A design model for knowledge-based pricing services in the retail industry

Tobias Kowatsch*

Institute of Technology Management,
University of St. Gallen (ITEM-HSG),
Dufourstrasse 40a, 9000 St. Gallen, Switzerland
E-mail: tobias.kowatsch@unisg.ch
*Corresponding author

Wolfgang Maass

Institute of Technology Management,
University of St. Gallen (ITEM-HSG),
Dufourstrasse 40a, 9000 St. Gallen, Switzerland
and
Research Center for Intelligent Media,
Hochschule Furtwangen University (RCIM-HFU),
Robert-Gerwig-Platz 1, 78120 Furtwangen, Germany
E-mail: wolfgang.maass@unisg.ch
E-mail: wolfgang.maass@hs-furtwangen.de

Abstract: Marketing research has identified several benefits of dynamic pricing strategies in the retail industry. However, today's retailers are limited to apply them in real-time to customer needs as corresponding pricing services provided by smart product infrastructures have not been adopted so far. In addition, dynamic pricing strategies rely on a business service ecosystem of retailers, suppliers, customers and regulatory bodies and thus, interoperability is required. Because unprecedented, our objectives are therefore to propose, implement and evaluate a design model for pricing services that rely on explicit semantics and rules, denoted as knowledge-based pricing services (KPSs). In this work, we propose a design model for KPSs and empirically evaluate their utility from a customer perspective with the help of a web-based application. We finally draw implications for business models in the retail industry and discuss tools that already exist to adopt KPSs in the near future.

Keywords: pricing service; knowledge-based design model; retail industry; ecosystem; operational agility; interoperability; business model; semantic services; ontologies; web-based information system; adoption and diffusion; empirical study; experiment.

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Biographical notes: Tobias Kowatsch is a Research Associate at ITEM-HSG. His research interests in the management of information systems are the adoption and diffusion of innovations, consumer behaviour, mobile business, smart products, internet of things and recommendation agents. He studied media informatics at Hochschule Furtwangen University (HFU) in Germany and wrote his diploma thesis about semantic web applications in 2005. After studying in Scotland and doing social volunteering in South Africa, he attended the Master's programme in Computer Science in Media at HFU in 2006 and passed with distinction. Then, he did empirical research on the user acceptance of mobile information systems at the Research Center for Intelligent Media at HFU.

Wolfgang Maass leads the division Smart Products at ITEM-HSG. He is University Lecturer at the University of St. Gallen and Professor of Media and Computer Science at Hochschule Furtwangen University where he is also Head of the Research Center for Intelligent Media (RCIM). His research interests in information management and information systems include ambient intelligence with a focus on smart products, internet of things, electronic knowledge markets and paid content. He is a member of the editorial board of *Electronic Markets* and a reviewer for the *European Journal of Information Systems*, *The International Journal on Media Management*, and the *Journal of Theoretical and Applied Electronic Commerce Research*. He received his PhD from the University of Saarbrücken in Germany. In the end of 2007, he was awarded with a Habilitation by the Department of Management at the University of St. Gallen.

