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Using Ontologies in an E-Commerce Environment: Help or Hype?

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ABSTRACT

Even though online shopping is becoming increasingly popular, many consumers are still reluctant to buy online, especially when it comes to apparel. One approach to improve adaption is to base e-commerce search engines on *ontologies* to allow a more intuitive search process. This paper[1] presents the results of an analysis how a sample of online shoppers perceived various ontology-based features in an online shop. The data was gathered in two focus groups with panelists coming from different socio-demographic backgrounds (middle-aged women, students in their twenties). Most of the middle-aged women panelists actively shopped for apparel by means of catalogues. However, across the focus groups, most panelists are very reluctant buying apparel online. Our study suggests that age has a higher influence on the information search behaviour of consumers in online shops than gender. The study concludes with suggestions for adapting ontology-based systems to these findings.

Keywords

consumer decision process, e-commerce, ontology-based search, ontology engineering, low-fidelity prototyping

INTRODUCTION

Even with more than 10 years of experience in e-commerce, online shops are still not able to address all consumer needs, especially during the information search online. Shopping online entails many advantages for the consumer, e.g. cost and time savings. Disadvantages originate, among other factors, from the replacement of the sales assistant who could give recommendations by an information system (IS) (Bakos, 1997). In online shopping, products cannot be tested, touched, lifted or tried on, and important product information for taking a buying decision may be missing. Further problems originate from the consumer's interaction with the online shop, such as unclear query formulation or a lack of relevance of search results. Finally, organizational disadvantages such as the availability of products, possible delays in shipping and additional costs (shipping and handling) can reduce customer satisfaction.

However, online shops try to confront these challenges. One approach aims at bridging the offline-online gap by employing interactive consumer decision aids. For example, Amazon is known for its successful implementation of item and user-based collaborative filtering recommender systems, addressing consumers' needs for recommendation and sales conversation (Konstan, Miller, Maltz, Herlocker, Gordon and Riedl, 1997; Sawar, Karypis, Konstan and Reidl, 2001; Wang, de Vries and Reinders, 2006).

Another possible approach is to employ ontologies in e-commerce search engines. An ontology is an explicit representation of a domain of discourse (a conceptualization) usually composed of a set of concepts and relationships (Gruber, 1993). The conception of ontologies is not new, there is a myriad of technical studies discussing interoperability, mapping and matching of ontologies. However, beyond academia they are rarely employed: only few authors analysed technology acceptance (Davis, 1989) of ontologies from a user perspective, in particular regarding the employment of ontologies in the context of e-commerce (Fensel, McGuiness, Schulten, Ng, Lim and Yan, 2001).

This study i) provides an inventory of current problems in online shopping; ii) analyses the technology acceptance of certain ontology-based features employed in an online shop; and iii) deduces requirements for engineering ontology-based systems based on the results of i) and ii). Parts i) and ii) are an explorative analysis based on focus groups. The analysis in part ii) was based on low-fidelity prototype testing.

The paper is structured as follows: After describing the theoretical background, ontology-based features are presented that serve as a basis for the low-fidelity prototype being used in the focus groups. Subsequently, the research methods and the results are depicted. Finally, implications and conclusions are presented.

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RELATED WORK

Our study touches upon several research areas: consumer research, human-computer-interaction, information retrieval, and technology acceptance.

In online decision processes, the extent of a consumer's information search depends upon certain antecedents. These particularly influence aspects of user-system-interaction and the evaluation of the usefulness and effectiveness of an IS for satisfying consumer information needs. Product-related antecedents such as involvement (Mittal, 1989; Mittal and Lee, 1989) and prior product knowledge (Brucks, 1985; Flynn and Goldsmith, 1999) are especially important. The extent of an information search correlates positively with situational involvement or enduring involvement in the information search process (Beatty and Smith, 1987). It correlates negatively with the amount of prior product knowledge, however (Jepsen, 2007). Finally, consumers with imprecise information needs usually employ exploratory search tactics, and strategies that induce an evolvement of the information need during information search, achieved by learning processes during search (Bates, 1979, 1989; White, Muresan and Marchionini, 2008). Consumer research also deals with the issue of risk. According to this, the main task of information search is the reduction of perceived product and transactional risks. The perceived risk relates to the concreteness of an information need, which in turn depends mainly on the amount of prior product knowledge (Swaminathan, 2003).

