PERSONAL SHOPPING SUPPORT FROM DIGITAL PRODUCT MEMORIES

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Abstract: Auto-ID as well as traditional identification technologies such as barcodes allow for linking physical products with digital data. Thus products become "smart items", which may contribute to the consumer's retail experience in future retail environments. In this article, we discuss how digital assistants can utilize so-called digital product memories for personalized support during tasks typically for the interaction between consumer and product. A demonstration system allowed participants of an IT fair to explore various approaches to personalized support on the basis of this technology in a storyline spanning several spaces, some of them public, some private. Feedback gathered from 132 visitors indicates that this kind of support is in general perceived well; however, it also emphasizes the diversity of people's interest in interaction metaphors and means of privacy protection.

1 INTRODUCTION

The domain of retail is on the verge of a new era as pervasive computing technologies become mature and as ubiquitous as large scale mobile internet services and consumer phones equipped with barcode reading and Near Field Communication (NFC) capabilities. Within well-defined smart spaces it becomes feasible to access and utilize real-world information from all kinds of different sources for the potential benefit of various stakeholders such as consumers, retailers, or manufacturers. By means of a link to digital data, physical artifacts – including products – may become "smart items" integrated into this novel information structure. In this context, Digital Product Memories (DPM) relate to the notion of products that "keep a diary" of relevant events gathered throughout their lifecycle in order to provide valuable services: A product might warn about critical incidents such as increased temperature or pressure during transportation, or provide information regarding its carbon footprint that is calculated from its actual logistics and production emissions (Kröner, 2010a).

Installed and initialized during production, this functionality is of special interest for manufacturers and logistics experts to capture and communicate artifact-level information along the supply chain (Stephan, 2010). Beyond supply chain management, this approach may provide retailers with an information source, which they can exploit to satisfy the consumers' growing interest in tracking the way a product at hand went from production to consumption (Horovitz, 2009).

Assuming that retailers might receive products already equipped with such technology, we focus in this article on the application of the DPM for consumer support in a retail scenario. Particular questions in such a setting address the customers' preferences concerning the interaction with services built on top of the DPM (and in consequence, which data and which technical realization would be

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required for installing a DPM), and their interest in using a DPM after the point of sale.

In order to research these questions and to reflect the DPM's unique feature of artifact-based, cross-domain information transport, a system is required which comprises not only different kinds of support, but also spans different domains. Therefore, we realized a demonstration system showcasing a scenario comprising all steps of a typical shopping trip. After a personal, interactive "shopping trip" with that system, visitors of an IT fair were interviewed concerning their opinion.

The remaining article continues with a brief review of related work, followed by a summary of the system's technical setup. Afterwards, the system's various services and their interaction with the user along a coherent scenario are discussed. Then, feedback from visitors of an IT fair is summarized. The article concludes with a wrap up of the results and an outlook on future work.

2 RELATED WORK

The idea of utilizing the combination of physical artifacts and linked digital data for consumer support is subject of considerable research activities. Most notably, Goggles (Google, 2010) relies on visual features of a product at hand to retrieve linked data. However, this approach is not appropriate to distinguish different instances of a product – a feature essential for the DPM. Another characteristic aspect of the presented work is user support across services and contexts. Similarly, the MyGrocer system (Roussos, 2002) provides information about the product at hand in a scenario that combines retail and stock-keeping in a smart home, although no real-world context except for querying product IDs is utilized. In this context, mobile shopping list applications have been commonplace for some time (e.g., RTM, 2011) and also mobile product recommender systems are emerging in greater numbers (e.g., von Reischach et al. 2010). The DPM may be exploited to extend such services; its uniqueness of our approach lies in the integration of usage patterns of products previously bought. Regarding interaction, Janzen and Maass discuss how an interactive natural language communication between users and products can be exploited for a redesign of communication at the point of sale (Janzen, 2008). Here, our vision is that the product artifact becomes an integral part of a continuous dialog between digital assistants and consumer that may involve very different interaction types.

Beyond, "smart products" with embedded input and output capabilities, actuators, sensors, and product-specific data may proactively assist their owners in performing their tasks (Miche, 2009) – an extension of our assumption that digital extensions to products may be beneficial for the consumer even after the point of sale. However, while customers are interested in such after sales services, they might nevertheless prefer to destroy RFID chips at store exits. This suggests to enhance trust through security and privacy visibility, and to keep such privacy enhancing technologies simple (Spiekermann, 2008). Here, feedback obtained in our demonstration showed a positive impact of a security mechanism with a high reputation.

