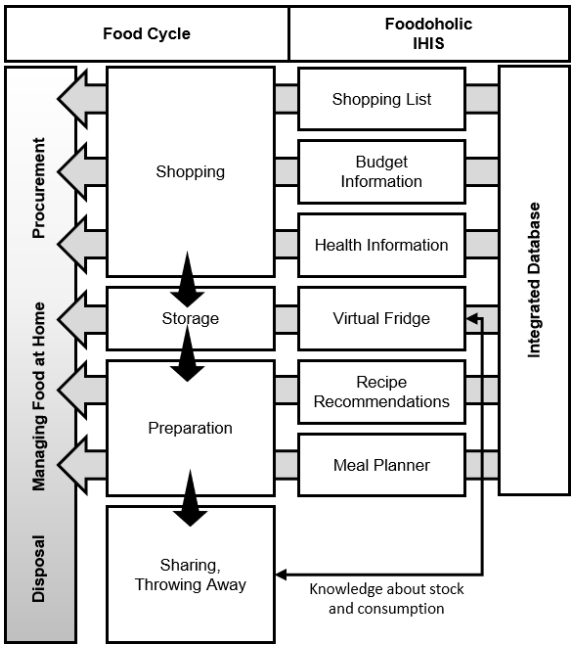

Figure 2: Functions of Foodoholic along the food lifecycle.

4 RESULTS

4.1 Current (Digital) Food Practices

Before the introduction of the IHIS, our participants food practices were supported by a variety of apps, services, and artifacts. For example, 5 participants wrote already shopping lists on their smartphones for the planning of the shopping trip. The other 8 participants, however, still used a piece of paper and a pen for this task.

> ”So I buy what I see and what appeals to me, and I probably get inspired by what I cook when I’m shopping myself.” –[P7]

However, it must also be noted that the younger participants tend to shop more spontaneously, while those with partners and families do more planning. This effort is made to buy the right products for all household members and keep an overview. Nevertheless, most participants try to follow a healthy diet through targeted shopping. This is associated with fresh and healthy foods such as vegetables, even if sweets end up in the cart from time to time, either planned or spontaneously. Besides planning, P10 explains how she uses a different app for food sharing and leftover procurement.

> ”I have an app called ”TooGoodToGo”, where you can buy food or dishes or something from supermarkets or restaurants that would otherwise be thrown away. Bundles in principle, with things that will soon expire or no longer look good, but are still edible. And this for little money.” –[P10]

Regarding the overview of the storage of purchased goods, there is also a difference between the younger participants, who tend to be more independent, and those who are responsible for the household stock and organization. The former shop more frequently and have less food at home, which makes it easy to keep track.

> ”Approximately, I have in my head what I have at home, but we also have a lot at home that I have already forgotten that we once bought it.” –[P7]

While for the other participants it is often difficult to reliably know which products they already have at home, especially when they go shopping without extensive planning. In those situations, they sometimes forget to restock certain goods or re-buy products although they are still in their fridge. Similarly, most of the participants are not aware of the shelf-life or decay of their food products, such that they have to dispose some of the food from time to time. P12, here, guesses that around 10% of the food is wasted by her household. Against this background, some participants anticipate a huge chance arising from better technologies, as they might help with a better overview and make things more easy.

> ”And that it’s about making things easier with technologies, which is actually very positive. Because then you don’t have to think about it as much and maybe it works better.” –[P5]

The most commonly used technologies are actually found in cooking. Here, most participants use various websites to search for recipes. As P6 explains, it is also apparent that consumers sometimes search specifically for recipes for the remaining ingredients.

> ”I use that with a recipe app sometimes, that if I somehow have some leftovers where I have no idea what I can fabricate with it, then you can enter a few ingredients there and then a recipe comes up that fits it.” –[P6]

For 3 participants, eating is accompanied by diet trackers, where the calorie balance is tracked or nutrients are monitored for fitness. Here, all food must be recorded manually.

In summary, current food practices are already making use of various digital and non-digital artefacts. While the participants value the simplicity and positive experience with the support of such apps,

some practices are not supported and for others a manual transfer of data is needed, e.g., leftovers to the recipe website to get a recipe recommendation or the receipt to the diet tracker to keep track about the healthiness of ones diet.

4.2 Appropriation of the IHIS

Overall, the participants described the app mostly as a rather interesting and new experience. Interestingly, most participants described their consumption practices as routinized but saw substantial benefits for planning concerning consumers with less time or less experience. Still, participants wished for a more automized system that recognizes their consumption patterns like frequently bought products and preferences to get improved recommendations of recipes and supermarket offers.

