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Advising Customers on Products in Navigating Online Shops – An Empirical Analysis

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ABSTRACT

Most online shops do not provide advisory services that take advantage of expert product knowledge. Therefore, consumers may spend a higher search effort than necessary to find products that serve their needs. This study investigates to what extent an ontology-based, "advisory" navigation menu can decrease a consumers' search effort. For this purpose, we conducted a laboratory experiment with 159 participants to assess the impact of an ontology-based navigation menu on participants' information behavior in an online shop. Our log file-based comparison with a conventional navigation menu showed a significant decrease of search effort for the advisory navigation menu. Comparison criteria include the number of product result pages viewed, the number of detail pages viewed, and the amount of filters used in a session. Implications of this research concern the development of online shop interfaces that use ontology-based product catalogues and therefore support consumers in their information search.

Keywords (Required)

Online shop, consumer information search, search interfaces for e-commerce, product-catalogue ontology, log file analysis.

INTRODUCTION

Even though the use of the Internet is becoming increasingly popular in the search for product information and for online purchases, consumers often feel that there is a lack of a personal advisory service. In an offline shop, a sales agent can provide general advice and specific product recommendations to the consumer. Sales agents take into account the variety of products available on the market as well as the usage context before advising on an appropriate product, i.e. a specific model of camera for a beginner. Such advice summarizes a complex configuration of experience-based knowledge and several product attributes. For the consumer, such summarized product configurations serve a function similar to the function of brands that chunk up several product attributes and allow consumers to infer an unknown product's overall quality (Ford and Smith, 1987). These summarized concepts substitute for the consumer's elaborate attribute-by-attribute evaluation of product options and decrease cognitive effort during search. While shopping online, consumers can interact with several decision aids such as recommendation systems, but it is still difficult for an online vendor to offer an advisory service in its information retrieval systems that uses expert knowledge. Semantic technologies, such as product- catalogue ontologies, are able to address this issue. An ontology is an explicit representation of a domain of discourse (a conceptualization), usually composed of a set of concepts and relationships (Gruber, 1993). Product-catalogue ontologies provide options for storing expert knowledge in a product domain, and for selecting appropriate products according to their suitability for modeled product concepts such as product target groups. As a result, consumers can be supported during information search and search effort can be minimized if consumer-relevant product concepts are available during search.

The results of the current study are based on a high-fidelity prototype-based user study. This prototype integrates a product catalogue ontology with the search interface navigation. We investigate if advising consumers on products during navigation through online shops reduces the effort involved in search. In the user study, the ontology structures the product catalogue of the online shop in the navigation menu categories in terms of the expert knowledge based concept of target groups. In contrast, conventional navigation categories are usually based on a product's core attribute, such as the class of goods (Hearst, 2009). For online vendors, this marks a promising approach for providing advice on products by improving existing information retrieval systems.

RELATED RESEARCH ON ADVISING ON PRODUCTS ONLINE

Several technological solutions exist for providing advice on products online. These approaches support consumers in different stages of their purchase decision process. In the initial stage of the search for information, query expansion methods try to improve information retrieval processes (i.e. Shen, Pan, Sun, Pan, Wi, Yin, and Yang, 2006). In addition, conversational agents or faceted search interfaces are popular methods for influencing the relevance of search results by enabling a user-centered filtering of search results (i.e. Capra, Marchionini, Stutzman and Zhang, 2007). On the result level, collaborative filtering methods for recommendation systems try to support evaluation and decision processes with item or user-based recommendations that are also considered interactive decision aids (i.e. Murray and Häubl, 2008).

The latter are particularly successful in product recommendation, but they possess two major limitations: firstly, recommendation systems suffer from cold-start problems where early on no initial information is available upon which to base recommendations. If a retailer adds a new product to its product catalogue, no product history for user- or product-profiling is available and therefore no recommendation is possible. Secondly, the product itself is black-boxed in the recommendation. There is therefore no differentiation of products according to the varying relevance of single product attributes for different user groups.

The deployment of ontologies is able to overcome these problems by providing semantic knowledge structures that include similarities and enable an automatic configuration of products according to specified user requirements (i.e. Fensel, McGuiness, Schulten, Ng, Lim, and Yan, 2001).