3 TECHNICAL SETUP

In a previous demonstration (Kröner, 2010a), the main goal was to illustrate how to *build* a DPM. The demonstration described in this article focused on the *interaction* with the DPM; particular goals included:

- Communicating a continuous shopping experience across public and private spaces involving various services realized on top of the DPM
- Illustrating the different roles physical items may take in the interaction between service and consumer
- Obtaining feedback concerning different approaches to DPM-based personalization, and to derive hints concerning the deployment of such technology

The concept of the DPM is based on the idea that some "smart label" attached to the product allows for identifying a product on artifact level as well as for continuously collecting data concerning this artifact. This requires a data link between a product and some digital storage. Depending on the expectations to the DPMs behavior, this link can be established via various technologies.

In the context of this demonstration, it was sufficient to identify products and to get access to linked data. In order to achieve these features across the various stages of the demonstration – and to enable a continuous shopping experience –, we decided to employ barcodes and different RFID technologies. In general, their appliance was guided by well-known observations (Ngai, 2008). Products in this demonstration are equipped with all of these labels.

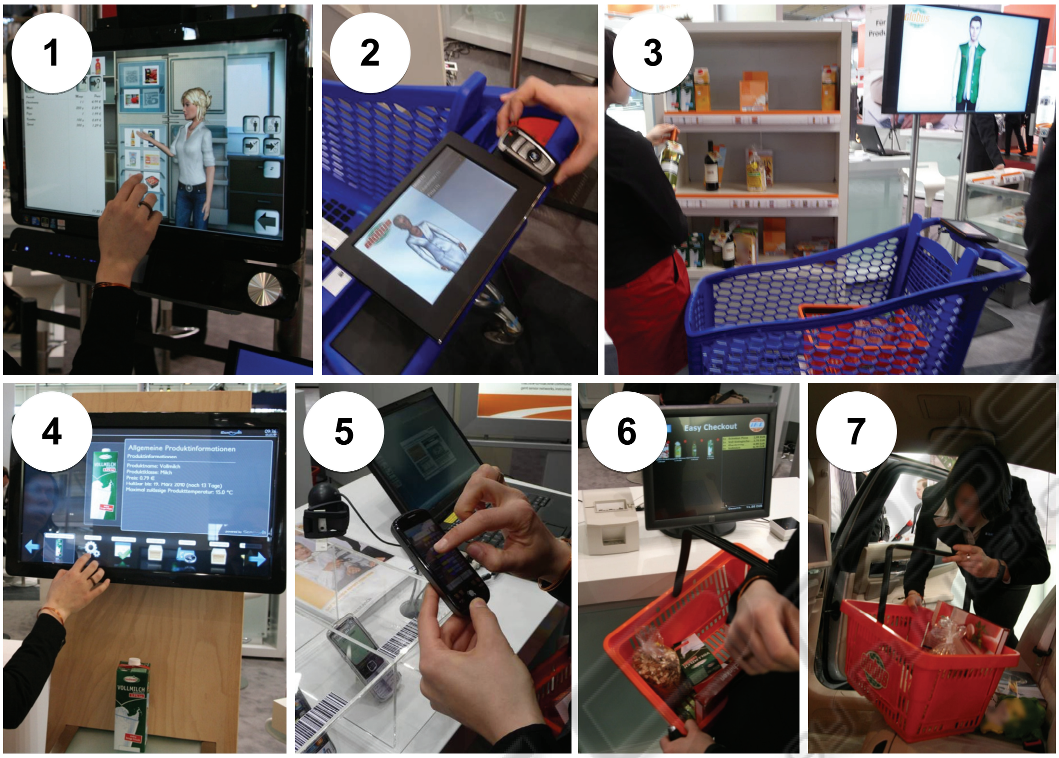


Figure 1: The user interacts with DPM-equipped products in a shopping scenario comprising shopping-related actions at home (1), in the store (2-6), and in a car (7).