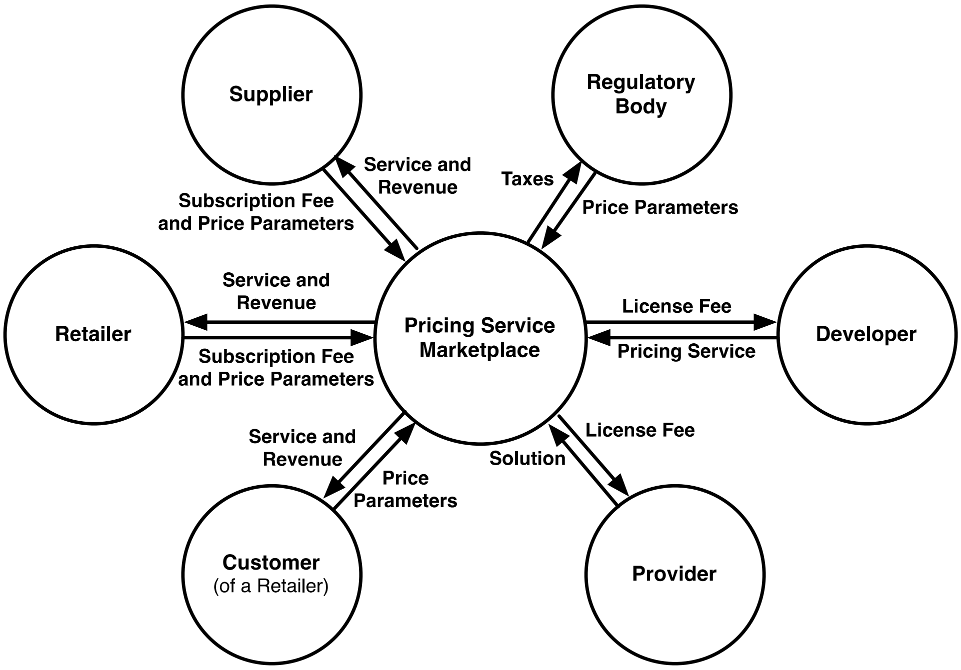
1 Introduction

Marketing research has identified several benefits of dynamic pricing in the retail industry. For instance, pricing strategies that address inventory considerations and time horizons (Elmaghraby and Keskinocak, 2003; Gallego and van Ryzin, 1994; Su, 2007), bundling (Bitran and Ferrer, 2007; Gaeth et al., 1991) or personalised offerings (Choudhary et al., 2005; Liu and Zhang, 2006) have been found to increase sales volume, customer satisfaction and to skim reservation prices. Dynamic pricing is therefore highly relevant to retailers but time and costs limit frequent updates of price tags. Especially for low-cost products, personalised pricing is not feasible at all and can be only indirectly applied through the use of loyalty cards that promise discounts after or at the purchase. In this sense, retailers lack the capability of applying sales strategies that rely on real-time pricing with regard to customer needs and thus, pricing in retail stores is rather static today. Accordingly, retailers' operational agility, i.e., the ability to accomplish speed, accuracy, and cost economy in the exploitation of pricing strategies is strongly restricted (Sambamurthy et al., 2003).

Pricing services and flexible price delivery infrastructures may address this challenge. Prior research suggests that smart products could support the presentation of dynamic prices as they incorporate information technology for business purposes (Konana and Ray, 2007; Maass and Varshney, 2008). In contrast to electronic shelf labelling systems (Southwell, 2002), the concept of smart products is more flexible because products can be directly identified through attached barcodes or RFID tags in order to request price information, for instance, on a mobile device. Accordingly, smart product infrastructures can be used to present price information instantly to customers in retail stores (Maass and Filler, 2006). The adoption of these technologies by consumers is also promising as shown by recent studies (Kowatsch and Maass, 2010; Kowatsch et al., 2011).

However, the application of dynamic pricing strategies does not only require a delivery infrastructure but also a service platform for the management and configuration of pricing models. In particular, dynamic pricing relies on several parameters provided by various stakeholders such as retailers (e.g., inventory data), suppliers (e.g., recommended sales price), customers (e.g., buying history or products in the shopping basket), or regulatory bodies (e.g., taxes). Thus, the evolution of a service business ecosystem for the implementation of pricing strategies is most likely if early adopters apply them. And similar to IT-based ecosystems like the App Store with Apple being the keystone (Iansiti and Levien, 2004), developers and providers of pricing services would be part of this new ecosystem as well (Tian et al., 2008). Figure 1 exemplifies such a service business ecosystem for pricing services in the retail industry.

Figure 1 Example of a service business ecosystem for pricing services in the retail industry



Source: The figure is partly adapted from Tian et al. (2008)

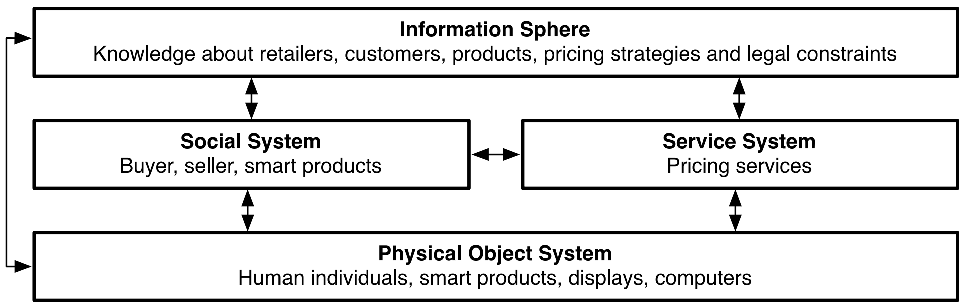
Having a delivery infrastructure and a pricing service platform, retailers and their suppliers would be able to promote dynamic price information to their customers with all the benefits identified by marketing research. This also implies an enhancement of operational agility in terms of improved availability and quality of price information in the retail industry. But bearing in mind various stakeholders as shown in Figure 1, it is obvious that interoperability is a key challenge for a successful adoption of pricing services as it has been in IT for over two decades (Legner and Lebreton, 2007; Tolman et al., 2009). In addressing this issue, semantic services are promising as they enable an automated exchange and integration of semantically rich information. There are three primary advantages for using those services for dynamic pricing scenarios in the retail industry: "they promote reuse and interoperability among independently created and managed services; ontology-supported representations based on formal and explicit representation lead to more automation; and explicit modeling of the entities and their relationships between them allows performing deep and insightful analysis" [Sheth et al., (2006), p.56].