Consumer satisfaction will increase consumer loyalty and revenue. It can be measured by perceived ease of use and perceived usefulness (Davis, 1989; Venkatesh, Morris, Davis and Davis, 2003) as well as the resulting overall information and system satisfaction (Delone and McLean, 2003, 2004; Wang, 2008). Consumer satisfaction can be increased by a higher relevance of the search results and creating new features (Hill, Roche and Allen, 2007; Lee and Joshi, 2006; Shankar, Smith and Rangaswamy).

Three general approaches for influencing information search in online buying decision processes can be distinguished. First, human-computer-interaction approaches emphasize the importance of task-orientated user search interfaces (Marchionini, 2006; White et al., 2008). Second, system-based approaches aim at improving information retrieval processes by query expansion and query specifications (Kumar and Lang, 2007; Shen, Pan, Sun, Pan, Wu, Yin and Yang, 2006). In an e-commerce context, the evaluation of IS effectiveness should include user-centric relevance (Baeza-Yates and Ribeiro-Neto, 1999) such as the concept of situational relevance, which describes the relevance of a search result at a certain point in the search process (Borlund, 2003; Schamber, Eisenberg and Nilan, 1990). The third approach employs recommendation agents in order to deal with issues regarding product evaluation and selection (Ansari, Essegaier and Kohli, 2000; Bodapati, 2008; Bruyn, Lietchy, Huizingh and Lilien, 2008; Häubl and Trifts, 2000; Murray and Häubl, 2008; Schafer, Konstan and Riedl, 2001; Senecal and Nantel, 2004; Swaminathan, 2003).

However, a holistic approach that integrates and extends the approaches mentioned above seems most suitable to tackle conceivable barriers in information search. Semantic technologies may contribute to such solutions. As few studies have systematically addressed possible B2C applications of ontologies (Meij, Mika and Zaragoza, 2009), and as they predominantly focus on technical aspects, this study analyses consumer-related aspects.

ONTOLOGIES IN E-COMMERCE

Ontologies consist of concepts, relations of those concepts, attributes, rules and instances (see above). In today's shopping context, the latter will normally be the products. Ontologies allow i) to define rules for soft product attributes and soft product categories; and ii) to extend the search space by including concepts that are similar to the search term, as opposed to a mere search for synonyms.

Thereby, ontologies create a model of reality, which is based on rather subjective stipulations. Thus, the influence of ontologies on functionality and information retrieval will always depend upon the overall setting, such as the type of online store (brand store, general retailer, specialized retailer), the type of products offered, the degree of specialisation (heterogeneity of products), and also upon the degree of heterogenity of customers regarding age, gender, income, education and IT experience. Using navigation, however, will not necessarily solve this due to the fact that soft product categories or navigational categories and indexes are also not commonly agreed upon.

RESEARCH METHOD

Data Collection

The relevant data for this study was collected with the help of two independent focus groups of eight panelists each. A focus group is an acknowledged method of exploratory research used to understand consumers' motivation and experiences, and to derive hypotheses that can be tested in further analyses (Churchill and Iacobucci, 2002). The number of focus groups was limited due to resource restrictions, but as there was a sufficient saturation of the data material during the second focus group, we do not consider this a disadvantage. The panelists were recruited through

convenience sampling, as they were either students of Humboldt University or related to the private and professional network of the researchers. To counteract a possible bias, they represent different customer segments. As the study aims at understanding the influence of demographic aspects of current and future behaviour in online shops, we invited a student sample and a middle-age women sample. The students (majors: business, mathematics and web design) had greater experience with the Internet than the other sample. The middle-age woman sample consisted of panelists between 35 and 60 years of age. Participation only was possible if the candidate affirmed some experience with online shopping.

The discussion in the focus groups was guided with the help of two sets of structured open questions. It took place within 90 minutes at the end of 2009 at Humboldt University and was recorded and transcribed. In the first part, each group discussed general experiences in online information search and the type of products they buy online. In the second part, panelists evaluated ontology-based features by means of low-fidelity prototypes (graphical mockups). Although such prototypes do not provide any functionality, they can considerably support the evaluation of design alternatives early in the product development cycle (Rudd et al., 1996). To maximize the representativity of the discussion, we chose the two prevailing user interfaces used in online shops, i.e. the 'direct search' and 'navigation' and combined them with two main product categories, i.e. digital cameras and apparel. The direct search enables the customer to type in a query term, whereas the navigation offers a choice of product categories (i.e. digital cameras or apparel) and navigational categories (i.e. digital camera for beginners). The two scenarios for digital cameras are graphically depicted in figure 1 and 2.