> ”Such an app could, if I use it for a longer time, recognize my preferences, what I like to cook or so. Then it would have to somehow combine this with the supermarket nearby and what is currently on offer. If there are a lot of things from the recipe on offer, the app tells me: 'Okay, you have to go to this supermarket, because 3 out of 10 ingredients are on offer and then you save five euros'.” –[P1]

This automated personalization was also evident in the participants' desire for even more data integration. According to their ideas, for example, fitness data, budget specifications, knowledge about local supermarkets, and their own recipes should be included and evaluated to a greater extent. It reflects the positive aspects of the general idea of data integration, offering the mentioned opportunities for better planning and better services.

4.2.1 Shopping

Within the app, shopping lists were only available as a means of procurement with no online purchase options involved. Most of the participants already used lists to better structure their grocery shopping. They appreciated the function to directly transfer the ingredients of a recipe to the shopping list, excluding the items already stored in the virtual fridge. This new experience was welcomed since planning is usually based on a recipe or some idea of a meal.

> ”I liked to use it because it was so handy when you had a recipe, for example, the spring rolls or whatever they are called and that you only have to buy the ingredients. I also knew that I already have these items, but not that item. It was very, very practical.” –[P5]

This quote shows the general appreciation of the practical aspects of combining both the data of recipes and the shopping list. In particular, the ease of just 'checking' the goods already added to the basket is repeatedly mentioned. Some participants were already used to this kind of practice by using pen and paper in the store. However, some participants like P2 reported disliking the idea of handling a smartphone during their grocery shopping, because of the need to carry bags in the store or a perceived socially inappropriateness.

At this point, we observed deliberate trade-offs by our participants. Some of them preferred to stick to a paper-based list, others synchronized both lists. Still, others used the digital version for information needs and then transferred the items on a paper-based list for the shopping trip.

4.2.2 Eating

The app offers a detailed meal-plan with one recipe per mealtime a day. Participants value the preplanned eating routine as well as the inspiration they get.

> ”Usually I think about what I'm going to eat over the week in advance. With the app it's easier, you already get a weekly plan. And then I shop accordingly and try to follow the plan. The app has made everything a bit more creative.” –[P2]

However, some participants wish for more flexibility. They would like to adjust the week plan towards personal preferences, diet choice, fitness goals, and budget. For example, P5 reports that he used diet tracking before to optimize his nutritional input and was missing this kind of feature in the app. Consequently, participants reported on the gap between their personal routine and the meal plan. By ignoring breakfast suggestions, P4 represents a typical deviation from the plan. Most participants eat bread for breakfast, but the app recommends a variety of meals, ranging from muesli to porridge, to fruit salads for a change. Moreover, spontaneous eating-out, cravings, or leftovers lead to the deliberate adaption of the plan.

4.2.3 Preparation

Highly integrated with the meal plan is the provision of recipes for preparation. Participants value the recipes provided by the app as an inspirational source. However, they would further prefer to include their own recipes as well as other recipe resources, such as the popular German recipe website 'chefkoch.de', which was repeatedly mentioned.

> "I don't think you can add, your own recipes in the app. For example, when I say: I would like to make a chicken curry, I need 200 grams of chicken and so much rice and so much rice that you can maybe add it." –[P4]

Further, most of the participants were reluctant to appropriate the recipe recommendation feature for leftovers. As the major issue was remarked that the recommended recipes did not match the physical fridge content, as the maintenance of the virtual entries was too time-consuming. Thus, they felt they had to buy too many additional ingredients to cook.

> "And that you get dishes suggested that you can cook from the leftovers, such that you do not have to go shopping again to get something." –[P7]

Even though the feature was not extensively used, the provided inspiration for leftover-based recipes and the general idea was appreciated especially in the light of sustainability and food waste. As with all recipes, participants adapted them to their personal taste and ingredients available.

4.2.4 Storage

The most critical feature of an IHIS is the storage. Participants mentioned the virtual fridge and its potential for food waste reduction repeatedly as a future strength of the app design.

> "I think it's very positive that when you're out and about, you can look at your smartphone and see what's missing in the fridge without having to go home first. Or also not buying things too much anymore in terms of food waste that you already had at home." –[P11]

However, adding and deleting items of the fridge content was one of the barriers to the appropriation of this particular feature, claimed as time intensive and annoying.

> "I should just simply transfer the stuff I bought into the app. It would have to work digitally somehow." –[P1]

Asked for 'what could make the virtual fridge more attractive', participants articulated a need for automatization and trade-offs between the best-possible data and heuristic assumptions by 'some algorithm'. This can be, for example, just working with some leftovers that need to be used, rather than all of them. At this point, some participants also indicated that the integration of best-before data or assumptions by the system could further improve the value of the virtual fridge.

While the app only supports one user, participants asked for multiple user support. This was most evident regarding the fridge and the shopping list, where multiple household members contribute to shopping and take on their products, such as snacks, from the fridge.