However, related research about ontology deployment in product recommendation deals mainly with technical issues such as semantic user profiling. There are no known studies that examine the impact of ontology-based product advice and recommendation on consumer information search from a behavioral perspective. Furthermore, no studies are known that investigate the deployment of ontologies for the navigational categorization of information objects.

RESEARCH QUESTIONS AND METHODOLOY

In order to investigate if an ontology-based, advisory navigation menu impacts consumers' information behavior, we formulate two research questions:

- How does the consumer's interaction with the online shop change if an advisory navigation menu is provided?
- Is an advisory navigation menu able to reduce the search effort made by consumers?

In order to answer these questions, research approaches from Human-Computer Interaction (HCI) and consumer research have been combined. By synthesizing both, we relate a general perspective on information search and its information retrieval characteristics in HCI to the transaction orientation of information search in consumer research. As a result, the general research frameworks from HCI are substantiated for investigating the information retrieval characteristics of consumer information search.

Inferring Consumer Behavior from Information Searching

We investigate the impact of an advisory navigation menu on consumer information behavior by attaching a general framework in HCI, the nested model of information behavior (Wilson, 1999; 2000), to the concept of search effort that originates in consumer research.

Wilson's model relates three perspectives on investigating information searching: information searching, information seeking, and information behavior. According to Wilson (2000), *information searching* describes a searcher's direct interaction with an information retrieval system, which can be evaluated by means of the links a searcher clicked on. *Information seeking*, however, is defined as the purposeful seeking of information that aims at satisfying needs by using individual search strategies and includes an examination of the user's interaction with search interfaces at the meso-level. *Information behavior* is finally defined as the totality of human behavior in relation to sources and channels of information.

The latter perspective enables us to draw conclusions about the economic impacts of information retrieval systems, for which we use the concept of search effort. It describes the costs of obtaining price and product information at the structural level of an online shop (Bakos, 1997). This also includes the cognitive costs for the evaluation and selection of product options (Moorthy and Ratchford, 1997). As a result, our methodology infers, from the user-system interaction during search on the micro-level, the search costs involved on the macro-level. Both are moderated by the consumer's information needs during search and the information system's ability to satisfy these needs at the meso-level.

This is applied in our study in the following way: *information searching* is investigated empirically by calculating session ratios out of user study log files that serve as implicit indicators of information searching (Senecal, Kalczynski and Nantel, 2005). The ratios further indicate *information seeking* in terms of the consumers' interaction with the shop's categorized content with regard to the consumers' information needs and satisfaction. For investigating *information behavior*, we use a measure of the cognitive costs involved in search efforts and the total amount of pages viewed in a search session to make final inferences about consumers' site usage and interaction with the advisory navigation menu.

Interpreting Log Files as Indicator of Information Seeking

In order to interpret the session ratios in term of our nested approach, we deploy another research approach from HCI that focuses on information seeking. Belkin and Croft (1992), Belkin, Marchietti and Cool (1993) and Belkin, Cool and Stein (1995) developed a multi-level model of information seeking, which includes four two-dimensional levels, describing 16 information-seeking strategies in total. This model is useful because it allows for the classification of session ratios in terms of the interaction with the advisory navigation menu. Based on this classification, the economic impacts of the navigation menu on consumer information behavior can ultimately be determined. Belkin et al. (1992; 1993; 1995) use several levels for classifying information seeking behavior. For our analysis, we use only those levels that are applicable for empirically investigating the interaction of consumers with an online shop's navigation menu based on log files: (i) information resource used, and (ii) mode of retrieval.

In the classification level *information resource used*, Belkin et al. (1993; 1995) distinguish an information system's information resources according to the amount of information detail present to the searcher. They distinguish *information* (i.e. product description page) and *meta-information* (i.e. search result page).

This distinction is useful for understanding the searcher's *mode of retrieval*, which defines *retrieval by recognition* and *specification* as opposites. Retrieval by recognition is defined as an implicit, cognitive recognition of relevant information according to a specific information need. Searchers identify relevant objects through stimulated association such as the display of search results already on a result page, which is a direct result of the categorization of the navigation menu. In a retrieval by specification, the searcher directly predetermines the relevance of search results by specifying the information need as precisely as possible in the searching process. For empirically classifying both modes, Belkin et al. (1992; 1995) use indicators such as filter usage. Filters, i.e. for price or brand, are typically used on product result pages. A high number of filters used indicates retrieval by specification, i.e. the searcher needs to further narrow down the search results; a low number of filters used indicates retrieval by recognition (Belkin and Croft, 1992).