- Shopping Cart and Shelf. For the envisioned kind of support it is important to know where products are stored (e.g., to derive manipulations such as place, take, move). The use of many low-powered HF antennas enables a fine-grained detection of passive HF tags attached to the product.
- Mobile Phone. In this application it is crucial to include a maximum number of end users, so that we rely on barcodes and their identification with standard consumer phones.
- Checkout. Products have to be detected fast and reliable. We use UHF (860 – 960 MHz) on gate readers and related tags that are used in logistic domains.
- User identification. In order to identify users via a "Personal Token", we rely on NFC (13.56 MHz).
- Car. Since cars are made mostly out of metal, we rely on active High Frequency (HF, 13.56 MHz) RFID tags and antennas.

A DPM may comprise data stored "on-product" (on the smart label) and "off-product" (in external data storages). The technical feasibility of the former approach was shown in previous work (Stephan, 2010); however, for the purpose of this demonstration, we considered this aspect less relevant. Thus, all products were linked via a unique identifier to an *Object Memory Server* (OMS). It provides an open infrastructure for storing and requesting data concerning some artifact (Schneider, 2007) – and thus implements the actual DPM.

In each stage of the demonstrator, the OMS is involved to read, change, and update product information (see Figure 2). Information concerning each product was represented using a product ontology comprising:

- General product knowledge, e.g., name, price, and producer
- Product features, e.g., nutrition facts, or technical properties
- Classification , e.g., ecological, traditional
- Product diary with events from production, logistics, and retail

In order to illustrate how the DPM may support the interaction with products from different categories, we deploy in this setup different types of products, including frozen or cooled products (e.g. pizza, ice, and milk), typical everyday food products (e.g.

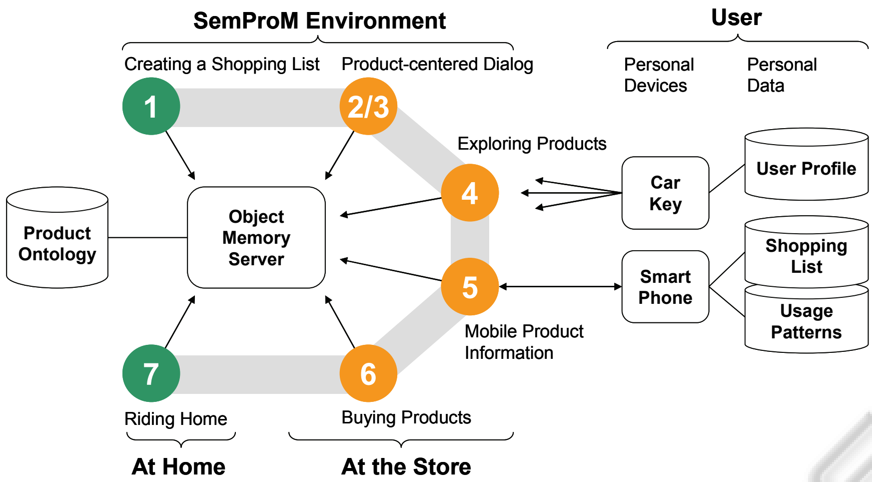


Figure 2: A simplified architecture of the demonstration system. The Object Memory Server implements the DPM.

cereals, rice, and wine), and personal products that belong to the user (e.g. PDA, car, and car key).

4 DEMONSTRATION

The system allows users without strong technical background to explore a future retail scenario spanning several linked stages ranging from home over the store to the ride back home. Here, decisions at one stage may affect services explored at another. All stages share the idea that the product plays some role in the interaction between consumer and service.

4.1 Creating a Shopping List

In the beginning, the user has to create a shopping list. This happens “at home”: In this private space, a large-scale touch screen allows the user to communicate with an embodied Virtual Character that guides the creation of a shopping list. The character acts in a kitchen environment (see Figure 1, Stage 1). It has a large repertoire of conversational gestures and is able to generate all needed utterances by using a template-based character control and text generation system together with an actual TTS system (Nuance). The character is aware of all products at home and their status, which can be a) available, b) need to buy, c) soon need to buy. In addition, the character suggests recipes, whose ingredients can be transferred to the shopping list.

Once the user is satisfied with the list, it is transferred to a “Personal Token” – a personal item the user owns and trusts: a car key that is equipped with a NFC chip (Schöllermann, 2010). Such a key can securely hold a shopping list, a credit card, and a personality profile. The latter consists of favorite products, allergy information, and individual nutrition aspects. The Personal Token is supposed to be taken to public spaces where it can be used to reveal – at will – a small set of personal data in order to obtain personalized support.