> "If you have entered the contents of your refrigerator and, as in our case, several people have access to it, one of them grabs a yogurt from it and you are convinced it is still there. In principle, everyone who uses the fridge should also maintain the app." –[P6]

In the current version of the app, the user has to keep track of the behavior of others, rather than allowing them to co-maintenance of the virtual fridge content.

5 DISCUSSION

While various IHIS concepts were proposed in research, to the best of our knowledge, there is a lack of research focusing on the appropriateness of these systems to support consumer practices. Moreover, the question arises if the integrated enterprise information systems are a useful role model for consumer practices. Against this background, we aim to discuss the observed usage of the probe as well as the reflection on it towards design implications.

5.1 Enable an Ecology of IHIS Artefacts

Integrated management information systems often consist of a variety of software that support the different processes of the organization Zhang (2016). For example, there are dedicated software systems that support production planning, automate supply chain management or standardize customer relations. Thereby, the different systems are integrated by a central database as well as software overlapping processes.

For the example of food consumption practices, we see a similar ecology of ICT artifacts, although the probe itself offered various services in one app. Our participants used artifacts, ranging from recipe apps to diet trackers to paper-based shopping lists. For all these artifacts, they have their reasons, either because they better fit their practices or simply because they offer better usability or services. Therefore, future IHIS design should respect the individual artifacts choices, but still enable a common data and service platform for integration. This is important as integration is perceived as an key feature that reduces

effort and increases usability. However, for some consumers special apps might be better suited rather than enforcing the services of the IHIS, e.g., for vegans Lawo et al. (2020b). For the same reasons, management information systems offer flexible architectures that allow for a selection of the best fitting software packages. A similar architecture is already used for fitness apps (Gay and Leijdekkers, 2015), where a single platform offers interfaces and data storage to exchange data within an ecology of artifacts.

5.2 Diverse Practices Rather than Optimal Processes

Integrated Business Information Systems are designed to provide optimal processes and therefore have a rather imperative character (Becker and Schütte, 2004). Although the selection of software packages or their customization allows a certain adaptation to own processes, the best-practices of software manufacturers are often adopted. Thereby, the introduction of systems is often combined with a restructuring of processes and the organization.

The variety of practices and diverse personal situations, however, make it very unlikely that users appropriate an imperative IHIS design. This is, for example, resembled in consumers who just go shopping without extensive planning, as they value flexibility over efficiency or reduction of food waste. Moreover, our results indicate that even the IHIS is adapted towards the own routines rather than the other way around. To account for this variety, future IHIS design should be flexible to serve a variety of practices and routines, rather than enforcing 'optimal' food consumption processes. Participants also articulated the wish for a stronger personalization and consideration of the personal situation. This, on the one hand, covers the personalization of their taste preferences, commonly bought groceries, budget, or diet goals. But on the other hand, also more personalization towards the context, for example, the inclusion of supermarket offers and what is avilable in their neighbourhood (Lawo et al., 2021).

5.3 Data Exchange Instead of an Extra Exercise

In the enterprise domain, integrated information systems are usually integrated into a data exchange scheme along the whole supply chain. Master data of products as well as transactions of are exchanged with connected organizations Becker and Schütte (2004). This enables those organization to make better planning decisions and streamlines the processes of the whole supply chain.

In our IHIS probe, consumers need to track and manage their household stock by hand. Moreover, other research shows that a lot of applications come with a manual scanning of data, the search for product information, and tedious tracking of consumption Lawo et al. (2020b). In the IHIS context, the virtual household storage is an essential feature (Angara et al., 2017; Stevens et al., 2017). However, the time-consuming work to maintain the fridges content is a barrier to appropriation. Therefore, future IHIS design focus on two mutually related areas. First, as Stevens et al. (2017) propose, IHIS should be connected to the information supply chain of the retailers and producers, e.g. digital receipt to transfer the master as well as the transaction data. Second, IHIS should automatize inventory maintenance, e.g. through machine-learning. The focus should be on making trade-offs between completely accurate data and anticipated effort (Fuentes et al., 2019).

6 CONCLUSION

New IHIS concepts offer opportunities to account for the integrated nature of food practices. In this paper, we have been concerned with probing IHIS 'in-the-wild', to understand the future design and appropriation of this new class of systems within HCI. Results of our research show how participants embedded the system in their routines rather than adopting predefined practices. Furthermore, we draw attention to the automatization and personalization of IHIS design.

Regarding the limitations of this work, first, we conducted no formal evaluation of the usability, which could extend the results of the interview study to better understand how to design and integrate the relevant features. In addition, the consideration of food retailers as well as the evaluation of the automated transfer of data via a digital receipt is missing. We, therefore, aim to extend the analysis of this study, especially towards a formal evaluation of the usability, as well as the quantitative validation of the usage and usefulness of the functions of an IHIS. Second, we want to co-create our own user-centered IHIS design that better fits the expectations and practices of the users to further study its appropriation.

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