Because unprecedented, our objectives are therefore to propose, implement and evaluate a design model for pricing services that rely on explicit semantics and rules. We call them knowledge-based pricing services (KPSs). In the next section, we propose a design model for KPSs in the retail industry. In Section 3, we then apply this model to a shopping scenario and evaluate the utility of two KPSs from the perspective of customers of a retail store. We therefore develop and empirically test a web-based application that applies those KPSs. Then, we draw implications for business models that are based on KPSs in the retail industry in Section 4 and discuss tools that already exist to adopt KPSs in Section 5. We finally conclude this paper with a short summary.

2 Design model for KPSs

Our design model for KPSs is based on the work of Spohrer et al. (2007), which discusses steps towards a theory of service systems. They claim that components of a service system are "people, technology, internal and external service systems connected by value propositions, and shared information" (ibid, p.73). Consistently, our design model also comprises four components (cf. Figure 2). But no recursive definition of service system is used for ease of presentation and which is also consistent with the abstract information system model (AISM), a model that is used to design service-based information systems (Maass and Varshney, 2009).

Figure 2 Design model applied to KPSs in the retail industry



According to AISM and Spohrer et al., our model consists of a social system, a service system, an information sphere and a physical object system. The social system describes a set of roles with rights, obligations, and prohibitions in a shopping environment. Role-taking actors, e.g., retailers, customers or smart products, interact and communicate according to implicit or explicit pricing rules and protocols. Thus, the social system is strongly related to the concept of people as described by Spohrer et al. For their interactions and communications, role-taking actors make use of pricing services provided by the service system, which covers both internal as well as external service systems (Spohrer et al.). The information sphere provides all information objects used within the social system, service system and physical object system, whereby the latter comprises a set of physical entities such as smart products available in a shopping environment.

Table 1 Pricing domains and corresponding pricing parameters with references

Pricing domain	*Description*	*Parameters*	*Literature*
Knowledge about the retailer	Here, pricing parameters describe general requirements and constraints that are derived from the retailer's strategic goals.	Terms and conditions, contract, stores, inventory, configuration of pricing strategies, assumptions about customer segments, sales observations.	Aviv and Pazgal (2005), Bichler and Kalagnanam (2006), Chinthalapati et al. (2006), Choudhary et al. (2005), Elmaghraby and Keskinocak (2003), Gallego and van Ryzin (1994), Kelkar et al. (2002), Su (2007), and Zhiqiang and Xiong (2008)
Knowledge about the individual customer	This domain focuses solely on information that is related to an individual customer and which is used to implement personalised pricing strategies.	Reservation price, shopping frequency, products in the shopping cart, age, gender, price sensitivity, price aversion.	Bichler and Kalagnanam (2006), Chinthalapati et al. (2006), Choudhary et al. (2005), Dewan et al. (1999), Gaeth et al. (1991), Hardestya et al. (2007), Kelkar et al. (2002), Liu and Zhang (2006), Tellis and Gaeth (1990), and Zhiqiang and Xiong (2008)
Knowledge about the product	This domain covers product information that is provided by a retailer, supplier or other third parties, such as review portals like eOpinions.com.	Product description and specification, product costs, recommended sales price and its validity time period.	Aviv and Pazgal (2005), Bichler and Kalagnanam (2006), Chinthalapati et al. (2006), Choudhary et al. (2005), Elmaghraby and Keskinocak (2003), Gallego and van Ryzin (1994), Kelkar et al. (2002), and Zhiqiang and Xiong (2008)
Knowledge about legal constraints	This domain involves all aspects that are specific to a country and its policies.	Delivery region, currency, laws, policies, time, taxes, logistic costs.	Aviv and Pazgal (2005), Gallego and van Ryzin (1994), Kelkar et al. (2002), Stremersch and Tellis (2002) and Su (2007)
Knowledge about pricing strategies (meta-domain)	This domain provides meta-knowledge about pricing strategies. Correspondingly, the basic entities in a pricing marketplace are services that are instances of these pricing strategies tailored for different retail industries.	Contract, currency, price, price type, bundling, personalised pricing, dynamic pricing, inventory, price aversion.	See references above, Bitran and Ferrer (2007), Karpowicz and Szajowski (2007), and Stigler (1963)