4.2 Product-centered Dialog

At the entrance of the store, the user takes a shopping cart. In our demonstrator we carefully distinguish between a public and a semi-private shopping space. An instrumented shelf and a refrigerated display case represent a public space. These are aware of the position and amount of locally stored goods. An instrumented shopping cart represents a semi-private space. Once the user places the key at the cart handle, the shopping cart system retrieves the shopping list and the personality profile from the Personal Token to enable a guided shopping tour (see Figure 1, Stage 2).

Cart and shelf are equipped with a display showing (different) Virtual Characters that communicate via natural language and natural conversational behavior with each other and the user. In addition, the cart display shows the current state of the shopping list. The characters react every time a product is taken or placed.

The cart character guides the user through the shopping list and recommends products matching list and user profile. It resembles a personal advisor that checks every product that is placed in the cart with respect to individual needs and interests. The underlying service exploits content of the respective DPMs to reason about conflicts with the personality profile. On a technical level, a real-time query to the OMS for each involved product is made (see Figure 2). Emerging conflicts are addressed via natural language by the cart character in a low voice – respecting the privacy. Additional information is presented on the cart's display. In addition, the cart character may ask the shelf character with a loud (public) voice for help, e.g., if there is a product alternative.

The shelf character resembles a salesperson. It provides assistance by giving in shelf navigation hints for faster product localization. In addition, the character communicates general product-related information (e.g., price, producer…) in a natural conversational style.

The user becomes part of the dialog between the characters (see Figure 1, Stage 3). Knowledge retrieved from the DPM of the involved products helps to create the illusion that Virtual Characters reacting intelligent to the consumer's interaction with the product.

4.3 Exploring Products

An information kiosk enables the customer to interact with contents stored in the DPM. The so-called DPM Browser uses a kiosk metaphor; if the user places a product on an RFID antenna, then a "product diary" is presented – a temporal sequence of events from production over transportation up to product display at the retailer (see Figure 1, Stage 4). While most of these events were fixed for the purpose of this particular demo, the user may observe changes in temperature of products taken from the refrigerated display case, thus experiencing the idea of quality control via DPM.

The browser visualizes the diary as a timeline with event-associated icons. Clicking on such an icon reveals more detailed information of the corresponding event, e.g., the temperature value measured, and the time when this event was recorded. Depending on the event's content, it is combined with external information sources (e.g., GPS data is presented in an online map).

This interaction relies on public data provided by arbitrary entities along the supply chain. However, we assume that there is considerable potential for user support from products with DPMs carrying personal data. This idea is demonstrated by a weekly medicament blister with DPM. Such a blister is individually produced for each patient by a fully automatic packaging plant; the contained medicines are arranged in solid oral forms and in the correct dosage, pre-sorted for the seven days of the week and for taking four times a day (see, e.g., 7x4 Pharma, 2011). Samples of such a product were

Figure 3: A screenshot of the mobile product information service.

equipped with a DPM containing similar data as the regular products as well as information about the intake of the contained medicine.

However, since such a blister's DPM may allow for undesired conclusions concerning their owner, access is controlled by means of a roles and rights management concept with identification by electronic identity card (Brandherm, 2010). In the demonstration, such access to private data in a public space requires the customer to prove his or her identity via prototypes of the upcoming German electronic identity card. Once access is granted, the user can browse the diary of the blister and retrieve hints containing the intake of the medicines. In addition, a drug interaction alert service is enabled. If additional products are placed on the browser's surface (e.g., food, supplement or drug previously selected in other parts of the store), then this service checks for interactions based on contents retrieved from the blister's and these products' DPMs. If an interaction is detected, then external information sources are used in order to support patient and physician with different views on an interaction.

4.4 Mobile Product Information

Access to the user profile from the shopping cart introduced before was semi-public in nature, as the rather large display on the cart is unsuitable for completely private interaction.

In order to provide explicit means for accessing and even altering user profile dimensions in a public space using a private interaction device, we introduce an Android based mobile phone application called "SOPHIA" (*Wisdom*) that stands for "SemProM Product Hybrid Information App" (see Figure 1, Stage 5 and Figure 2) and effectively links information stored on the product at hand and

Figure 4: The customer's car detects products (left-hand side) and exploits their DPMs for personalized assistance (right-hand side, example: recommended time to drive home).

relates it to a user profile stored on the mobile phone.