Operationalization of Frameworks Used

Table 1 illustrates our integration of the research frameworks used and shows how to quantify and operationalize them. For implicitly measuring consumers' information searching, we calculate several user session-based ratios out of user study log files. A user session is defined as a delimited number of a user's explicit requests in the online shop (Senecal et al., 2005).

The information-seeking classification based on Belkin et al. (1992; 1993; 1995) uses the ratios of the numbers of product result pages and product detail pages viewed, and filters used. The number of *product result pages viewed* describes the usage of meta-information at the online shop's categorization level. The number of *product detail pages viewed* indicates information resource usage at the detailed product-attribute level of the online shop. The mode of information retrieval is determined by referring to the number of *filters used* on product result pages, with a high number of filters indicating a retrieval by specification and a low number of filters indicating a retrieval by recognition.

For measuring search effort in terms of cognitive costs for obtaining price and product information (Bakos, 1997), the ratio *total number of pages* is used. This ratio is the sum of the number of product result pages viewed, the number of product detail pages viewed and all other pages, such as filter result pages or the shopping cart.

The ratio *topic* is used as control variable in the user's comparison of different navigational categorizations. The number of topics corresponds to the sum of different navigation category types that were clicked on. They indicate the topics of interest that represent the consumers' information needs during search (Senecal et al., 2005). For deriving valid results from comparing different navigational categorizations, the consumers' information needs must be similar.

		Information searching behavior
Information seeking behavior	Information resource used • Meta-Information • Information	• Number of product result pages viewed • Number of product detail pages viewed
	Mode of retrieval • Recognition • Specification	• Low number of filters used • High number of filters used
	Information need	• Number of topics
Information behavior	Search effort	• Total number of pages

Table 1. Operationalization of Frameworks Used (cf. to Bakos, 1997; Belkin et al., 1992, 1993, 1995; Wilson, 2000)

HYPOTHESES AND RESEARCH DESIGN

We conceptualize an ontology-based advisory categorization of products as a specific feature of an online shop that supports consumers' browsing of the shop's content. According to this categorization, products are already pre-grouped according to customer-relevant concepts, i.e. different target groups, and it uses previously collected expert knowledge that is modeled and stored in a product catalogue ontology. Products are then automatically assigned to a category according to their fit to modeled concepts in the ontology. We expect that the use of an advisory navigation menu will impact two general aspects of consumer interaction with an online shop with regard to information seeking and information behavior: it will change the amount of searching, and the mode of retrieval (research question 1), as well as the amount of search effort (research question 2).

Hypotheses

Amount of search

The number of product options consumers viewed using different information resources determines the amount of search (Moorthy et al., 1997). In our study, this corresponds to the number of product result and detail pages viewed, presenting product information in different degrees of detail. Product result pages are a direct result of the navigational product categorization, which supplies an overview of suggested products in the selected categorization group. On this level, consumers screen product options based on apparent core-product attributes such as brand, price, and pictorial information. Product detail pages contain detailed attribute information. The sorting of products at the result level according to consumer-relevant criteria reduces the amount of searching because it results in the omission of exhaustive attribute-by-attribute evaluation of products for those criteria (Murray et al., 2008). Thus, we hypothesize that those consumers who interact with an advisory navigation menu have already determined product options at the meta-information level of product result pages which advise on adequate product options. More result pages are viewed because product options for the modeled criteria can be explored directly. As a consequence, consumers will view detailed attribute information about fewer products (Häubl and Trifts, 2000).

H1: Use of the advisory navigation menu leads to an **increase in product result pages viewed**.

H2: Use of the advisory navigation menu leads to a **decrease of product detail pages viewed**.

