Design Guidelines for Assistance Systems Supporting Sustainable Purchase Decisions

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ABSTRACT

While shoppers increasingly value sustainable products, considering sustainability can be difficult and time-consuming while shopping. In an expert workshop with 22 stakeholders, we gathered requirements for an assistance system supporting customers in identifying the sustainability of products at the point of sale. We integrated the resulting demands in a first mockup prototype, which was tested and discussed with a focus group. From the workshop and the focus group discussion, we deduced a set of ten guidelines for sustainability-oriented assistance systems. These guidelines were transferred into a prototypical mobile application, which allows customers to specify their personal understanding of multiple dimensions of sustainability. According to this profile, they receive easily understandable ratings for scanned products while shopping. A user study in a real supermarket strengthens the deduced guidelines and indicates that such a system can support customers to make more sustainable product choices.

ACM Classification Keywords

H.5.2 Information interfaces and presentation (e.g., HCI): User Interfaces

Author Keywords

System Guidelines; Sustainability; Shopping Assistance

INTRODUCTION

Even though many customers consider sustainability as an important factor in grocery shopping [20], there is a gap between this attitude and actual behavior when purchasing [2, 34]. One reason for this is the required time and space in one's life to become involved in the topic [37]. Even consumers acquainted with sustainability need to invest further time within the store to read product packages and compare the given information with the aspects they are concerned with. This contrasts with the approach humans typically use to make quick decisions, where only a very few important cues are considered and most of the available data is ignored [32]. Generally, grocery shopping can be seen as a mix of routine elements with advanced cognitive and emotional processes [13], where a wide variety of factors impact our food decision making (cf. [29] for an extensive interdisciplinary survey). Due to the time constraints customers usually face when shopping, purchase decisions are to a large degree automatic, unconscious and intuitive, and therefore not purely rational [6]. Even when customers attempt to buy more sustainable products, they often lack confidence in their ability to identify appropriate products [23]. One possible approach to overcome this problem is the use of persuasive computing systems [12]. But how should systems guiding customers towards more sustainable products at the point of sale be designed? How can the complexity of the topic of sustainability be integrated into easily understandable and usable assistance systems, and how can we ensure that customers accept this?

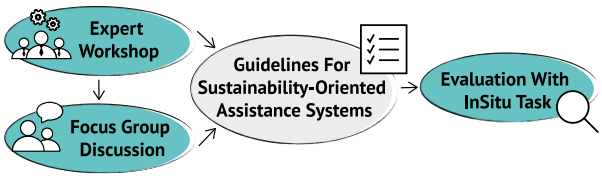


Figure 1. Process of guideline deduction and evaluation.

We address these questions by developing guidelines for sustainability-oriented assistance systems at the point of sale in a multi-step approach (cf. Figure 1). After discussing related works, a workshop is carried out to gather requirements from several stakeholders. A mockup prototype incorporating the findings from the workshop is discussed with a focus group of sustainability-oriented shoppers. Ten guidelines based on the literature analysis, the workshop, and the focus group discussion are deduced and explained in detail. In order to strengthen these guidelines, we implement an assistance system guiding customers towards more sustainable products at the point of sale and evaluate it in a user study conducted in a real supermarket. Finally, we discuss the implications of these guidelines to sustainability-oriented shopping applications.

RELATED WORK

Several freely and commercially available tools providing assistance regarding sustainability exist: websites calculating

DIS 2018, June 9–13, 2018, Hong Kong.

ACM 978-1-4503-5198-0/18/06…$15.00
DOI: https://doi.org/10.1145/3196709.3196726

carbon footprint[1]; apps providing information on product labels[2], on catch methods[3], or on seasonal produce[4]. Apart from these single-dimensional tools, apps providing information on multiple aspects such as price, ingredients and sustainability information about retailers[5] also exist. The application offering the most information on sustainability aspects we found is Code Check[6], which provides expert ratings, nutrition values visualized in a traffic-light style, warnings for harmful substances or allergens, and information about palm oil and vegan food. However, these tools usually only work for a small subset of products, consider only a few aspects of sustainability, or are only designed for interested users as a reference.

The research area of sustainable HCI [11] analyzes the use of interactive technology to work towards more sustainability, with a growing interest in the food domain. Since the food supply chain is a large and complex construct, it is hard to simultaneously design for change in every link in the chain. Therefore, we focus on the point of sale, since a shift in consumer buying habits also indirectly influences all other parts of the chain. A recent study on the varying place food has in people's lives proposes that computing systems should draw awareness on the environmental impacts of food and offer supporting perspectives on products [9].

An early system called the iGrocer [25], offers product recommendations based on nutritional profiles specified by the user to support healthier lifestyles. Kallehave et al. [16] also want to motivate a healthier shopping behavior by using the two persuasive techniques already introduced by Fogg [12]: reduction and suggestion. While the reduction of complex nutrition values to three simple classes changed the purchase decisions in an experiment, the suggestions of more nutritious products rarely did so and were perceived as ads. When asked who should perform this classification , the participants stated it should be controlled and accredited by public authorities. Another approach to enable reflection about nutrition called Nutriflect was presented by Reitberger et al. [22]. It shows a household's collective food consumption patterns and compares the aggregated nutritions of bought products to the food pyramid. Furthermore, people can define their own goals, e.g. in terms of calories, and receive simple visualizations. Ahn et al. [1] present an augmented reality approach focusing on healthier purchase decisions by providing real-time, customized recommendations on healthy products.

In an experience report on challenges in designing mobile sustainable HCI systems [19], Linehan et al. present a system allowing users to upload images to a social media platform, where they are tagged according to how well they fit into the slow food movement. These tags should help in understanding the sustainability of one's own food choices, and personal goals can also be set. Kalnikaite et al. [18] present a clip-on handle for standard supermarket carts, containing a barcode scanner, a tiny display, and a row of LEDs. When a user scans a product, the LEDs show whether the product is organic and regional, while the display visualizes the relation between the average mileage of products in the cart in comparison to other customers. The authors also express that it could be generalized for other sustainability aspects by letting the LEDs display nutritional, ethical, environmental or organic information on products [4]. In an in situ task the authors could show that the system, when used for food miles, nudges customers towards more regional products. Clear and Friday [8] present a *food qualculator*, calculating and color coding the carbon footprint of item in a shopping list. Furthermore, additional information on sustainable usage is provided. Blevis [5] proposed to create similar calculators for organic and fair-trade properties.