Because it addresses the challenge of interoperability in a heterogeneous ecosystem as depicted in Figure 1, the main advantage of our model lies in the semantics-based component, i.e., the information sphere. This component is used to describe KPSs and their interactions with people and smart products with explicit semantic descriptions and rules. In contrast to dynamic pricing models that are solely based on historical data about prices and customers (e.g., airlines pricing passenger seats), the knowledge-based approach relies on logical statements to determine a price. We have conducted a literature review on pricing models that reveals five domains of knowledge, which are relevant for a pricing information sphere. These domains cover knowledge about retailers, customers, products and legal constraints. In addition, knowledge about pricing strategies is required and thus, this dedicated meta-model is considered as well. An overview of these domains, corresponding pricing parameters and relevant literature is provided in Table 1.

All in all, each of these five knowledge domains must be made explicit for interoperability reasons, such that the configuration and adoption of a specific pricing service reduces time and effort for all members of the business service ecosystem in Figure 1, which would in turn increase operational agility in the retail industry.

3 Application and evaluation of the design model

Having introduced the basic components of our design model for KPSs, we now exemplify its use and evaluate the value of KPSs from the perspective of retail customers. We chose a shopping scenario in the retail industry of Switzerland as shown in Figure 3. In this scenario, the retailer applies two pricing services. First, a personalised pricing service is used in order to skim consumer surplus of a particular customer segment (e.g., Choudhary et al., 2005; Liu and Zhang, 2006). It calculates prices according to the following rule:

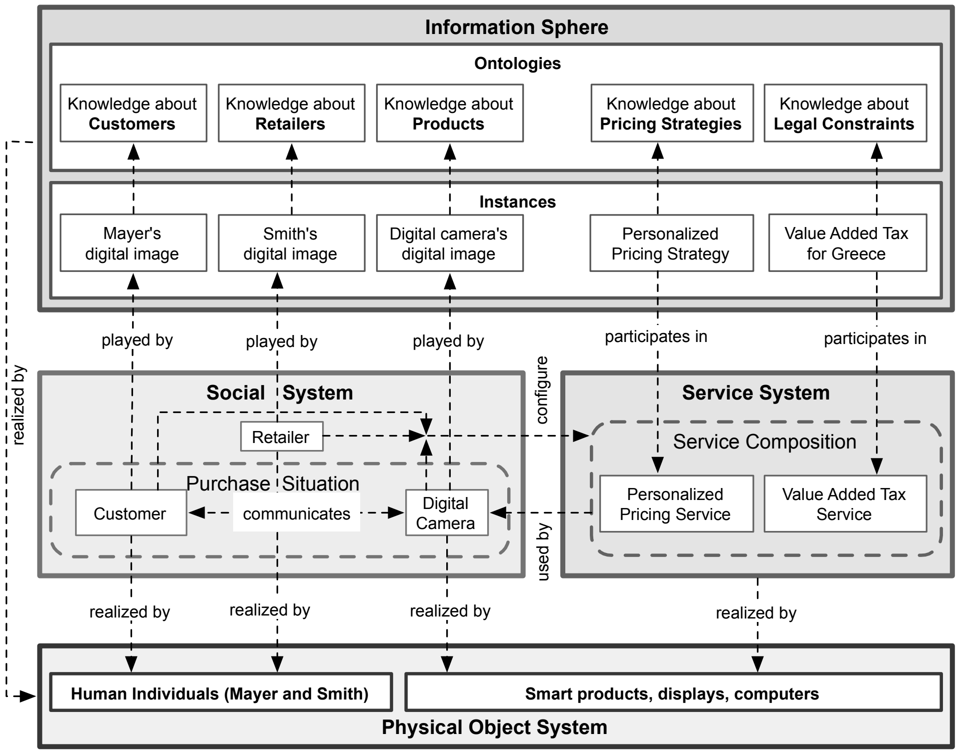
1 *Personalised pricing rule:* If the customer is a student and has made a sales volume of 100 Euro in the last four weeks, then reduce the recommended sales price by 3%.

