Winter 12-1-2013

A Reference Model For Mobile Product Information Systems

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ABSTRACT

This paper analyses the state of the art in research and practice on mobile product information systems. Based on literature review and multiple case study research, we design a reference model that is suitable for researchers and practitioners as a first reference point and recommendation for the construction and analysis of mobile product information systems.

Keywords: design research, mobile services, product information systems, reference modelling, Unified Modelling Language

INTRODUCTION

Product information is used for different purposes. In business-to-business (b2b) context, for example, it can be used for management, assistant or decision systems. In business-to-consumer (b2c) context, on the contrary, it can be used to provide consumers with information such as price or ingredients and to influence their buying decisions. Mobile devices are perfectly suitable for consumers to access product information at the point of sale (POS) since they provide mobile added values like ubiquity, context-sensitivity, identifying functions, and command and control functions [51]. The diffusion of smartphones and the cost-efficient access to mobile Internet services increases the usage of mobile services and applications (apps) rapidly. These developments have not only changed the nature of the apps offered but also transformed the way of searching for information. Apps for product information search support these developments. A *mobile product information system* is a software for mobile devices that allows users to access information on a product (e.g., ingredients, price) by scanning a barcode or using other search mechanisms.

The purpose of this paper is the development of a reference model for mobile product information systems. Based on literature review and multiple case study research, we design an according use case and class diagram. The developed reference model can be used from researchers as well as practitioners as a first reference point and recommendation for the construction of new and the analysis of existing mobile product information systems.

The remainder of this paper is organised as follows: Section 2 describes the methodology and the research process. Section 3 presents the state of the art in research and Section 4 the state of the art in practice. Based on the literature review and multiple case studies, we design a reference model for mobile product information systems in Section 5. Section 6 draws conclusions, discusses limitations, and proposes future research.

METHODOLOGY

Considering the aforementioned problem, the development of a reference model requires a design-oriented approach. *Design research* is a normative discipline that implies a usage concerning the design objective. It consists of three activities: (1) construction of artefacts, (2) evaluation of artefacts, and (3) reflection of results and theories [63]. Artefacts can be software, composite systems, user and application processes, organization methods and interventions [44]. The object of knowledge lies in socio-technical systems which consist of three types of objects and their relationships: humans, information and communication technology (ICT), and organizations. Knowledge objectives can be recommendations of action for the design and operation of information systems or innovations in such systems [45]. Result types are constructs, models, methods, and instances [39], [45].

In order to design a reference model for a mobile product information system, the first step includes the identification of actors and functionalities. Therefore, literature review and case study analysis are suitable. *Multiple case study analysis* [52] is chosen since it enables a holistic detection and analysis of activities [11], [66]. The outcome is a set of actors, use cases and objects necessary for a comprehensive mobile product information system.

Based on the identified actors, use cases and objects, the second step includes the modelling of the artefacts. The most common and standardised modelling language in the field of object-oriented software engineering is the *Unified Modelling Language (UML)*. For presenting how the system is going to be designed and to show user interactions with the system and specifications of use cases, two UML diagrams are adopted: *use case diagram* and *class diagram*. The designed reference model can be used as a reference point and recommendation for the construction and analysis of mobile product information systems.

The main modelling elements for UML use case diagrams and UML class diagrams are shown in Figure 1.

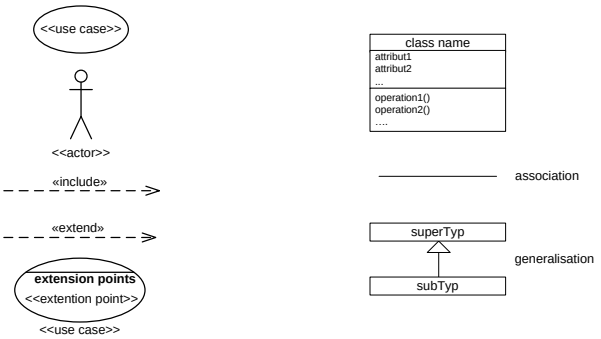

Figure 1 Modelling elements for UML use case diagrams (left) and UML class diagrams (right)

STATE OF THE ART IN RESEARCH

Academic literature on product information in general can be divided into b2b and b2c research. While b2b research concentrates on product information search like product information assistance systems [4], product information management systems [53], corporate dynamic decision-making management information systems [7], information sharing systems supporting heterogeneous information sharing across departmental boundaries [70] or product information archive systems [58], we focus on b2c systems and services. Therefore, relevant literature can be found in three major areas:

- information search and search behaviour,
- mobile services and consumer acceptance, and
- mobile information search.