Ecofriends [30] supports users in conceptualizing their own understanding of seasonality. For this, information from the user's group of ecofriends, experts and the general public is presented, where the system dynamically gathers information about the origin of products. Users testing the system were particularly interested in pursuing the truth and understood these information fragments as catalysts for opinion-making. The EcoPanel [6] also focuses on critical reflection of food choice practices, specifically for organic products. By using the receipt data of a retailer, the system provides insights into the percentage of organic products. Additionally, the system provides information about sustainability and it suggests items that should be bought organic. An evaluation showed a 23.3% increase of organic products bought [38].

Apart from these related works presenting concrete systems, other works have already provided some insight into possible design guidelines for sustainability-oriented assistance systems: Todd et al. [31] argue that the challenge is to balance the need to simplify and streamline information with the need to provide enough information. The goal is to provide just enough information in the right form to facilitate good choices, thus pruning down the complex information in order to not overwhelm the customer. Kalnikaite et al. [17] found that the salience of information is especially important because grocery shoppers rapidly select products considering only a very few factors. Overall, they present three design guidelines for product information technologies used by supermarket shoppers: 1) the amount of information should be kept to a minimum, 2) the product information must be presented in a simple form, and 3) the displayed information should be personalizable. Jong et al. [10] evaluated a system that allows users to explore and negotiate different food values collaboratively, e.g. with other family members. Particularly interesting are the two important factors people base their food choices on: 1) the trustworthiness of information and 2) balancing different food values, e.g. focusing on health vs. financial aspects. While not specifically focusing on sustainable shopping, general design principles for persuasive systems were outlined in [21], of which many like reduction, personalization or trustworthiness also hold for sustainable purchasing which will be shown in this paper.

[1] http://www.footprintnetwork.org/resources/footprint-calculator
[2] https://itunes.apple.com/de/app/id857722032
[3] https://play.google.com/store/apps/details?id=duesseldorf.greenpeace.de.fischratgeber
[4] https://play.google.com/store/apps/details?id=com.nbapps.gokalender
[5] https://itunes.apple.com/de/app/id339525465
[6] https://play.google.com/store/apps/details?id=ch.ethz.im.codecheck, all links last accessed: March 20, 2018

Summarizing, the literature review showed that behavior changes can be induced by shopping assistance systems towards more sustainable purchase decisions. Apart from the few guidelines presented above, most related works focused on providing new systems and proving that these can induce behavior changes. The different systems dealt with different aspects of sustainability, such as food miles or organic production; however, the question of which aspect actually is the most important remains unanswered. We have also seen that it helps users if they can specify their own goals or diets and the system considers these. How far should such personalization options go? Furthermore, while simple visualizations have been proven effective, a large variety of possibilities to present salient information exists and the huge amount of related systems has shown that many of these can persuade users; however, we could not find a comparison of different options in this context. In contrast to the presented works, we want to involve multiple stakeholders and potential users early on to deduce a set of well-founded guidelines.

WORKSHOP

We conducted a one-day workshop to gather requirements and to deduce an initial set of guidelines for a sustainability-oriented assistance system. Overall, 22 highly relevant stakeholders participated, who could be grouped into the following roles: researchers of the areas HCI & sustainability, retailers, potential end-users, standardization service providers, consumer protection, technology & service providers for retailers, designers, and teachers in the field of retailing. This heterogeneity allowed us to look at the topic from different perspectives. The workshop took place at a living lab where assistance systems for retailing are demonstrated [26]. This way, the participants experienced modern technologies and could be inspired by the demonstrated systems' capabilities.

The workshop started with a brainstorming session to gather the stakeholders' requirements for an assistance system. To facilitate the debate, we presented several prototype concepts targeting single aspects of sustainability (e.g. the carbon footprint or seasonality), which were identified during a small group discussion after reviewing the literature. The participants identified several difficulties customers face when intending to buy sustainable products. For example, an immense and confusing variety of labels on packages exists, some designed only for marketing purposes. Therefore, an assistance system should provide additional information about information printed on the packaging. Furthermore, the importance of the data basis used for a sustainability-oriented assistance system was emphasized: the reliability of the data and the trust in the data provider would be a major factor concerning the user acceptance of the system. Currently existing projects visualizing the complete product chain[7] or the overall ecological footprint (myEcoCost [35]) still only offer data for very few products. The discussions also showed that the priorities regarding different aspects of sustainability vary from individual to individual, and that no common definition could be agreed on. Therefore, a customer guidance assistance system needs to be personalizable to the user's own prioritization.

[7]http://www.ftrace.com/, last accessed: March 20, 2018

The second part of the workshop had the objective to transform the above results into a more concrete concept for a prototype. To facilitate participation and to allow for potential group differences, the stakeholders were split into two groups. Even though the groups worked independently, both came to the conclusion that multiple dimensions of sustainability have to be integrated into the prototype to achieve broad user acceptance. Considered aspects of sustainability could be regional origins, organic production, animal protection, genetic engineering or contained allergens. Since the prioritization of these aspects differs between users, there should be a possibility to weight them accordingly. Still, the visualization of a product's sustainability, given a user's profile, should be kept simple and easily comparable.

Summarizing, the main findings of the workshop can be stated in form of the following guidelines: Incorporate multiple dimensions of sustainability (**G1**); Use reliable and trustworthy data (**G2**); Offer personalization functionality to reflect the user's individual understanding of sustainability (**G3**); Use easily understandable visualizations for complex information while ensuring transparency (**G4**); Provide additional information about the sustainability aspects of products (**G5**). We will extend this initial set of guidelines throughout the paper.