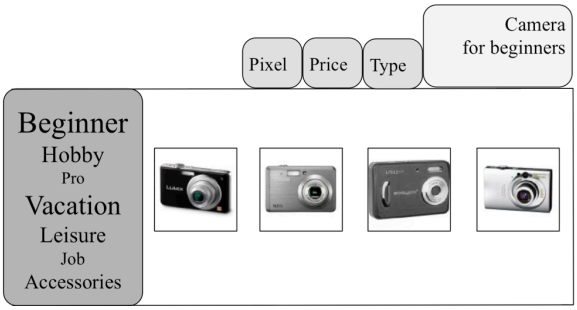

Figure 1. Mockup "direct search and tag cloud"

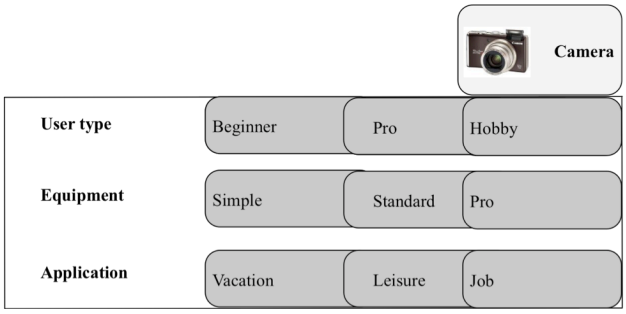

Figure 2. Mockup "categories for navigation"

The scenario that combined "navigation" with "apparel" offered navigational categories according to style (modern, elegant, etc.), occasion (casual, office, etc.) and season. The scenario for the direct search was combined with a tag cloud (a graphical depiction of words related to the search term) displayed on the left side of the user interface. For the direct search, panelists were confronted with soft search terms such as "summerly dress".

Data Analysis

In order to analyse the focus groups transcriptions we have used an interpretive approach (Miles and Huberman, 1994) based on grounded theory (Glaser and Strauss, 1967). Interpretivism stresses that theory does not emerge from data, but data are constructed from observations (Strauss and Corbin, 1998). Due to the subjectivity of the emergent theory, we do not claim objectivity, but instead we argue that the emergent theory is one possible explanations of reality, which can be more or less relevant, credible and acceptable. In the first stage, we identified concepts and discovered their properties, similarly to what Strauss and Corbin (1998) and Miles and Huberman (1994) refer to as open coding. Then we grouped these concepts into categories according to their properties and dimensions, also referred to as selective coding (ibid.).

Finally, we validated our results by taking over theoretical concepts from consumer research such as antecedents (demographics, Internet experience, search routines, etc.).

EMPIRICAL FINDINGS

The concepts and categories resulting from our qualitative analysis are introduced in this section. The implications derived from these findings are presented in the section thereafter. In general, we perceived reluctance in both groups to buy goods online that habitually are only being bought after trying them on physically. Surprisingly, panelists from the first group, the middle-age woman sample, who are frequently buying apparel via catalogues refuse to buy online even though there is much more product information available, e.g. pictures with side and back views of the model wearing the item of interest.

Channel selection

The decision process is influenced by the following aspects: i) the consumer has to balance the cognitive effort, time and costs for retrieving product information (price, features, color, etc.) and transactional information (such as the time of delivery) online against getting such information offline, and sometimes the required information is not available at all; ii) the consumer has to compare the information retrieved and must base the buying decision upon this. The initial phases of the consumer decision process, the 'need recognition' and the 'search for information' (Blythe, 2006) can be realized offline, online or alternatingly.