Mode of retrieval

Due to the availability of expert-based knowledge used for advising products, the information quality of the online shop is generally enhanced because a typical sales agent's knowledge is now incorporated into the online shop for instance knowledge about the fit of products for a certain target group. Using this expert knowledge to pre-categorize products according to customer-relevant concepts allows customers to consider and recognize the relative relevance of a product at the result level (H1, H2). This also impacts the mode of retrieving the relevance of products. The advisory navigational

categorization facilitates stimulus-based retrieval, which supports customers with a low degree of available product knowledge and expertise, in contrast to the memory-based retrieval that mainly uses specification and necessitates available product knowledge on the part of consumers (Alba and Hutchinson, 1997). As a result, an advisory navigation menu enables shifting from memory-based to stimulus-based mode of retrieval. Thus, consumers interacting with an advisory navigation menu retrieve the relevance of products by stimulus rather than by specification, which is expressed in less filter usage (Belkin et al., 1992).

H3: Use of the advisory navigation menu leads to a **decrease in filters used**.

Search effort

As formulated in the previous hypotheses, an advisory navigational categorization provides an overview of consumer relevant product options at the meta-information level. As a consequence, customers view less detailed information (H1, H2). Furthermore, stimulus-based information retrieval processes are enhanced, necessitating less product related knowledge for selecting and evaluating relevant product options (H3). The decrease in viewing product options at the detail level, accompanied by fewer elaborate attribute-by-attribute evaluations of product options can be seen as the most prominent indicator of the decreased effort a consumer expends in selecting and evaluating product options (Moorthy et al., 1997). Moreover, less product-related knowledge is necessary prior to search (Häubl et al., 2000). Thus, consumers interacting with an advisory navigation menu expend less search effort in total, which corresponds to fewer pages viewed in total.

H4: Use of the advisory navigation menu leads to a **decrease in the number of total pages viewed**.

Experimental Design

We conducted a user study by means of a lab experiment to investigate how advising on products in navigating online shop can decrease search effort. For this purpose, we programmed a high-fidelity prototype of an online shop for digital cameras. In order to examine how the interaction between consumers and the shop changes with an advisory navigation menu, we compared two categorization styles in a between-subject design. We compared the ontology-based, advisory categorization of different product target groups with a conventional categorization that uses the product core attribute class of goods:

- The advisory navigation menu deploys a product-catalogue ontology categorizing digital cameras into *beginners, hobbyists* and *professionals* (German 'Anfängerkamera', 'Hobbykamera' and 'Profikamera', see figure 1).
- In the conventional navigation menu, a camera's classes of goods were used for product categorization into *compact camera, bridge camera,* and *single-lens reflex camera*. A good classification is the result of the hierarchical structuring of the product catalogue and is inferior to a product category.

Digital cameras were used as the object of study, because they possess both search and experience attributes that are relevant for information search. In the product catalogue ontology developed for digital cameras, 60 concepts such as weight, image sensor and display were used (eb semantics, 2007), including relevant attribute values such as the actual weight in grams or the display type. In total, product details of 185 digital cameras were used as instances in our ontology. Several qualitative pre-studies were conducted in order to model three target groups of digital cameras for specific user types such as focus groups and expert interviews (Brecht and Schäfer, 2010). In total, eight attributes with different values for each product target group were used (table 2). After successfully assigning the products to a target group, the complete experimental design was successfully pilot-tested with 20 subjects.

Product target group (Zielgruppe)	Concept	Attribute	Value
Beginner (Anfängerkamera)	Image sensor	Pixel value (in mega pixels)	</= 12,0
		Image sensor has photo sensitivity (ISO)	= AUTO, 400, 200, 100, 80
	Weight	Weight (in grams)	</= 300,0
		Weight without memory card and battery	</= 300,0
		Weight with memory card and battery	</= 350,0
Hobbyist (Hobbykamera)	Image sensor	Pixel value (in mega pixel)	</= 12,1
		Image sensor has photo sensitivity (ISO)	=Manually

			=3200,1600, 800, 400, 200
	Display	Precise display size (in inches)	</= 3,0
	Additional feature	Additional feature has additional camera function	="Optical picture stabilization"
			="Automatic face detection"
Professional (Profikamera)	Image sensor	Pixel value (in mega pixel)	>/= 12,0
		Image sensor has resolution	=15-30 MP
			=Manually
		Image sensor has photo sensitivity (ISO)	=6400, 3200, 1600, 800
	Display	Precise display size (in inches)	>/= 3,0
	Image property	Camera has file format	=RAW, JPEG