FOCUS GROUP DISCUSSION

To refine and extend our findings from the workshop, we conceptualized and implemented a rudimentary mockup illustrating our first findings in oder to discuss them with a focus group of sustainable-oriented shoppers.

Mockup Prototype

We created a mockup prototype on a mobile phone where participants could specify their own sustainability profile, scan products and receive (simulated) ratings about how well the products match this profile. The dimensions of sustainability in the profile comprise regional origins, product labels (including e.g. fair trade, organic production), catch methods for fish, allergens, and consumption accelerators (*G1*). Since the displayed information was simulated for this evaluation, *G2* was only targeted in the discussion. Each aspect of sustainability could be personalized in a menu (e.g. how many food miles are considered regional) (*G3*). In order to provide intuitively understandable information, a thumb representing the simulated rating for each sustainability aspect was displayed as an overlay (*G4*). Furthermore, users could view additional information about the labels by being redirected to the label's official website (*G5*).

Method

The focus group evaluation and discussion took place at a real supermarket. In total, nine paid participants (5 female, 4 male, aged 20 to 39) took part in this initial evaluation. All participants placed high or very high importance on the topic of environmental and social sustainability. One participant stated that she had already tested a wide variety of shopping apps but was not contented with any.

We created two comparable shopping lists where items were defined broadly and without specifying a brand, to offer flexibility when selecting a specific product. The lists contained

fruits and vegetables to target the regionality and genetic engineering aspects, and fish for the catch methods; coffee and chocolate for fair trade, and dairy products for organic production. Consumption acceleration was reflected only for drug store items, where the mockup also offered the possibility to view instructions for sustainable use.

First, the volunteers were asked to go shopping in as normal a way as possible, without any assistance; half of them received the first shopping list and the other half the second list. This first shopping trip had the purpose to get them comfortable with the store and to have them recall their usual shopping behavior, thus allowing a better assessment of changes induced by shopping with our prototype. After finishing the purchases, the subjects received a brief introduction to the application, set their profile, and went shopping again with the simulated support of the mobile application; however, not knowing that the received ratings were faked. The shopping lists were exchanged in order to mitigate learning effects. Following the second shopping trip, qualitative feedback was obtained from the subjects in a semi-structured group discussion with all participants to obtain qualitative feedback on the guidelines deduced from the workshop after having tested a prototypical mockup thereof. Among other things, it was important to learn if our findings in the workshop still hold in a practical test, and which other aspects sustainability-oriented assistance systems should incorporate. Since the overall goal of such assistance systems is to help customers to buy more sustainable products, it was particularly important to analyze the participants' opinions on possible steering effects. Overall the study took five hours, including the three-hour focus group discussion.

Results

We can partition the outcome of the discussion into three categories: reported changes of behavior, discussions about the application, and occurring side effects.

Behavior Change

When asked if their purchasing behavior has changed through the assistant system, the participants unanimously agreed. With regard to a possible nudge effect on the purchase decision, several participants stated that they purchased a product other than their usual choice, since the mockup told them that this matched their sustainability profile better. For example, a subject had chosen a toothpaste other than his usual one because the visualization stated that it was produced nearby. Likewise, several participants stated that they compared many products with each other rather than purchasing the standard product of a trusted brand, which also made a subject find a cheaper product with a better simulated rating than his usual choice. All subjects also believed that when customers are unable to find items matching their profile due to a limited selection, they would switch to another store to find a substitute.

Discussions About the Application

Several participants reported that the resulting rating often did not make sense, which was the case since simulated instead of correct data was used to compute the rating. In a discussion about potential data sources and providers, similar statements to those of the innovation workshop were made, namely that the trust in the data was seen as important and should be assured by neutral organizations, such as consumer protection. One participant requested better support for vegans in the application, which he imagined to be a form of exclusion criteria. Another sustainability aspect that the participants suggested was to include the producer and corresponding umbrella brand, either by simply visualizing it when scanning, or even by incorporating it into the rating function. A further idea was to automatically show which product within a category matches best to the user's profile upon scanning. Moreover, the explanations given in the prototype, such as information about labels was appreciated by all participants, as they would educate users. One participant stated that, even more information about sustainability should be integrated to strengthen this learning aspect. While the participants did not notice that consumption acceleration was considered when rating drugstore products, they liked the concept and its integration in the prototype. Furthermore, they proposed to additionally include a feedback channel to the producer to complain about accelerated consumption through badly designed packages. Another proposal the subjects agreed on was to define individual profiles for different product categories since regional origins might be considered more important for fresh produce.

Side Effects

The shopping experience with the application was described as "zombie-like" by two participants, since the application was used to explore nearly every product. Due to this exploration, some participants stated that using the app would take time; however, others argued it would save time since reading packages becomes superfluous. Nevertheless, it was argued and agreed that users would quickly learn which standard products fit their profile, so the amount of scans would decline over time. A participant argued that some users might define low sustainability requirements in their profile to calm their own conscience with the resulting better ratings. In the discussion, they also described that rebound effects [3] might occur: customers might be less sustainable in other areas because they buy more sustainable groceries with the prototype. Nevertheless, the potential of the application was recognized to lead to more sustainable purchasing without investing too much time.

DESIGN GUIDELINES FOR SUSTAINABILITY-ORIENTED ASSISTANCE SYSTEMS

Based on the literature, our initial requirements derived from a workshop with experts, and the qualitative feedback received from our focus group evaluation, we deduced ten design guidelines for sustainability-oriented assistance systems, summarized at the end of this section.