Second, the retailer applies an inventory pricing service with the business goal to increase the sale of slow-selling articles (e.g., Elmaghraby and Keskinocak, 2003; Gallego and van Ryzin, 1994). This KPS calculates prices as follows:

2 *Inventory pricing rule:* If a product's sales volume for the last two weeks lies significantly below the average of products that belong to the same product category, reduce the recommended sales price by 5%.

Due to legal constraints in Switzerland, each transaction requires a value added tax (VAT) to be added to the product's price. Thus, a mandatory VAT service, i.e., an external service, is added to this shopping scenario as well. With the exception of the VAT service, the pricing services are implemented instances of personalised and inventory pricing strategies, which are likewise pricing strategies according to a given ontology. All services are realised by adequate semantic web technologies. In addition, existing digital instances of retailer Smith, customer Mayer and the smart product, here sugar, provide relevant pricing parameters such as sales information (provided by Smith), customer characteristics (provided by Mayer) or the recommended sales price (provided by the product). In this purchase situation, the customer would request the price of the product with the help of a mobile device such as a mobile phone.

Figure 3 Design model applied to a knowledge-based pricing scenario in the retail industry



3.1 Evaluating KPSs

Today, it is an open issue, whether the stakeholders of the retail ecosystem adopt KPSs. As a first step, we empirically test KPSs from the perspective of customers that buy products in in-store shopping situations. This customer-oriented approach tries to identify new customer needs that are not satisfied as of today and thus, would give other members of the ecosystem a rationale to develop and adopt KPSs in the future. Nevertheless, evaluating KPSs with retailers and their suppliers is required as well but out of the scope of the current work.

We evaluate the utility of KPSs by applying innovation diffusion theory (IDT, Rogers, 2003), theory of planned behaviour (TPB, Ajzen, 1991) and technology acceptance model (TAM, Davis, 1989). According to IDT, a KPS represents an innovation that a customer can adopt for price information acquisition in in-store shopping situations. Another research stream applies intention-based models to understand the adoption of products or services. Accordingly, corresponding models such as TPB are grounded in social psychology to identify attitudes, social influences and facilitating conditions that predict intention of usage. The intention to use a KPS for price information acquisition predicts its adoption, respectively. For instance, TAM is based upon this line of research. In addition, several studies successfully integrate both research domains (e.g., Moore and Benbasat, 1991; Venkatesh et al., 2003). Consistent with the latter, our work takes both perspectives into account, too.

Three constructs from prior work are adequate to be used in the current work. The first one is relative advantage, which is defined as the degree "to which an innovation is perceived as better than the idea it supercedes" [Rogers, (2003), p.476]. In our context, a KPS represents the innovation and is assumed to supersede a static price label present in retail stores today. Consistent with TPB, relative advantage of KPSs is assumed to have a positive influence on two other constructs that represent behavioural intentions. First, relative advantage may positively influence the intention to buy a product after using a KPS because buying behaviour reflects trust in that pricing service (Komiak and Benbasat, 2006). Second, relative advantage may also positively influence the behavioural intention to prefer a retail store that provides KPSs. Accordingly, Kamis et al. (2008) found that perceived usefulness being similar to the relative advantage construct (Moore and Benbasat, 1991) strongly predicts the intention to return to it, which is related to our research as return reflects store preference. Considering both assumptions, we postulate the following hypotheses:

H_1 Perceived relative advantage of KPSs has a positive relation with the intention to buy products that offer them for price information acquisition.

H_2 Perceived relative advantage of KPSs has a positive relation with the intention to prefer retail stores that offer them to their customers.

3.2 Method

In order to test the hypotheses, we developed and evaluated two KPSs for the semantics-based Tip'n Tell infrastructure for smart products (Maass and Filler, 2006). Hereby, rules were implemented with the Semantic Web Rule Language (Maass et al., 2008). In the following, we briefly describe the application, before we present the experimental setting and the survey instrument.