The user profile can be automatically created by analyzing the characteristics of products of a similar category that a user already owns. The central idea of this mechanism addresses the fact that the DPM technology allows for storing product-related events that occur in the lifetime of that particular artifact. Consequently, a product that is often used should provide many events in its DPM and many events should then equal a high relevance to its owner, simply because he uses the product frequently (which is a strong simplification, of course). In this respect, due to the utilization of DPM technologies, the product recommendation can be based on actual usage histories and not merely on the purchase history, even without a semantic analysis of the events contained in the DPM. In the demonstrator setup, we utilized a small number of products from the previously mentioned categories.

Interaction with the system is straightforward. The user accesses the DPM of a product simply by reading its ID via the built-in barcode reader of the phone and then accessing the relevant product properties via the aforementioned OMS. By relating the subjective importance of each relevant profile dimension to the properties of the concrete product, a "suitability index" is calculated and displayed that is a measure for how well the product matches the profile of the user. Due to the private nature of the interaction device, the weighing of individual profile dimensions can be explicitly altered by dragging respective slider controls as shown in Figure 3 within the product category of mobile phones, for which the price, community ratings, carbon footprint, compatibility, and raw functionality are the relevant dimensions shown on the screen.

By evaluating for a given product category the DPMs of all products belonging to a user, it becomes possible to implicitly create user profiles based on deduction, following Cattell's notion of past behavior predicting future behavior (Cattell, 1969), i.e. it is plausible to assume that a new product is more likely to appeal to the user if it matches the properties of the user's existing items.

From this perspective it is possible, but not always necessary, to control and adapt explicitly profile dimensions that have meaningful default values based on the past interaction with DPMs.

4.5 Buying Products

At the next stage, the user has to pay – just by moving a shopping basket with the previously selected products a through a gate and authorizing the payment process via the Personal Token (see Figure 1, Stage 6). A regular screen displays all products recognized; if the user places actively the car key at a specific location nearby, the DPM of each detected product is updated with the information that it is now owned by a specific customer (respectively its id). In addition, time and location (store) are stored to build a seamless product history. Furthermore, a Matrix Code is displayed that serves (in addition to a printout) as receipt. By taking a picture of this code, the receipt can be transferred electronically to the mobile device for further exploitation – e.g., for housekeeping books to track costs.

4.6 Riding Home

New external communication interfaces, fixed and wireless, increasingly become integral part of automotive on-board networks. These wireless interfaces enable new value-added info- and entertainment services, such as internet services and seamless mobile device integration. Besides technologies such as GSM, Bluetooth and USB, RFID technology enables new proactive scenarios within the vehicle (Steffen, 2010). In combination with the processing of personal information as well as context information, this technology can be used to detect and infer user intentions inside the vehicle and thus provide means to enhance usability of functionality and new personalized value-added services.

During the demonstration, this idea is illustrated by a car, which reacts on products deployed in the passenger cell (see Figure 1, Stage 7). Products which are equipped with (active) RFID technology can be automatically detected via respective receivers inside the vehicle. Thus, the vehicle can process information from its own sensors, the respective DPMs, and further information describing the user's context available via the vehicle's connectivity services. Eventually, a user intention can be inferred. Services exploit this information to assist the customer in the area of:

- Configuration and personalization of software and services according to the provided context
- Object-centric execution and triggering of services inside the vehicle as well as integration of infrastructure based services
- Seamless recommendations and assistance with continuous evaluation of the DPM and context information

Thus, groceries bought within the store interact with the vehicle; it evaluates their DPMs in conjunction with additional context information, such as outside and inside temperature, planned route and estimated time of arrival. Then, the car computer offers services matching the particular kind and state of the product at hand (see Figure 4, left-hand side).

For instance, the vehicle can advice the driver at which time she/he needs to drive back home in order to put the products into the fridge right in time (see Figure 4, right-hand side). Further advice can be given with respect to products which have not yet been bought but are still on the shopping list: for instance, the vehicle may suggest the next shopping mall, where the product can be purchased, as a new destination. Furthermore, the vehicle compares products inside the car with the list of paid products stored on the key in order to warn the driver if she forgot something at the checkout point.