Due to the complexity, it is hard to define how sustainable an item is. It is therefore partly a value judgment [19]. Both in the workshop and in the group discussion participants stated that a variety of sustainability dimensions should be incorporated and considered in combination with each other instead of individually. The following aspects were mentioned: regional origins, product labels (including e.g. fair trade, organic production), catch methods for fish, allergens, vegetarianism, veganism, consumption acceleration, and umbrella brands. However, more dimensions can be considered to support special diets, help avoid micro-plastic, etc. Therefore, we do not

believe that this is a complete set, but we argue that multiple dimensions need to be considered to reach a broad user base and that assistance systems should be easily extendable to further dimensions (**G1**). Balancing different food values is also a topic discussed in the literature [10] and it is in line with the statements of participants of related studies, who reported considering multiple aspects to different extents [16, 30].

In both discussions, the participants emphasized the importance of reliable data sources. Instead of producers and retailers, who might only try to maximize profits, a trustworthy independent institution (e.g. customer protection) should provide verified, reliable and always up-to-date data (**G2**). This again is in line with [10] and reported statements of participants in [16] arguing for data accredited by public authorities.

People have a highly individual understanding of sustainability. For example, our participants had different opinions about the importance of regional origins, and even those placing similar importance on the topic had different views on concrete distances that can be considered regional. Furthermore, sustainability is always a trade-off. It remains unclear if a fish with plenty of food miles is more or less sustainable than one being caught with a less sustainable method nearby. Thus, assistance systems should offer personalization settings to reflect individual preferences (**G3**).

In accordance with [17], the saliency of information is especially important because decisions at the point of sale are being made rapidly. Still, it should be possible to get understandable and transparent information on how the salient information was determined. Hence, such assistance systems should provide an easily understandable visualization despite the complexity of sustainability aspects (**G4**). This also matches the findings of [36], stating that services on mobile phones should not present as much information as possible, but rather present precise and well-aggregated information.

To bring the topic of sustainability to a broader target group and to educate users without overwhelming them with information, details for interested users should be accessible according to our focus group. It should be easy to look up unknown aspects; however, participants need not be patronized by the system. Due to the high complexity, such assistance systems should not only assist the user, but also provide additional information about sustainability aspects to encourage participants to learn about the topic (**G5**). The issue of not understanding what certain sustainability markings mean (e.g. a label) has also been reported by a participant of [30].

The focus while shopping should remain on the shopping itself instead of transitioning mostly to the assistance system. Users should be able to perceive all relevant information in a short period of time to reduce the "zombie-like" effect mentioned by some participants in our focus group. Therefore, it is important to reduce interactions with the system to a minimum (**G6**).

As reported by our participants, the relevance of different dimensions of sustainability differs depending on the product category. For example, regional origins could have a high importance for locally grown vegetables and eggs, but are less important for coffee where regionally grown alternatives do not exist. As stated by a participant, customers know that coffee has lots of food miles, but they drink it anyway. Therefore it is important to discern better alternatives based on other aspects such as fair trade, instead of receiving bad ratings for all options. Summarizing, the importance of different dimensions of sustainability differs across categories; thus it should be possible to use a category-dependent weighting of the different sustainability aspects (**G7**).

Purchasing and consumption is only a single part of the whole food supply chain. In both groups, participants argued for not only presenting information to the user but also making it possible to give individual feedback. In addition, users should have the possibility to define the recipient of the feedback (e.g. retailers, producers, or a specific community). Especially information on consumption-accelerating packaging or the ingredient list could be reported back to the originators. Even though losses can occur due to a transition of customer choices to more sustainable products and propagate through the food supply chain, this can help and speed up the transition to more sustainable groceries by providing a feedback channel (**G8**).

As reported by a participant of the focus group, believing one has made more sustainable purchases could lead users to a less sustainable lifestyle elsewhere, e.g. by driving more than usual. Therefore, explicitly stating savings through the assistance system can on the one hand be motivating, but on the other hand it can have negative impacts elsewhere. While such rebound effects can never be entirely avoided, it is important to take them into consideration when designing such systems, e.g. by considering the impact on the Sustainable Development Goals (SDGs) [24] (**G9**).

Despite the discussion within the focus group on whether using the prototype is time consuming or time saving, all participants agreed that the system would not be used for each purchase decision. Since humans tend to buy the same products frequently, these systems are mainly relevant for initial purchases in a category, or infrequent checks for changes. Therefore, the applications should be designed for lookup usage by being immediately able to analyze products (**G10**).

All guidelines can be summarized as follows:

G1 Incorporate multiple dimensions of sustainability

G2 Use reliable and trustworthy data

G3 Offer personalization functionality to reflect the user's individual understanding of sustainability

G4 Use easily understandable visualizations for complex information while ensuring transparency

G5 Provide additional information to educate interested users

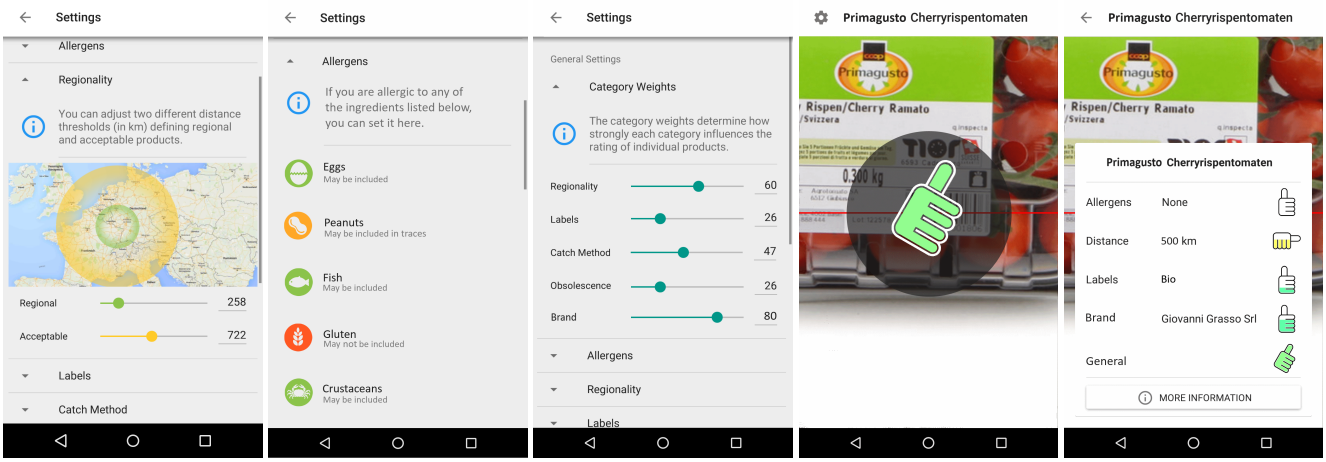
G6 Reduce active interactions while keeping the information at a glance

G7 Offer the possibility to use different personalization settings for different categories

G8 Provide a feedback channel to other parts of the food supply chain

G9 Consider potential rebound effects

G10 Design for infrequent, mainly quick lookup use



(a) Personalizing the meaning of regionality.