Table 2. Modeled Product Target Groups in the Digital Camera Ontology

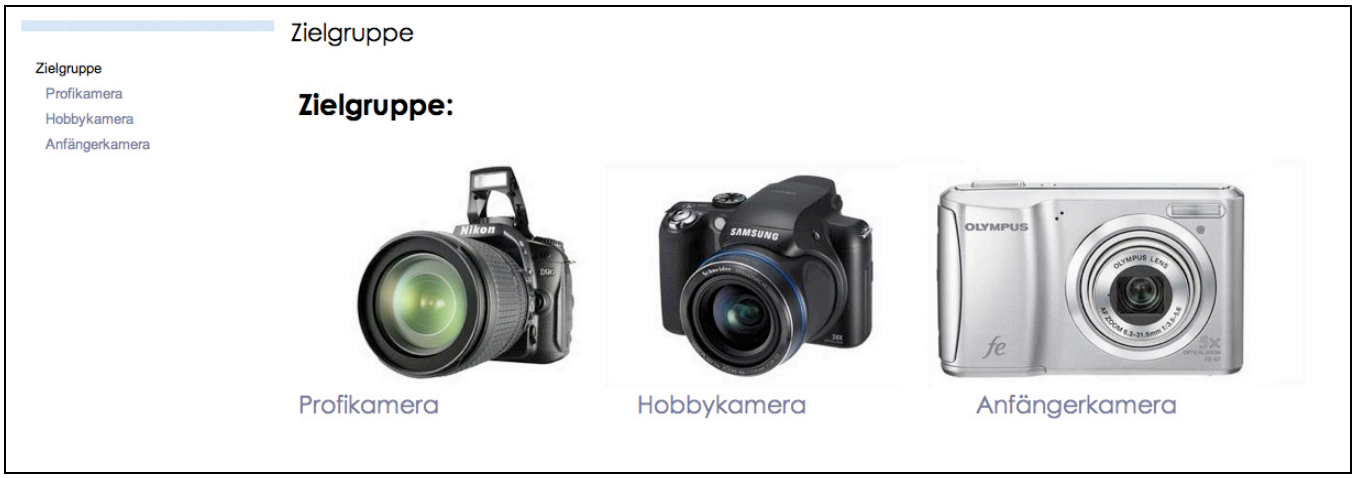

Figure 1. Advisory Navigational Categorization (Professional, Hobbyist, Beginner)

In the main lab experiment, participants were randomly assigned on the navigational categorization styles. The participants were all undergraduates and received a 10€ online voucher as incentive to participate. Before starting with the experiment, the participants were informed about their task: the browsing of the product catalogue with the aim of finding an appropriate digital camera for themselves. In order to disable access to other online information sources and to avoid the use of the back button in the tool bar, the browser's navigation menu was hidden. The participants had two options for finishing their search task in the shopping cart area: either with the simulated purchase of a product or with an abort of the search. All user interactions during the experiment were logged and stored as Apache log files.

Methods

The participants' site usage data was prepared with log file analysis according to the methodological approach of Jansen (2006). Microsoft SQL Server 2008 was used for data preparation and calculation of user-session based ratios. The data was analyzed with PASWStatistics v18. In the data analysis, the session ratios were tested for statistical significance of population differences between the navigational categorization samples.

DATA ANALYSIS AND RESULTS

159 participants took part in the lab experiment (42% males and 58% females; 44% in the age group from 18 to 24 years, 49% between 25 and 34 years and 7% over 35 years old). 82 participants conducted their search using the advisory navigational categorization in the navigation menu, whereas 77 participants conducted their search using the conventional navigational categorization. We had a total conversion rate of 16% - a satisfactory value for electronic products in e-commerce (Coremetrics, 2009).

None of the calculated session ratios were normally distributed. Therefore, non-parametric statistics were used. The Mann-Whitney-U-test (MWU) was used to analyze mean differences between both navigational categorizations. We used Mood's median test (MM) for data with unequal population variance (Brunner and Puri, 2001). To enable a better comparison of results, the mean is reported in parentheses in table 3 where Mood's median test was applied.