The two KPSs as discussed above are provided to the customer of a retail store via a web browser on a mobile phone. HTML 5 and CSS 3 were used to implement an interactive client application on Apple's iPhone, whereas PHP 5 and MySQL 5 were used as a proxy layer to the Tip'n Tell middleware. By the use of standard web technologies, this approach is quite flexible as KPSs can be provided easily to almost every mobile device that offers a web browser. The customer has just to open the web page of the retailer to search for products he is interested in. By logging in with a customer ID, related information such as the customer segment or historic sales data can be used by KPSs to calculate personalised prices. In order to guide the customer in his purchase task, the application also allows the customer to manage a shopping list, i.e., to add, edit and remove products she or he needs to buy.

A lab experiment was conducted to test the utility of KPSs. In the first part of the experiment, the concept of KPSs was explained to each participant in detail. Further, she or he was trained in the use of the KPS application on an iPhone. Then, each participant had to log in with a customer account that was linked to a student's profile such that the personalised pricing rule could be applied. A shopping list with pre-defined product categories was shown to the participants and they were asked to buy corresponding products based on the prices being provided by the mobile application. In order to apply the inventory-based pricing rule, some of the products were modelled as slow-selling products and thus, a corresponding price was calculated, too. Figures 4 and 5 show the experimental setting and the shopping list, whereas screenshots of the mobile application are depicted in Figures 6 and 7. In the last part of the experiment, the participants had to rate statements regarding the research constructs on seven-point Likert scales ranging from strongly disagree (1) to strongly agree (7). For the relative advantage construct, we adapted the items from Moore and Benbasat (1991), whereas intention to purchase a product after using KPSs and the intention to prefer a store that provides KPSs were adapted from Kamis et al. (2008) and Kowatsch and Maass (2010), respectively. After the experiment, which took about 30 minutes on average, each subject received 5 Euro for participation.

Figure 4 Participant using the KPS application during the experiment

Figure 5 Screenshot of the shopping list

Figure 6 Screenshot of products with inventory-based discounts

Figure 7 Screenshot with a personalised discount of 2%

3.3 Results

Twenty-one male and 11 female students from a European University participated in the experiment. Their age ranged from 20 to 24 (N = 20) and from 25–29 (N = 12). Cronbach's alpha yielded viable .90 for the multi-item construct relative advantage.

Furthermore, the means of the three constructs lie all above the neutral scale-value at highest level of significance ($p < .001$) by applying one-sample t-tests with a test value of four (relative advantage = 5.83; intention to purchase a product after using KPSs = 5.88; intention to prefer a KPS-enabled retail sore = 5.19). This indicates quite positive evaluations of KPS from a customer perspective. In order to test our hypotheses and in line with Davis (1989), we calculated correlation coefficients. As a result, both relationships are positive and significant (H_1 $r = .652$, $p < .01$; H_2 $r = .30$, $p < .05$) and thus, H_1 and H_2 are supported by our empirical data. As a result, our findings indicate that potential customers of retail stores perceive KPSs better than static price information available in today's retail stores. Furthermore, subjects of our experiment would even prefer retail stores that provide KPSs. However, the results must be interpreted carefully with regard to external validity before they are not supported by field studies.

4 Implications for business models

We now draw implications of the use of KPSs for corresponding business models in the retail industry to motivate their adoption. Like the experiment presented above, one should note that the following discussion assumes that a smart product infrastructure and mobile devices are available through which prices can be presented on demand to customers at the point of sale. The following discussion addresses business models that involve dynamic pricing strategies in terms of personalised offerings, bundling, inventory considerations and time horizons as these approaches are relevant in the retail industry (Bitran and Ferrer, 2007; Choudhary et al., 2005; Elmaghraby and Keskinocak, 2003; Gaeth et al., 1991; Gallego and van Ryzin, 1994; Liu and Zhang, 2006; Su, 2007).

- *Personalised pricing:* personalised pricing services allow the application of first degree price discrimination strategies according to Pigou (1920). Their main objective is to skim consumer surplus and therefore to increase the retailer's sales volume. With the exception of individual negotiations for high-cost or high-complex products such as individual software products or cars, the application of personalised pricing strategies in in-store shopping situations is currently restricted to loyalty cards, that promise a discount after the consumer has made enough purchases. KPS scenarios would change these kinds of business models. For instance, if the digital instance of a consumer provides information that is relevant to the retailer (e.g., whether he is a student or a retired person), the latter is able to provide an individual price and present it on demand through the channel of smart products. Furthermore, retailers have the potential to deeply listen into their customers' interests and pricing needs if they capture shopping interactions and buying behaviour. This kind of 'listening in' might also lead to new personalised pricing models (Urban and Hauser, 2004). In addition, suppliers or producers might also price their products according to the input of individual customers. For example, to increase customer retention a supplier may give a discount on his product because the customer already owns another product of the same supplier. In this sense, business models related to personalised pricing might also foster the cooperation between retailers, suppliers and customers.