(b) Defining own allergic profile.

(c) Assigning weights to the different aspects.

(d) Thumb visualization of the sustainability rating.

(e) More detailed visualization of the rating.

Figure 2. Screenshots of our prototype.

PROTOTYPICAL IMPLEMENTATION OF ALL GUIDELINES

We created a prototype demonstrating our findings. Overall, the following aspects of sustainability are considered (*G1*): regional origins, product labels, catch methods for fish, allergens, obsolescence, and umbrella brands. We decided not to include price and suggestions of alternative products, as this would require supermarket-specific data, while the assortment and prices are subject to frequent change. Furthermore, we excluded explicit support for vegans/vegetarians, since it is often unclear if the production process required animal products (e.g. rennet is required to produce Parmesan). However, the prototype was created to be easily extendable to any further dimension of sustainability. For regionality we compute the distances between the origin of products and the user's location. While this does not completely cover carbon emissions, participants of our discussions still valued regional products to support the local economy. We incorporated labels since they already reflect a variety of sustainability aspects such as organic production, fair trade, genetic engineering or responsible management of forests. It is also possible to cluster and order a set of labels, e.g. to express that the requirements for some eco-labels are stronger than those of others. The catch methods were integrated as indicators for sustainable fishing. Allergens are considered in the prototype to avoid wasting food and to protect customers from food intolerances. Obsolescence in this context relates to in-built consumption accelerators, such as a toothpaste tube with a larger opening than necessary. Umbrella brands were considered to reflect the fact that most food is produced by one of the ten largest companies, which place different importance on sustainability[8].

We checked available data providers to realize such a prototype, but no source we found had independently verified information on sustainability aspects for a variety of products. Therefore, we decided to manually acquire the data for the evaluation of the prototype. A mobile application was created to enter relevant data and upload it to a database. We used the information on the packages which is required to be printed due to European law, assuming that this information will be available in digital and verified form in the near future (*G2*).

Overall, the prototype consists of three main parts: setting the sustainability profile, scanning the barcodes of products to see how well they match the stored user profile, and a clear and transparent visualization of the result. To fulfill the requirement of personalization to the user's own understanding of sustainability (*G3*), several configuration possibilities are offered. For each label it can be defined whether it is considered important or not. For regionality, two threshold distances can be defined: distances below the lower bound are considered regional, everything above the upper bound should be avoided, and everything in between is acceptable (cf. Figure 2a). Similar settings are used for the catch methods and umbrella brands, where users can define whether they are favored, tolerated or disliked. No settings for obsolescence have to be made, since the database value directly indicates if a product accelerates consumption. For allergens the user can simply define whether an allergen can be present in large amounts, only in traces, or not at all (cf. Figure 2b). Products leading to allergic reactions are visualized as not purchasable. Finally, labels, regionality, catch methods, umbrella brands and obsolescence can be proportionally weighted according to perceived importance (cf. Figure 2c). This weighting is reflected in a simple rating function comparing product information with the user's profile. An individual score for every sustainability aspect is calculated and used in the overall rating by computing the weighted average.

This combined rating was used for a clear representation (*G4*) in form of a thumb (cf. Figure 2d). The rotation and color indicate how well the product matches the user's profile. Besides this quick overlay, allowing the user to quickly scan a variety of products without any touch interaction (*G6*), two more detailed visualizations are implemented. After clicking

[8] https://www.oxfam.org/sites/www.oxfam.org/files/file_attachments/bp-journey-to-sustainable-food-btb-190416-en.pdf, last accessed: March 20, 2018

on the thumb, an overlay showing the ratings for individual aspects of sustainability (rotation) and their influence on the overall result (fill level) is shown (cf. Figure 2e). If even more information is requested, a full-screen visualization of all product data is displayed. The general settings are applied to each product category except for those where the user has defined separate settings (*G7*).

Furthermore, the app provides the possibility to receive information about labels or catch methods by clicking an information icon next to the entry (*G5*). This is realized by showing a short text with an illustration and linking to more information (official websites and consumer protection information about labels or explanation of the catch methods by Greenpeace).

Since a feedback channel to other parts of the food supply chain (*G8*) would most likely only be used after having bought and tested a product, we did not integrate this feature into the prototype but instead only considered it in the evaluation. Furthermore, we tried not to provoke rebound effects (*G9*) by avoiding statements about benefits in comparison to the average product within a category and by positive reinforcement through the thumb visualization. Generally, we optimized the design of the application for quick lookups while at the point of sale (*G10*), i.e. the camera-based scanner directly opens on startup such that products can be rated and compared. Due to this infrequent, mainly lookup-based use case, the decision to use mobile phones, which are a permanent companion, was made. Bird et al. [4] argue that repeated access to mobile phones should be avoided, which is in line with Underhill [33] emphasizing the importance of having the hands free while shopping. Therefore, we added a 3D-printed phone holder to the shopping cart, which the participants could use.

EVALUATION

Since our guidelines were primarily deduced from discussions within the workshop and the focus group, we wanted to verify and strengthen our findings with an evaluation of the prototype.