Research on *information search and search behaviour* is many-sided. Some authors focus on search engines (e.g., [14], [33], [34]) or related search behaviour (e.g., [29], [62], [67]). Furthermore, some research concentrates on differences in information search behaviour caused by consumer characteristics like culture (e.g., [10], [30]), personality traits (e.g., [16], [30]), age (e.g., [46]), gender (e.g., [5], [35], [41]), and product characteristics (e.g., [31], [40]). Moreover, some authors focus on information search and search behaviour in different shopping channels (e.g., [18], [25], [48]). Besides research on information search in retail, further research exists on product information search in financial (e.g., [28]), health care (e.g., [19], [24]), and travel service markets (e.g., [43]). Moreover, some authors examine search criteria and strategies (e.g., [12], [54], [61]) or focus on factors influencing the intention to use information search systems (e.g., [26], [36], [57], [60]). Further research focuses on the design and development of information search systems (e.g., [17], [27], [32]).

During the last years many researchers have analysed different types of *mobile services and applications* like mobile payments (e.g., [50]), location based services (LBS) (e.g., [9]), mobile social media (e.g., [20]), augmented reality (e.g., [15]), mobile ticketing and parking (e.g., [37]), mobile marketing (e.g., [47]), mobile loyalty (e.g., [38]), and mobile couponing (e.g., [3]). How mobile services have to be designed to be accepted by users is also content of many academic studies (e.g., [49], [65], [68]). The impact of mobile services on shopping experience is analysed by [21]. The results show that mobile services can improve consumers' shopping experience both in general and at different stages of consumers' decision-making process.

However, up to now, only a few academic papers focus on *mobile information search*. In doing so, some authors concentrate on b2b topics like production processes (e.g., [1]) or mobile sales assistants (e.g., [23]). B2c topics, on the contrary, focus on the influence of product information systems on consumers' buying decisions (e.g., [8], [55]), user acceptance (e.g. [22]), attitudes (e.g., [64]), and location-based information (e.g., [30]). Design-oriented research on mobile information search includes, for example, the development of a mathematical model for describing the information search process through the Internet with or without mobile access [59], the design of a platform architecture of mobile e-commerce information search based on mash-up technology [69], and an approach to adapt mobile Web browsing [2]. [13] evaluate technological and socio-economic conditions influencing the development of the mobile search market. Findings show that substantial development work for creating new services is still needed. Identified key trends are: LBS, augmented reality, real-time information search, and social network search and recommendations. Even if there is a few literature on mobile product information systems, there is a lack of literature on the design of an according reference model.

STATE OF THE ART IN PRACTICE

In order to identify actors, use cases and objects necessary for the reference model, we examine existing mobile product information systems. Therefore, we analyse public information available on companies' websites and app stores. So far, only a few mobile product information systems exist. In the following, we examine five of most known approaches in the market:

barcoo

With about 6 million downloaded mobile apps *barcoo (owner: checkitmobile GmbH)* is one of the most popular mobile product information system for different product categories like food, personal care, electronic, cars, pet food, toys, and household in Europe. It has implemented various external data sources categorised in basis information, health care information, price comparison, test reports, and ecological information. The data input and the supplement of product data is

carried out by users and/or by automated or manual assignment of external data sources. The data input by users is possible without any registration. The information is accessible through the (mobile) website, as well as iPhone, Android, Blackberry, Samsung, and Windows apps. Therefore, the user has to scan the barcode or QR code attached on the physical product. The system offers product pictures, price information, test reports, user ratings and reviews, food signal lights that show how healthy a product is, Wikipedia articles, ecological ratings, information on producers and retailers, store information, ingredients, weakly deals, and guides for various topics (e.g., fish, wine, packaging). The service is free of charge for users and financed by third parties via marketing and market research revenues.