If the customer has bought a new mobile device, the vehicle can detect based on the DPM, which software is needed to install in the car in order to pair the device accordingly. This software can be downloaded to the on-board system once the item is detected inside the car, so that the device may be used right away.

In addition, a product may trigger services supporting communication concerning the product, e.g., a Twitter application. The Twitter application registers to a specific tweet in the context of the product, e.g., the mascot of the football world championship registers to the respective tweets on this topic. The product may also trigger the download of an application (e.g., a travel guide) or media content and thus adapt the car's infotainment system to the user's interests based on what she takes into the vehicle.

Finally, in order to support safety and transparency during its own maintenance, the car exploits information from the DPM of spare parts to inform about their compatibility and correct usage.

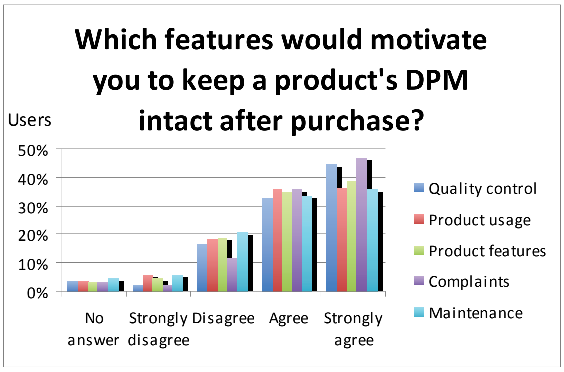
5 FEEDBACK

The demonstration was presented at the CeBIT 2010 technology fair. Accompanied by an expert for the respective demo stage, a visitor could explore the various system components. The resulting "shopping tour" followed the fixed sequence of stages depicted in Figure 1. Each stage provided some degree of freedom (e.g., concerning the products in the shopping list). Visitors who made a complete tour spent up to 40 minutes at the exhibit.

While the setup did not aim at an evaluation of the DPM, this event was nevertheless an interesting opportunity to identify trends and gain hints concerning future extensions of the system. Therefore, visitors who explored all demo stages were asked to answer a couple of questions from three areas related to the interaction with the DPM: user interface, usefulness of service, and privacy. The questionnaire addressed:

- Demographic data and purpose of the visit
- Knowledge about RFID and similar technologies
- Preferences regarding interaction device and modality
- Utility of car-related services and factors affecting a buying decision
- Conditions motivating a user to keep a product's DPM intact after purchase
- Trust in the protection of personal data, and rating of privacy at the different demo stages
- Effects of the application context

For most of these questions, potential answers were arranged on a four point Likert scale. Filling out the questionnaire took between further 10-20 minutes; a



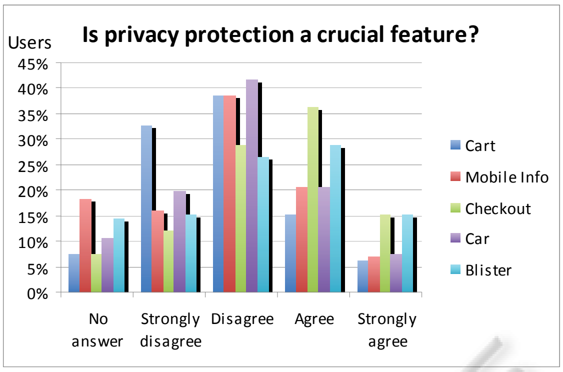


Figure 5: Visitors' feedback – would they keep the DPM intact (left-hand side), where is privacy protection (especially) crucial (right-hand side)?

project member guided the visitors through the questionnaire and provided additional explanations.

5.1 Participants

132 visitors answered the questionnaire, 71% male and 24% female. 65% of them were up to 30 years old, further 23% were between 31 and 50 years old. The reason of the CeBIT 2010 visit was in most of the cases a private one (66%). Thus, the answers might be biased towards the perspective of male customers. The visitors' experience with RFID was surprisingly low (for an IT fair) - 50% of the answers expressed little or very little experience with this technology, opposed by 41% with (strong) experience.

5.2 User Interface

The demonstrator intentionally mixed a wide range of different interaction types. These involved specific mechanisms such as a smart shelf as well as general purpose access mechanisms such as the user's mobile phone. 84.85% of the answerers expressed a preference towards the latter approach.