Use of search interface and motivation for shopping

The panelists' amount of product knowledge acquired prior to an online information search mainly influences the use of search interfaces: panelists with high prior product knowledge prefer direct search interfaces. Panelists with low prior product knowledge usually combine this with the navigation search. However, the choice of a search interface seems also to be related to the shopping motivation. We could classify three motivations for online shopping: i) boredom / inspiration: the panelist wants to pass time or get inspired to purchase products (however, the latter result was strictly limited to female panelists); ii) the panelist is searching for a product in a specific product category, e.g. a pair of jeans; and iii) the panelist is looking for a specific product, i.e. a particular brand and model. Whereas panelists in category i) use the navigation, panelists in category iii) use the direct search and panelists in category ii) alternate.

Using the direct search interface, some panelists experienced problems formulating a query resulting in a resonable amount of search results. Most panelists feared choosing too narrow query terms, thereby excluding relevant search results. Panelists complained that they never know whether a product is linked to more than one product category or not.

Product information and relevance of search results

Panelists often mentioned the importance of an "appropriate" number of search results meaning that they felt overwhelmed when getting too many and frustrated when getting too few search results. This phenomena seems to present a psychological barrier to consumer satisfaction. Panelists do not feel satisfied when they only get few results even if they are highly relevant to their search. The relevance of the search results depends not only on the number of search results, but also on the perceived quality of the product information provided. In general, we discovered a gap between the retailers' product description and the panelists' information need. Panelists stated that they often search for experienced-based knowledge, which cannot be provided by the retailer but only by consumers having consumed the product. Furthermore, the credibility of customer reviews and ratings is perceived to be much higher by the panelists than the information provided by the retailer. Providing adquate product information considerably reduces the functional, social and financial risk from the panelist's point of view.

Evaluation of ontology-based features

The definition of soft criteria in ontologies influences the choice of the categories for the navigation, as well as the search terms for the direct search. Panelists were generally very interested and open to the new features; however, most of them asked about the functionalities of the features presented to them. This implies that the chosen functionalities were not as intuitive as we assumed.

Panelists felt that the ontology would be useful for interpreting their query terms when using the direct search. However, most panelists stated that independent from the product category they would refrain from using soft criteria. The reason is that they fear to exclude relevant search results because of a possible incongruence of their own search terms and the ontology. Some panelists predicted that consumers would adapt to using soft product criteria. The navigational interface was perceived more useful and transparent since the structure of the ontology can partially be seen through the choice of the categories.

However, the panelists' evaluation of the usefulness of the categories depended upon the product category and user-related characteristics. For example, we could state a clear age divide concerning the usefulness of the given apparel categories. While older panelists found all categories useful, the student panelists stated that they would only use the categories for seasonal apparel, and some panelists for style. The student sample collectively agreed that they would not use the navigational category "occasion" (casual, office, festive). Further discussion revealed that fashion is becoming less constrained with regard to occasion, e.g. short pants or skirts are worn in winter combined with leggings. Panelists stated that they were not aware of how the given categories were generated, respectively of how the soft product criteria were defined.

This was different with regard to digital cameras. As before, the older panelists were very satisfied with the categories suggested. The student panelists were also keen to use the proposed categories but claimed information of how these are defined.

A surprising result was the altered shopping behaviour of the panelists when buying for someone else, e.g. when a gift is bought. All panelists agreed that they would rely much more on the navigation categories in such cases.

Another surprising result was the rejection of the tag cloud by all panelists according to usability criteria such as ease of use and perceived usefulness: it was being evaluated as "very confusing" and "not intuitive". Even the student sample - where all panelists were accustomed with tag clouds in blogs - could not explain how the tag cloud functions, nor its purpose. Across the focus groups and their opinions, we did not note disagreements between the genders.

Managerial implications for deploying and modeling ontology-based systems in online shops

The interpretation of our data revealed the following problems: i) *featuritis or creeping featurism*: releasing new software always bears the risk of overloading the user with features. However, if insufficient features are used to structure the displayed information, the consumer could suffer from ii) *information overload*: there are many different online shops and there is a large amount of product information available. However, one of the main problems in online shopping is a lack of specific product information presented online, such as experienced-based information The challenge for online shops is therefore to provide the right features and the right information; iii) *paternalism*: by employing soft product attributes (e.g. "summerly" dress) or navigational categories (e.g. digital cameras for beginners), consumers might get confused if they do not agree with the definition of the attribute or navigational category. This phenomenon is also related to iv) *trust*: consumers may lose confidence if they do not agree with or do not understand the choice of categories made. In the following, we suggest solutions to reduce the challenges mentioned above.