Codecheck
The Swiss organisation *Codecheck* offers consumers information for more than 11 million products from different product categories like food, personal care, electronic, books, toys, pet food, stationary, and sport in the German speaking countries. The aim of Codecheck is the provision of an open information system for the public. It has implemented various external data sources like health care information, price comparison, test reports, and ecological information. The data input and the supplement or change of product data is carried out by users and/or by automated or manual assignment of external data sources (e.g., nutrition facts and food signal lights). The data input by users requires their registration. The information is accessible through the (mobile) website, as well as iPhone and Android apps. Therefore, the user has to scan the barcode or QR code attached on the physical product or executes a text search. The system shows ingredients and seals of quality as well as related expert reviews, advices customers of contents on endangered fish species or palm-oil. It also provides food signal lights, ecological information, test reports, nutrition facts, reports and guides for various products and product categories (e.g., fish), user reviews, product comparisons and recommendations for alternatives, cross-national price comparisons, closest stores (LBS), and the possibility to buy products online or mobile. The service is free of charge for users and financed by third parties via donations (users and foundations) and revenues from affiliate marketing.

GoodGuide
The US American product information system *GoodGuide* offers information for more than 170,000 products from different product categories like personal care, food, household, babies and kids, pet food, apparel, electronics, appliance, and cars. The system is based on a 0 to 10 rating system for products and companies on their health, environmental and social performance. The data input and the rating is carried out by GoodGuide itself. Users are allowed to enter own ratings as well. The information is accessible through the (mobile) website, as well as iPhone and Android apps. Therefore, the user has to scan the barcode attached on the physical product or executes a text search. The system shows the product with the related rating of GoodGuide as well as the user rating. An additional function is the shopping list. The service is free of charge for users and financed by third parties via marketing revenues.

RedLaser
The US American product information system *RedLaser (owner: eBay Inc.)* supports users by searching prices, deals and coupons for millions of products across online and local retailers. The information is accessible through iPhone and Android apps. Therefore, the user has to scan the barcode or QR code attached on the physical product or execute a keyword, voice or image recognition search. The system shows product pictures, prices, deals, coupons, nearest locations for a product, product descriptions, product ratings and reviews, nutrition facts, critical allergen information, and popular products scanned by other users. Additionally, users can compare products and search for alternatives, check out books at the library, scan and store loyalty cards, create personalised QR codes, shopping, wish and gift lists, share information with friends, and create archives for books, media or wine. Moreover, the system enables users to buy products mobile. The service is free of charge for users and financed by third parties via provisions and marketing revenues.

ShopSavvy
The product information system *ShopSavvy* searches for online and local prices in North America and Europe. The information is accessible through iPhone and Android apps. Therefore, the user has to scan the barcode or QR code attached on the physical product or execute a keyword search. If users are missing a special keyword, they can add it to the system. Moreover, users can edit wrong prices and submit them for review. The system shows product pictures, prices in multicurrency (USD, EUR, GBP), and allows users to organise lists. Additionally, users can receive information on local retailers (e.g., location, directions, phone number, price matching policies, in stock availability) and marketing offers (e.g., Groupon offers, shipping promos, coupon codes, rebates, weekend sales). Users can also write own product reviews and share information on products, prices and lists with friends via email, Facebook or Twitter. The service is free of charge for users and financed by third parties via provisions and marketing revenues.

Evaluation
The analysed mobile product information systems show similarities in the involved actors. They are characterised by a service provider, users, retailers, and producers. Most of the systems also cooperate with third parties like marketing agencies or health care organisations.
All analysed systems have a broad range of product categories in common. However, the systems differ on the amount of available products. While some systems offer information on online and local products, others just provide information on local or online products. The provided information depends on the purpose of the system, the offered product categories (e.g., food or electronic), the cooperating third parties (e.g., health care organisation), and the implemented data sources (e.g., test

reports). Almost all systems provide product pictures, prices and reviews as basic information plus different additional information like marketing offers, lists, LBS, test reports, videos, in-stock availability, recommendations for alternative products, price comparison, ratings, and product guides.
The basic search process is similar for all systems. Users can scan a barcode or QR code attached on the physical product and execute a text search. *RedLaser* also enables a voice and image recognition search.
The kind and amount of functionalities differ strongly between the analysed systems. While all systems include search and rating functionalities, only a few systems offer additional functionalities like social media, mobile commerce, mobile payments, mobile marketing or LBS. Some systems also allow users to create an account, store loyalty programmes, perform reviews or create lists, archives and QR codes.
The usage requirements and user rights also differ between the systems. Most systems allow not only the information demand and performance of ratings and reviews but also the provision of additional product information and keywords without registration.
For the design of the reference model the following picture emerges.