Method

We performed an in situ task at a real supermarket similiar to Kalnikaite et al. [18]. The store offers over 100,000 items to ensure a sufficiently wide product range to select from. Instead of acquiring the data for all products in the store, we created two comparable shopping lists for which we gathered all data and which was then used during the evaluation (cf. Table 1). The organic labels were clustered and rated according to available sources online. Furthermore, we integrated a mapping from brand to umbrella brand. The obsolescence values were simulated, since currently, no well-founded data is available. However, as crowd-based information pools are emerging[9], we decided to incorporate it for the evaluation with artificial values in order to obtain user feedback, knowing that the concrete data is neither represented nor verifiable while shopping.

Participants had to go shopping twice, once with and once without the assistance system in counterbalanced order. Some started with shopping list 1 while others started with list 2. For both shopping trips we gave the participants the following scenario to consider: "Friends who run a website on sustainable lifestyle live with you over the weekend. You want to purchase this list of products for their stay. Please make your purchasing decisions as you would normally, but consider your guests' preferences. Please buy exactly those products that are on the list." This scenario had the purpose to ensure that participants considered sustainability while shopping but also tried to use their usual heuristics for making purchase decisions (e.g. pricing). By asking them to buy exactly the items on the list, we aimed for compatibility by avoiding products for special diets.

Shopping List 1		**Shopping List 2**	
deep frozen salmon	(6)	deep frozen saithe	(3)
fresh milk	(34)	yoghurt	(54)
ground coffee	(43)	milk chocolate bars	(30)
chocolate muesli	(39)	spaghetti	(42)
packaged tomatoes	(19)	packaged apples	(15)
toothpaste	(119)	liquid toilet cleaner	(77)

Table 1. The shopping lists used in the evaluations and the amount of products to select from.

We explicitly designed the study to validate our guidelines by providing specific questionnaires including yes/no or Likert-scale questions, usually followed by a free-text answer to explain the quantitative statement. Overall, the study comprises 54 questions. We explicitly do not focus on quantitative measurements such as product interactions or times, since these depend on too many variables which cannot easily be fixed. For example, the amount of inspected products could depend on how often the participant buys this product, whether he has a clear preference based on taste, or social factors. Thus, any result found using such metrics would be highly questionable.

The study consisted of four blocks with counterbalanced order of blocks 2 and 3: *Attitude towards sustainability* (**B1**); *Shopping with app* (**B2**); *Shopping without app* (**B3**); *Comparison and demographics* (**B4**). Initially the general attitude towards sustainability was assessed with a questionnaire (*B1*). In preparation for the app usage, the participants received an introduction to the app including a brief explanation of the profile setting. After this, they specified their individual user profile in the app, followed by a questionnaire regarding the personalization possibilities. Then the participants were asked to go shopping with the possibility to use the prototype and to fill out a questionnaire on app usage (*B2*). The third block comprises a shopping trip without any assistance system (*B3*). In both shopping blocks (*B2* and *B3*), an experimenter followed the participants to observe and ask why they chose the products that they did. After each shopping trip, the participants had to fill out a custom questionnaire about the sustainability considerations during that shopping trip. In the last block (*B4*), the participants had to answer a few questions comparing the two shopping trips and to provide demographical data.

Overall 16 paid participants (m=9, f=7) aged 20 to 39 participated in the evaluation. All participants self-assessed their smartphone knowledge as good (6) or very good (10) and the

[9] http://www.murks-nein-danke.de/murksmelden/, last accessed: March 20, 2018

vast majority of participants reported that they were able to place themselves in the given scenario after the study (8 yes, 5 mostly, 1 less, 1 no). 13 participants classified themselves as price-oriented shoppers, which is in line with their ratings on the importance of environmental, health, profitability, social, and quality aspects while shopping, where profitability was on average rated highest. Only few participants normally used shopping apps: 4 knew but did not regularly use crowd-based apps providing additional product information, 2 used shopping list apps and 1 subject reported he had used an app classifying products as vegan/vegetarian before, however, it had only a small product database and no scanning possibility.

Results and Discussion

In general, the study took between 90 and 120 minutes. Overall 15 of our participants reported that the assistance system helps users in sustainable shopping. They stated that the additional information supported them in their decision making process and that the fast overview of own relevant aspects due to the very detailed profile setting makes it easy to search and compare. The single participant that disagreed with all others reported that the system is very cumbersome and does not add value. Therefore, he also only used the app for very few products in B2. 11 participants stated they would use such an assistance system (*yes* or *rather*), while the remaining 5 declined (*rather not* or *no*). Reasons for using the system are the combined presentation of multiple sustainability aspects as well as learning which products fit to their profile. The most common reason against using such an application was that these participants were not interested in sustainability aspects at all while shopping. However, 3 of these 5 participants still argued that they would use it at times to gain an overview but not regularly. Interestingly, 7 participants reported that they would pay for such an application. The payment readiness along with general feedback provided on the final questionnaire (e.g. "Please bring it to market" or "the purchase decision becomes better") strengthen the necessity of such an assistance system. This statement is consistent with the results that 13 participants would (*definitely* or *rather*) prefer the app for sustainable purchasing, while 3 would (*definitely* or *rather*) not use such an assistance system while shopping in a supermarket. The main hurdle reported in purchasing sustainable products without such an app was the users' little background knowledge (e.g. about the meaning of labels).

Multiple Sustainability Dimensions

Before presenting any sustainability dimension, we asked the participants for criteria they use in their usual purchase decisions and which additional criteria they would consider in sustainable purchase decisions. All specified at least two different aspects of sustainability, either in their normal shopping behavior or in the extended setting, which substantiates the need to incorporate multiple dimensions. After each purchase decision, participants stated the reason of their choice. Many decisions were influenced by the system (e.g. bad ratings of the product they preferred first), physical parameters (e.g. material or product design), social feedback (e.g. toothpaste recommendation by a friend who is a dentist assistance), or smell and taste, just to state a few. These statements illustrate the complex interplay of a variety of factors when making a purchase decision. Thus, sustainability-oriented assistance systems should consider the topic as a whole such that it can act as one aggregated factor in the overall complex process of decision making. 11 subjects did not miss any aspect of sustainability in our prototype. The others stated that CO2 emissions, materials, price, and a larger selection of brands would be valuable extensions. The results of the workshop, the focus group discussion, and this user study demonstrate the need of including multiple sustainability aspects for assisting users in their decision processes. Due to the large variety of these aspects, the system should comprise the most important ones and must be easily expandable to further aspects (*G1*).