The interaction relied on implicit mechanisms (e.g., product detection during checkout) and on explicit ones (e.g., exploration at the kiosk). Employed modalities included point & click (touch, pen), tangible interfaces, and speech (output only). Here, the visitors could express multiple preferences. The majority of the answers (73%) expressed a preference on graphical user interfaces, followed by tangible ones (16%) and speech-based ones (11%).

Discussion. For the interface to the DPM, we conclude that the utilization of novel user interface types might not be crucial for the success of the DPM. However, we should devote special attention to access mechanisms and devices, which are familiar to users – such as the personal mobile phone.

5.3 Usefulness of Service

Regarding the application of the DPM in the context of a car, 85% considered reminders concerning missing products as a relevant or very relevant feature; 73% answered similarly regarding information on spare parts, and at least 68% considered information from transported products as useful or very useful.

Feedback regarding information affecting the actual buying decision revealed that 74% of the answerers would use product ratings provided by other customers. 64% take the similarity to products they already own into account.

Discussion. For the design of DPM-based services, we conclude that the customer's car might serve as one hub for DPM-based services related to shopping. Furthermore, people's interest in comparing and combining product-related data from a DPM at hand with other information sources (e.g., user ratings, other DPMs) indicates a need for standards and services, which explicitly support the alignment of DPM data as well as the communication about a product between customers. Finally, this feedback indicates an interest in product-related services across the actual shopping process. The latter observation is of special interest for the application of the DPM, whose open nature is meant to support such services explicitly.

5.4 Privacy and Trust

For applications of the DPM beyond the shopping process, e.g., transportation via the own car, it is crucial that the DPM hardware of a product stays intact after payment. 77% of the answers indicated a will to keep the DPM in place for quality control, information concerning product application, information concerning product features, and/or issuing complaints concerning the product (multiple choices possible, see Figure 5, left-hand side). However, there are considerable differences in the feedback to the various services.

The DPM and related technologies can be exploited to collect and transport data about a user. While the visitors' trust in the protection of their data was limited (32% positive, 63% negative answers), the means of privacy protection employed for the medicine blister were perceived positively (40% positive, 50% negative answers). The need for data protection was perceived differently for the individual elements of the scenario. It was rated as crucial for checkout, car, and blister (see Figure 5, right-hand side).

Interestingly, 71% of the visitors expressed that they wouldn't differentiate between a professional or a private use of a DPM.

Discussion. Regarding privacy concerns and trust in the DPM, we conclude that the deployment of the DPM should be judged with respect to the kind of the product. A special need for data protection exists if a DPM is applied in a public space to retrieve or communicate sensible personal data, in this case: about (driving) behavior medication, and payment. Furthermore, we speculate that there might be a relationship between indirect user interaction with the DPM and trust - the use-cases presented at checkout and car both included pro-active access to the DPM of personal items, which was not a direct response to an explicit user action. The presented mechanisms for privacy protection were perceived positively; however, they might not sufficient to resolve trust issues in general.

6 CONCLUSIONS AND OUTLOOK

Future retail may exploit novel technologies in order to enrich the customer's retail experience. Such a technology is the digital product memory (DPM) – a record of digital data linked with a physical product. We reported about a demonstration system, which illustrates how this information source can be utilized for the realization of personalized, product-centric services, which support the customer during shopping and beyond.

By means of a survey, we collected feedback from users of this system (visitors of a public presentation at an IT fair). From that feedback we conclude that user interaction with the DPM should integrate smoothly into technology people are familiar with. Feedback concerning services indicates a strong interest in applications of the DPM beyond the point of sale. However, despite powerful means of privacy protection, trust in this technology nevertheless stays limited. Therefore, we recommend limiting the storage of personal data in the DPM to particular combinations of products and services, such as medicine and quality control.

These conclusions have limitations, which might require additional experiments. Thus, the technically affine CeBIT visitors do not necessarily reflect the preferences of arbitrary shoppers. Furthermore, in order to facilitate the demonstration at a fair, the presented setting did not allow the visitor to "switch off" characteristic DPM features (e.g., logging) and thus to compare user support with products equipped with a DPM, any other smart item technology, or no such technology at all.

Future work will have to address these questions in order to enable retailers to judge more precisely where DPM-based applications are most promising. In addition, mechanisms for facilitating the deployment of DPM-technology are required. Here, we are planning to devote special attention to a standardization of memory structure and content (Kröner, 2010b), and to management tools which support setup and configuration of DPM-based services.

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