MODELING OF THE REFERENCE MODEL

Based on the examined literature review and the case studies, we develop the reference model for mobile product information systems. Therefore, we derive and categorise typical actors and elements from the above described case studies. In doing so, we analyse the identified actors on their capabilities and the identified elements on their content and usage.
For the analysis and the design of the system, the UML offers a range of different diagrams that help to "specify, visualize, and document models of software systems, including their structure and design, in a way that meets all of these requirements" [42]. In order to design the derived actors and related use cases of the mobile product information system, we first model a *use case diagram*. To provide a more detailed view of the involved actors and objects, we present then a *class diagram* showing classes of objects with similar characteristics (attributes and operations) and connections between them. These models are chosen because of their applicability for system development.

Use case diagram

The use case diagram demonstrates the different types of users in the system and the way they interact with it. It provides a higher-level view of the system and presents graphical what the system must do. Thus, it is an appropriate communication tool for stakeholders [56]. The outcome is a model showing actors and related use cases of the mobile product information system.
The system contains of four major *actors*: user, service provider, seller, and third party.
The *user* is a customer who has to register for the system before using it. After authentication, a user can buy products (mobile commerce), search for product information (e.g., via keyword search), create own lists (e.g., wish lists), archives (e.g., bought products) and QR codes (e.g., business cards), provide own information (e.g., pictures), send and receive messages (e.g., via email), scan and store data (e.g., loyalty cards), and redeem received marketing offers. The *service provider* is the owner and administrator of the system. He is responsible for administration of user accounts, can add new products and product categories, provide, change and delete product information, present users search results, send and receive messages, and provide LBS. The *seller* is a retailer or producer selling products and sending marketing offers to users as well as providing information (e.g., product data such as nutrition facts). The *third party* is an actor like a health care or test organisation providing additional product information to the system (e.g., test reports). The actors with their related use cases are presented in detail in Figure 2.