Trust in Data

After having learned about the importance of the trust in data in literature, discussions during the workshop and the focus group, there was already a lot of evidence for *G2* before the user study. However, we wanted to learn which potential data provider is perceived as trustworthy by our participants. As expected and stated in the prior discussions, independent organizations such as consumer protection were favored, with half considering them as *trustworthy*, and the other half as *rather trustworthy*; therefore, sustainability-oriented applications should use such organizations as data providers. The second best option would be a community (2 *trustworthy*, 9 *rather trustworthy*, 5 *rather not trustworthy*). Interestingly, retailers and producers were both considered the worst among the four, with not a single vote for *trustworthy*.

Personalization

13 participants reported that the personalization option implemented in the prototype is useful and sufficient, while the others even requested more specification possibilities, such as a vegan mode or specific options for meat. Looking at the variety of used profiles during the evaluation substantiates the requirement of individual personalization options and therefore *G3*. Due to the large set of options when defining the profile setting, we analyzed if users struggle with these settings. Overall, the participants found it quite easy to set the profile (5 reported it as *very easy*, 8 *easy*, and only 3 *hard*). However, setting the profile was relatively time-consuming with an average of 7:08 minutes (min=3:19 to max=16:00).

Simple Visualization

Prior to the presentation of our app, we asked the participants to describe or draw a possible visualization of a product's sustainability. 7 of 13 answers pleaded for a simple visualization such as a scale, star-rating, smiley or color coding. However, also the transparency, trust and incorporation of multiple aspects were mentioned. Other participants proposed a table or checklist style about the individual dimensions. Regarding the implemented visualization of resulting ratings, 11 subjects agreed that it was helpful and easily understandable. When asked to select the favorite level of detail implemented in the prototype, 12 participants preferred the medium detailed visualization which makes the overall rating more transparent, while 3 preferred to have only the thumb. None favored the fully detailed information. This shows that the visualization of sustainability in shopping assistance systems should be kept simple but still transparent, supporting *G4*. 13 participants

found it easier to make sustainable purchase decisions with the app. As reasons for this simplification, they stated that less searching on packages is necessary, that more information than available on the packages exists, and that the simple visualization of the important factors saves time.

Background Information

13 participants rated the possibility to view additional information about labels or catch methods as *very good* or *good* and stated that they learned through this information, while the remaining 3 found it *bad* or *very bad*. Reasons for the bad ratings do not comprise the concept but claims about the concrete implementation. Instead of integrating the summarized (dynamic) content into our app, we linked directly to the official websites and analyzing meta-websites in order to provide founded and up-to-date data. However, these participants would have preferred in-app information. Nevertheless, the fact that the majority of participants highly appreciated the simple possibility to receive additional information and their statements that they learned through this data support *G5*.

Reduce Interactions

In accordance with the focus group discussion, we tried to reduce the amount of interactions with the app. For this, we printed a mount for the smartphone and attached it to the handle of a shopping cart to support a hands-free shopping experience when not using the smartphone. Contrary to our expectations, the phone holder was not used by 11 participants. However, none reported something similar to the "zombie-like" shopping experience stated by two participants in our focus group. While we could not verify that interactions should be minimized due to the study setup, we believe that this holds true and should be considered in sustainability-oriented assistance systems as for all assistance systems in general. To prove this, multiple interaction formats need to be compared, which is not the scope of this paper. However, our previous findings with the focus group and the participants' opinions on the simple approach to retrieve information, strengthen *G6*.

Category-Dependent Settings

Before getting information about the app and the profile setting, 6 participants stated that different aspects are important for different categories, while 10 did not express that they distinguish in that regard. However, half of the participants used the category-dependent profile settings and argued that this would be especially useful for fish, drugstore items, or coffee. The other half did not use this feature, three reporting it was too much effort to do within the study, which could be an indicator that well-founded default values are needed. Since many participants actually used category-dependent settings, this feature is not only relevant to the interviewed stakeholders and our focus group, but also to the general public with less background in the topic, thus supporting *G7*.

Feedback Channel

Even though we did not implement a feedback channel since we assume it to become relevant only after using a product, we asked the participants in the questionnaire for their feedback. 10 subjects reported that they are interested in a feedback channel to producers, retailers or communities, while 6 declined this. It was argued that they would not have time, are not interested in general, or found it sufficient to mention the feedback implicitly by (not) buying a product. When designing feedback functionality, focusing on a simple mechanism with few interactions might convince some of these participants to use it anyways. However, the majority stated that they would want a feedback channel, thus strengthening *G8*.

Rebound Effects

Concrete approaches to avoid rebound effects are hard to measure, especially in short-term studies. In both discussions before the study, the topic was introduced independently by some participants. Since there is no general measurement, we can only encourage the designers of sustainability-oriented assistance systems to consider possible rebound effects (*G9*).

Lookup Use

All participants agreed that such an app is not made to be used every single time. Two reported they would only use it a single time per product, while all others stated that they would use the application either at regular intervals or depending on the category. This shows that such applications should be designed for lookup scenarios as stated in *G10*.