Engineering an ontology-based system

How can an ontology be modeled to meet the expectations of a majority of the relevant consumers? The formulation of rules is highly subjective and therefore particularly critical. Such rules, for example, define which products are suggested for product bundling, or they assign soft product attributes to certain product characteristics (e.g. "handy" to describe digital cameras weighing less than 200 grams).

Contrary to common practice in companies, we therefore suggest that at least two employees should contribute to the modelisation of ontologies. Especially when defining relations between concepts and rules, ontology modelers should additionally base their work on empirical findings. These can be generated by i) conducting focus groups or interviews with consumers. Also, ii) consumers could be incited to tag products when visiting the online shop, or iii) machine learning can be applied to adapt ontologies to consumer queries, and iv) existing logfiles can be analysed through web analytics.

Using soft categories for navigation bears certain risks: on the one hand, when incorporating soft categories next to hard categories, consumers might feel overwhelmed by the number of categories (cf. i) *featuritis* above). One solution could be to display only soft categories and offer the possibility to filter the search results according to hard product criteria at the same time. On the other hand, consumers might feel patronized when they disagree with the definition of a certain navigational category. This could be addressed by displaying the definitions used. In doing so, the searching process becomes more transparent and consumers can avoid the unwanted exclusion of relevant search results.

The impact of the ontology in a direct search is less obvious, because a search conducted with hard product attributes will lead to similar results regardless of the ontology. However, when introducing a new search engine, consumers should be adverted to its possibilities. This could be achieved by inserting a default query into the search slot (e.g. "I am looking for an elegant summer dress").

Ontologies can support recommendation functions such as "products matching the product you selected" (bundling), or "find similar products". Ontologies can support the establishment of newsletters and help to integrate Web2.0 sources containing consumer reviews. As our panelists attested high credibility to such reviews, it seems advisable to integrate

internal or external consumer reviews. However, for many products the writing of consumer reviews is not common, e.g. for fashion. This may be due to the ephemerality and the opacity of the apparel market.

User specific aspects

As human-computer-interaction research has shown, system development has to address different needs of different user types (Fischer, 2001). Accordingly, demographic characteristics of the consumer such as age, which often strongly correlates with technology affinity and Internet shopping experience can be considered. However, situational characteristics (such as the shopping motivation, the prior product knowledge and involvement) are not as relevant, because they may change frequently or abruptly.

LIMITATIONS

Deploying ontologies in search engines is only one approach to reduce problems in online shopping. All of the discussed functionalities could also be achieved with other solutions, e.g. statistical analysis, or relational databases. Moreover, the search function is only one of multiple factors influencing online shopping experiences, e.g. availability of products or costs for shipping and handling.

As to this study, methodological limitations arise concerning the representativeness of focus groups and due to low-fidelity prototyping. Panelists often mispredict their behaviour when asked about their future feelings in hypothetical situations as shown in a study by Loewenstein and Schkade (1997).

CONCLUSION

This study develops requirements for ontology-based system engineering by combining empirical findings about current usage of e-commerce with consumers' opinions about ontology-based features. Such features have not yet found widespread acceptance in e-commerce, mainly due to a lack of research and experience in this field.

An analysis of the focus group discussions showed that both the student panelists and the middle-age panelists classified as useful the navigational categories presented to them in a search for digital cameras. Only the middle-age panelists found the navigational categories for apparel useful, whereas the student panelists explained that due to the dissolution of fashion conventions they would feel patronized by engineers who define such navigational categories. However, all panelists would use soft product categories when buying presents.

The analysis also emphasized the importance of the information displayed in a search process for the consecutive phases of the buying decision process, because purchase and after-purchase aspects - such as transaction and delivery - already determine the purchase decision.

The following implications can be derived from this analysis: Not only one but preferably all phases of the buying decision process should be considered in ontology-based system engineering; ontologies should be modeled based on empirical findings concerning consumer opinion; definitions of soft product categories should be provided; and experience-based product information should be included by integrating internal or external consumer reviews.

Our findings presented above are based on low-fidelity-protyping realized with the help of a small sample size. These results should be validated by quantitative high-fidelity prototyping. If such future studies take all the above implications and limitations into account, it is possible to further refine the guidelines for ontology engineering and to offer additional advice concerning the selection and configuration of ontology-based features in online shops.

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