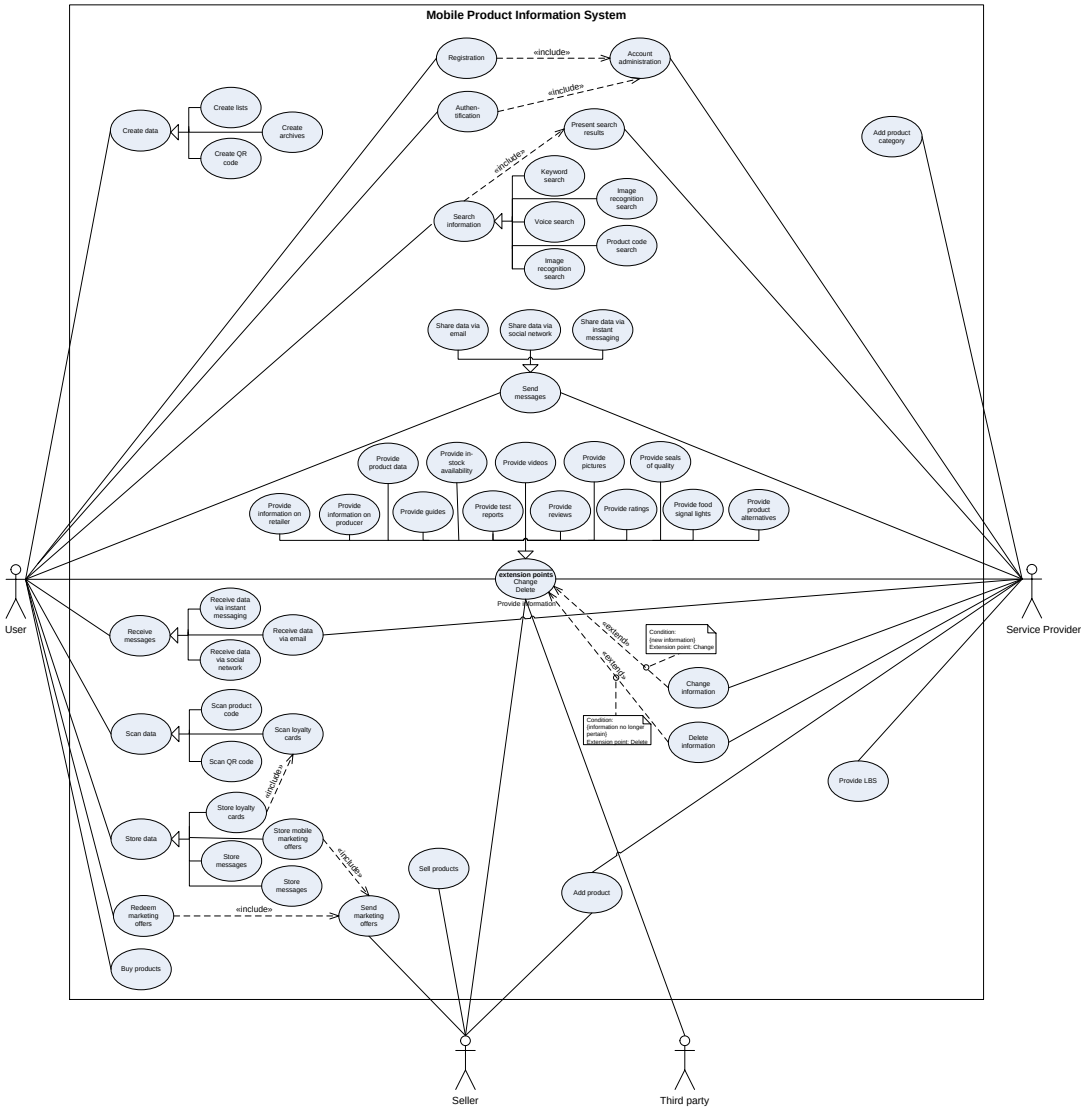

Figure 2 Reference model: functionality of the mobile product information system

Class diagram

The class diagram demonstrates classes, ports and connections between them. It is used to abstract objects and describes objects with similar structures and characteristics [42]. Thus, in the object-oriented analysis and design a class diagram enables the modelling of a defined system.

The class diagram presents six *classes* of objects similar to the actors shown in the use case diagram: *user*, *service provider*, *retailer*, *producer*, *third party*, and *product*. All classes are specified by a set of attributes and operations. The classes user, service provider, retailer, producer and third party are connected to the class product.

The system is shown on paramount abstraction level in Figure 3. For a more detailed analysis and design it can be specified on a more detailed abstraction level (e.g. by specification of additional objects like lists, reviews, etc.).