Feature Requests

As general feedback, two participants suggested that the system should memorize the already scanned products and offer comparison functionality. Furthermore, similar features as in the focus group were requested: 7 subjects stated that the app should either automatically compare all products in a category when scanning one or directly suggest the best one within the category. We did not integrate this due to the findings of Kallehave et al. [16] that suggestions had no large influence on purchasing behavior and the fact that in real-life scenarios the assortment of the retailer is unknown. However, since we found that 11 participants stated that they would consider the existence of such an application when selecting the store, we see the possibility that retailers might actually be supportive of providing their assortment for this purpose. Furthermore, 3 subjects wanted to have predefined profiles, such as a "Greenpeace-Profile" or useful presets, which was also requested in the focus group. This was not implemented because we were interested in their individual profile settings for validating our guidelines. Another proposal was to add a profile synchronization to allow families to share their settings.

Limitations

While the above results clearly strengthen the deduced guidelines, a long-term study would be necessary to show that the findings are not only short-term effects. Even though we performed an in situ task to get realistic feedback, the scenario with predefined shopping lists and the fact that the products were not actually bought might have introduced biases. We see this study as a call to data providers to offer this data such that realistic and long-term field tests can be conducted.

Putting It into Context: a Sustainability Eco-System

While we focused the presentation on deducing a set of guidelines for sustainability-oriented assistance systems, we want to use this section to present the concept in a broader picture, discussing the implications of an ecosystem comprising sustainability information and profiles of multiple users.

First of all, the profile settings could be made available for multiple stakeholders in an anonymized form. This data would allow retailers to better understand their customers and which aspects they are mainly concerned about. Using this knowledge, they could optimize their assortment. Producers could benefit from such an ecosystem by optimizing their processing and products according to their end users' needs. Furthermore, it would assist customers who are interested in sustainability but have neither deep insights into this topic nor time to dive in. By adopting feedback from a community, in particular friends, sustainability experts, and role models, they could get a better understanding of which aspects others are concerned about. This would help them in setting up their profile, e.g. by adopting existing profiles ("I want to consider the same aspects as Jamie Oliver") or by aggregating the settings derived from a group of people ("I am as strict in my settings as the average top 10 percent"). This would also encourage a more competitive view on the topic, which might lead to a larger presence of sustainability. Such profile data would also help organizations such as Greenpeace to understand which topics people are interested in, and which sustainability aspects suffer from unfamiliarity and thus need to be promoted more strongly. Furthermore, when using the feedback channel, one's own sustainability profile could immediately be sent together with the feedback to the appropriate party. This would allow for quick but still targeted feedback. Also, gathering data on retailers' product ranges would allow suggesting specific retailers based on one's own profile, possibly also in combination with a shopping list functionality. While we focused on offline shopping, the profiles could also be used in online shopping scenarios, e.g. by including them in web shops.

Besides positive effects on sustainability, many presented assistance systems have been criticized by the sustainable HCI community. Brynjarsdóttir [7] disapproves with the way most presented persuasive systems put the responsibility on individual actions without taking into account the social, economical and cultural context. Usually, there is a strong focus on minimizing the resources the designers of the system found important. The user is then assumed to act rationally on the information provided by the system by optimizing for the specified goal. This is in line with Grimes and Harper [14], proposing to focus more on so-called celebratory technologies, which try to strengthen the positive aspects, instead of the frequently proposed corrective technologies. In the domain of sustainable energy consumption, Strengers [27] criticizes that most sustainable HCI systems are designed for what she calls Resource Man: this persona is interested in all data, understands it, and wants to optimize the way he uses energy. While she acknowledges that systems designed towards this Resource Man can actually save energy, they make strong assumptions about the normal way of life for which they try to optimize. Instead, more thought should be invested in rethinking the whole system. Svenfelt and Zapico [28] agree with this critique and argue that more research on holistic approaches is needed, including several parts of the food supply chain.

One might also criticize the presented guidelines, since they also propose to build assistance systems targeted for users aiming to make more sustainable purchase decisions, thus to some extent putting the responsibility on the individual. However, there are some essential differences: we propose to let the user decide which aspects to consider to which extent without patronizing him. We do not argue that the mere provision of data yields to direct and long-lasting change in behavior. However, we think that the critical examination of defining important aspects, and the playful interaction with products to understand how the different dimensions of sustainability influence the overall picture, triggers a reflection on the topic in general. We believe that this confrontation with one's own beliefs and their fulfillment in reality could put the actual attitude, not the general idea of living more sustainably, in line with actual behavior. We believe that such an assistance system helps users to quickly look up which item matches their profile; however, we do not propose to persuade users on items where they have standard products, either for social, habitual or other reasons. Lastly, we encourage the more general view on such a system in the context of a whole ecosystem, which could have larger implications for the food supply chain than only inducing changed behavior of the users.

CONCLUSION

Summarizing, the participants of the innovation workshop, the focus group discussion, and the evaluation showed a great interest in assistance systems for sustainable shopping. In our studies, we could demonstrate that purchase decisions are a complex topic, especially when taking sustainability criteria into account. Apart from people interested in the topic of sustainability, many customers struggle to properly incorporate sustainability in their buying habits due to missing background knowledge. From our discussions with several stakeholders and the focus group, we deduced a set of ten guidelines that sustainability-oriented assistance systems should consider. We strengthened our findings, by implementing a prototype considering these guidelines and evaluating it using an in situ task in a real supermarket. While we found evidence for all guidelines, especially the coverage of multiple sustainability dimensions, personalization possibility, and an intuitive understandable visualization and interaction turn out to be highly relevant. In order to illustrate the possible impact of such an assistance, we discussed an ecosystem based on a community of users with implications not only for this community itself but also the remaining part of the food supply chain.

In order to evaluate our findings also in a long-term study, a verified database of product information is necessary. Currently, we are in discussion with a large German retailer about possibilities to establish means to access verified data in order to run a long-term study with the goal to better analyze behavioral change effects. Besides using mobile phones as interaction devises, we also implemented a first prototype for the Microsoft Hololens which directly detects the product packages instead of barcodes (cf. [15]), even though product images are currently not publicly available.

ACKNOWLEDGMENTS

This research was funded in part by the German Federal Ministry of Education and Research under grant number 01UT1418A (project INNOLAB). The responsibility for this publication lies with the authors.

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