- *Product bundling:* A KPS for product bundles would enable retailers and suppliers of complementary products (e.g., digital cameras and memory cards) to negotiate an individual price for a product bundle instantly by semantic reasoning mechanisms at that point of time, when a customer is interested in those products. This would not only make the product bundle more attractive to the customer but would also increase sales volume and profit of the retailer and its suppliers, if the customer buys two products instead of one. These kinds of scenarios would foster the cooperation between retailers and suppliers of complementary products in terms of price negotiations, whereby the tie-in product (here, the memory card) would generate less profit through a higher discount, because it was tied-in by the digital camera (see Gaeth et al., 1991). In addition to recommended sales prices, corresponding business models should therefore consider pricing parameters and constraints for ad hoc price negotiations of product bundles.
- *Pricing that considers the retailer's inventory:* IT-based inventory management tools such as collaborative planning, forecasting and replenishment, quick response or vendor-managed inventory have improved the availability of stock information for both retail and online stores (Elmaghraby and Keskinocak, 2003). Based on this information, KPSs can be parameterised such that they calculate prices according the current status of the inventory. For example, the retailer might dynamically reduce the price of slow-selling products as shown in our experiment to increase their attractiveness, whereas fast-selling articles of which only a small amount is still available might be priced higher in order to reorder them timely. In this sense, KPSs might change existing business models due to stock information that is instantly available at the time of purchase or when a consumer is interested in a product. Accordingly, the question will arise how to use this stock information in order to improve both availability and sales of products by adaptive pricing mechanisms.
- *Pricing that considers time horizons:* When a retailer faces a finite time horizon for selling products (e.g., for seasonal products), the business objective is to maximise expected revenues until the end of a selling season by pricing products adequately (Aviv and Pazgal, 2005; Su, 2007). For example, new swimsuits will be priced higher at the beginning of a summer season than at the end. Current business models consider a more static approach in changing prices over a finite time horizon due to high operational costs (Elmaghraby and Keskinocak, 2003). In this case, products are priced usually two times over a selling season. With the use of KPSs, new business models may therefore apply dynamic pricing strategies on a far more granular level. Higher prices in times of high-demand at the end of a week or a day would be one example. Pricing non-durable goods such as groceries relative to the time of their life cycle would be another. Hence, the concept of product life cycles may play a major role in the design of future business models with regard to KPSs.

In addition to these implications, it must be considered that each of the pricing scenarios discussed could have a negative impact on consumer behaviour and the image of a retailer, supplier, producer or service provider. Correspondingly, two of the most important topics that must be addressed by all business models are security aspects and price transparency. Both issues came up when briefing the participants of our experiment as well. The first one is important according to the design model presented in the last section, because there exist various knowledge domains and explicit descriptions about customers, retailers and products for which access models must be defined to prevent fraudulent use. By contrast, the second aspect is crucial in terms of consumers' negative attitudes towards prices, that vary from day to day or from one person to another. Thus, it must be made always transparent how a particular price is calculated to make the price traceable for the customer. Otherwise, customers would rather avoid retail stores that offer KPSs.

5 Existing tools guiding future work

In order to guide the adoption of KPSs in the near future, we now discuss existing tools that can be used to implement KPSs. First of all, we start with adequate delivery infrastructures into which KPSs can be embedded. Because there exist many potential infrastructures and related systems such as electronic shelf labelling systems, we briefly describe three of them, which are particularly related to the concept of smart products. Then, potential front-ends for KPSs are addressed, before we finally list standards for pricing services and semantic data models.