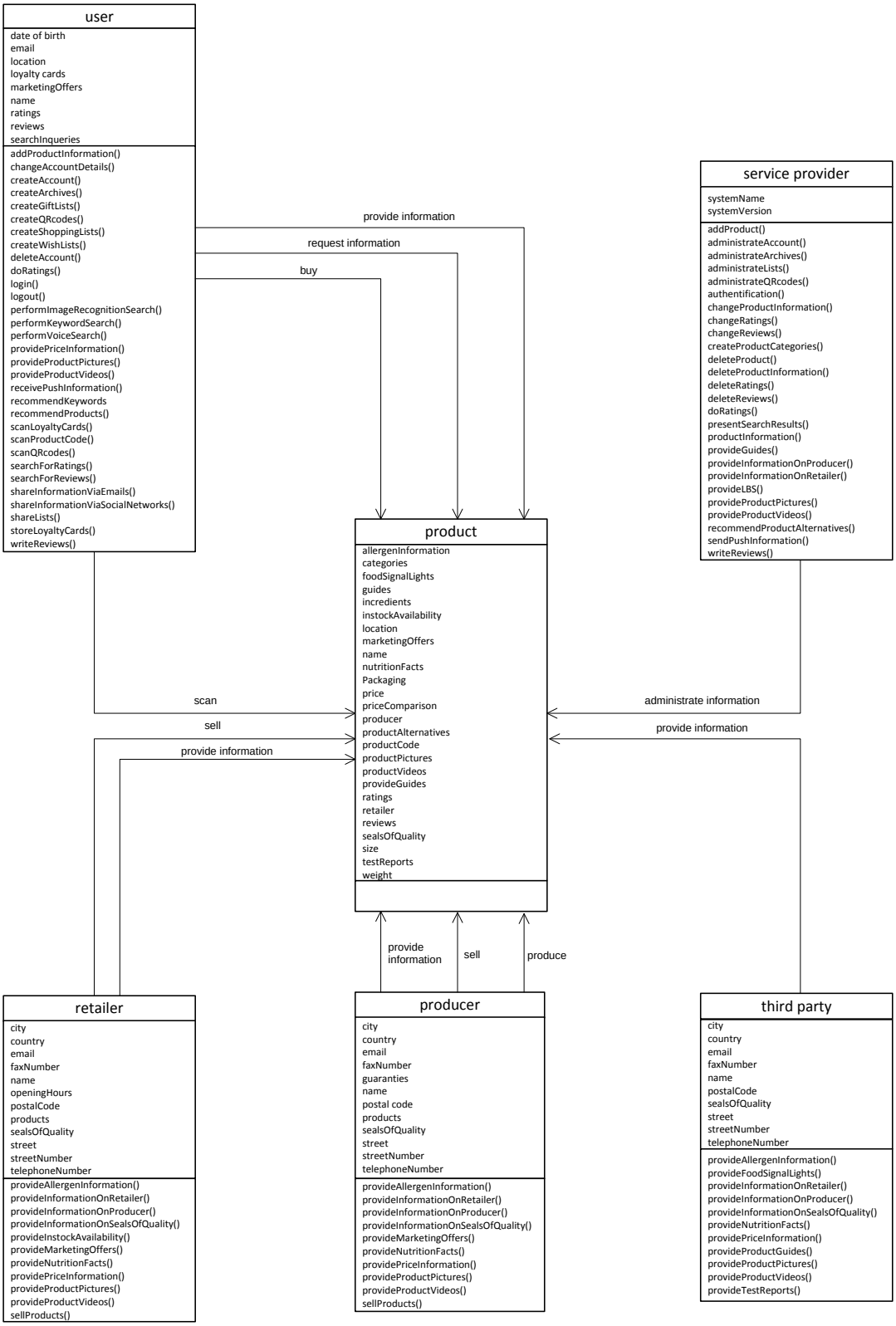

Figure 3 Reference model: data objects of the mobile product information system

Implications for research and practice

For researchers and practitioners the presented model can be used as basis to develop, analyse and compare mobile product information systems according to their actors, objectives and use cases. It can be combined with additional mobile b2b and b2c services like mobile inventory, mobile marketing, mobile payment or mobile social media.

The presented mobile product information system supports consumers by their shopping decision at the POS. Thus, users of the system can request and share additional information on the product (e.g., price and ingredients), the producer (e.g., ethical standards), and the retailer (e.g., opening hours). This information allows consumers to compare products, producers and retailers and therefore supports the complete information in the market.

CONCLUSION

In this paper, we used literature review and multiple case study research to identify relevant actors, use cases and objects of a mobile product information system. Based on that, we designed an according reference model using two UML diagrams (use case diagram and class diagram) showing the functionalities and data objects of the mobile product information system. The developed reference model can be used from researchers as well as practitioners as a first reference point and recommendation for the construction of new and the analysis of existing mobile product information systems. It promotes the analysis and comparison of mobile product information systems as well as the purposive construction of such systems. The implementation phase of a mobile product information system can be supported by a continuation of the aforementioned introspective analysis, resulting in a top-down deduction of requirements for system architectures.
In this paper, we limited the design of the mobile product information system to the main actors and functionalities in order to provide a clear overview. In the future it might be possible that a provider of a mobile product information system will integrate additional services. However, the reference model allows an extension of the analysis, design and development of such a system and thus an integration of additional functionalities. Therefore, future research should include the analysis and design of the mobile product information system on a deeper abstraction level to provide the complete functional and technical survey of the system. Further research could also include the validation of the presented reference model by experts.

ACKNOWLDGEMENTS

The project is supported by funds of the Federal Ministry of Food, Agriculture and Consumer Protection (BMELV) based on a decision of the Parliament of the Federal Republic of Germany via the Federal Office for Agriculture and Food (BLE) under the innovation support programme.

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