5.1 Delivery infrastructures

First of all, the smart product infrastructure Tip'n Tell (Maass and Filler, 2006) represents an adequate delivery platform for KPSs as it uses a semantic framework and reasoning mechanisms to provide information about products. Within a Tip'n Tell shopping scenario, physical products are equipped with a barcode or RFID tags to identify them and to start human product interaction through a mobile application. Then, if a consumer scans the product's identification number, the mobile shopping assistant informs the Tip'n Tell web service (Java & Axis 2) accordingly. The server components manage the semantic data pool using the semantic framework Jena 2 to allow the user to request the price information of a product. This framework was used in the experiment as backend system. A second infrastructure is Fosstrak (previously named Accada, Floerkemeier et al., 2007). Although it is an open source RFID middleware platform that mainly focuses on monitoring activities in supply chains, it can be used in combination with the concept of smart products when these products provide RFID technology. For example, e-commerce transactions can be triggered with the help of Fosstrak and tangible user interfaces in the form of smart products (Maass and Kowatsch, 2009). And finally, construct represents also a potential delivery platform for KPSs (Dobson et al., 2007). It is an open source platform for pervasive environments such as in-store shopping environments, which uses RDF as its data exchange model and which supports a knowledge-centric model for interactions. Therefore, construct fits well to the knowledge-based design model as presented in the current work, too.

5.2 Front-ends

In addition to backend infrastructures, price information of products must be presented to customers in in-store shopping situations. In contrast to electronic shelf labelling systems (e.g., Southwell, 2002), mobile devices are more flexible in combination with smart products. Correspondingly, first applications are being developed for customers to communicate with physical products (Maass and Varshney, 2008). MASSI (Metro AG), the Tip'n Tell mobile client (Kowatsch et al., 2008), the Mobile Prosumer (Resatsch et al., 2008), Easishop (Keegan et al., 2008) or APriori (von Reischach et al., 2009). All of them allow consumers to request product information directly at the point of sale and thus, are potential candidates to provide front-ends for KPSs.

5.3 Standards for pricing services and semantic data models

The last building block for the implementation of KPS is related to standards for price descriptions and semantic data models. The latter are useful, because they can integrate standardised and non-standardised product information (Maass and Lampe, 2007). In order to store and maintain price information of products, there exist several standards. Consistent with our knowledge-based approach and explicit product descriptions, Kelkar et al. (2002) reviewed existing standards for electronic product catalogues that are based on XML and which can be used to model and define prices. In detail, they evaluated the following standards: cXML, xCBL, BMEcat, EAN.UCC, OAGIS, RosettaNet. As a result of their theoretical and empirical analysis, Kelkar et al. proposed a new general price model, because the evaluated standards cover real world price models in a limited way.

Furthermore, prices can be modelled with the smart product description object (SPDO, Janzen and Maass, 2008). SPDO is a semantic data model for products and works hand in hand with the Tip'n Tell infrastructure. The SPDO consists of five facets of which the product description and business description are used to model the corresponding price information of a product. GoodRelations is another example of a semantic data model for consumer products (Hepp, 2008), which might also be relevant in the adoption of KPSs. In addition, semantic data models can be complemented with the use of rule languages (e.g., SWRL) and reasoning mechanisms in order to request or calculate prices in a knowledge-based fashion.

Finally, laws and licence agreements are required to deploy and maintain sophisticated and complex services (Gangadharan and D'Andrea, 2009; Spohrer et al., 2007). Accordingly, the licensing of pricing services could be managed with the ODRL services profile (Gangadharan et al., 2008). This profile is based on XML and fits therefore to our design model for KPSs. Complementary, Kumar and Mishra (2009) describe a multi-attribute approach for negotiations between semantic web services, which would be relevant for an on-demand pricing of product bundles as discussed above.

In summary, all of these tools, i.e., delivery infrastructures, consumer front-ends, pricing standards and semantic data models, are starting points for our future work that will predominantly address their integration (Tolman et al., 2009), upon which further evaluations of KPSs in the retail industry are planned. Even though pricing services will reveal their full potential within a business ecosystem of retailers, suppliers, service providers and developers, customers and regulatory bodies, forthcoming studies will primarily investigate the utility of KPSs from the perspective of retailers, suppliers and service providers as a next step.

6 Summary

In the current work, we proposed a design model for KPSs. In combination with adequate delivery infrastructures, they have the potential to increase operational agility in the retail industry, because they enable retailers to implement pricing strategies that address personalised offerings, inventory considerations, bundling and time horizons, i.e., all kinds of pricing strategies, which cannot be applied dynamically with static price tags as of today. KPSs use logic statements to derive prices and therefore extend dynamic pricing models that are solely based on historical data. In order to motivate the use of KPSs, we have applied our design model to a concrete shopping scenario and were able to show the utility of KPSs for a limited sample of retail customers empirically. We have then drawn implications for business models that are based on KPSs. And finally, a brief overview of existing tools was provided that might guide the adoption of KPSs in the near future.

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