Figure 2 contrasts the average session ratios of both navigational categorizations.

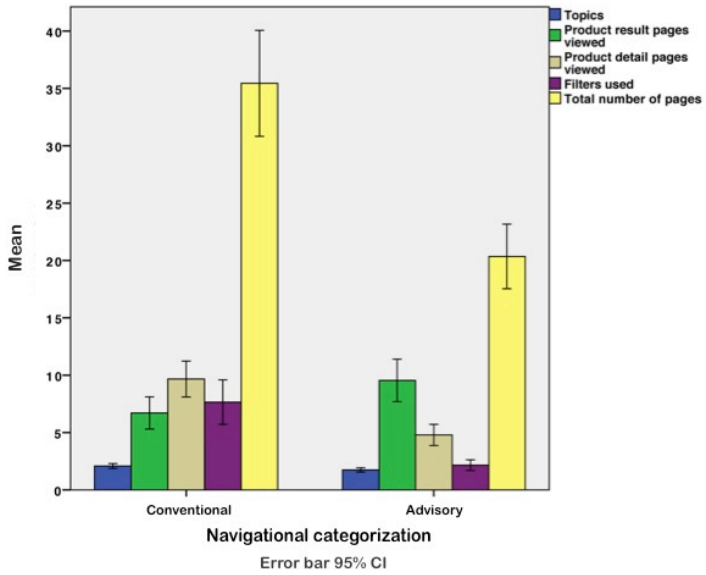

Figure 2. Means of Session Ratios in Navigational Categorization

Before testing our hypotheses, we need to verify that the participants of both groups possess similar information needs. Otherwise the different values for the comparison metrics could be due to different consumer characteristics and not due to the different navigational categorizations. This was done with the ratio topic as control variable. The comparison of means of the ratio topic was not significantly different and participants possessed similar information needs in both samples (see table 3). Hypothesis testing was therefore possible and results will be stated presently.

	Navigational categorization					
	Conventional (N=82)			Advisory (N=77)		
Session ratios	Mean (MWU)	Median (MM)	Standard deviation	Mean (MWU)	Median (MM)	Standard deviation
Topics	2.08		0.92	1.74		0.82
Product result pages viewed	(6.01)	4.00*	5.90	(9.55)	8.00*	8.15
Product detail pages viewed	(9.62)	8.0*	7.02	(4.79)	4.0*	4.07
Filters used	7.21**		7.99	2.16**		2.05
Total number of pages	33.76**		20.09	20.35**		12.4

Table 3. Comparison of Session Ration Means between Navigational Categorizations (*p < 0.05 and **p < 0.01)

The effect of the advisory navigational categorization on the amount of searching is significant ($p < 0.05$), as was shown in the mean differences of the ratios of product result pages and product detail pages viewed (table 3). A significantly higher number of product result pages were viewed by participants using the advisory navigation menu compared to the conventional navigation menu (H1). This is accompanied by a significantly lower number of product detail pages viewed (H2) in the advisory navigational categorization sample. This means that participants were scanning products at the meta-information level instead of the detailed one. Thus, H1 and H2 are supported.

Use of the advisory navigational categorization had a highly significant effect on the mode of retrieving relevant product options ($p < 0.01$), as analyzed by comparing the mean differences of filters used (H3). A significantly lower number of filters were used by participants who interacted with the advisory navigation menu, which indicates support for the stimulus-based mode of retrieval by recognition. This also illustrates the shift from a memory-based, specifying mode of retrieving relevant product options that was characteristic of the group who used the conventional navigation menu to a stimulus-based mode. H3 is supported.

Finally, participants interacting with the advisory navigation exhibited a significantly lower search effort in terms of total number of pages viewed ($p < 0.01$), as was reported in the mean differences. This indicates a decrease in cognitive costs for those participants interacting with the advisory navigation menu, which corresponds to an increase of product result pages viewed (H1), less product detail pages viewed (H2), and support for a stimulus-based mode of retrieving relevant product options (H3). Thus, H4 is supported.

CONCLUSION AND LIMITATIONS

These results show that an advisory navigational categorization impacts general aspects of consumers' interaction with an online shop during information searching. The effect of expert-knowledge that is used for modeling customer-relevant product categorizations such as different product target groups was demonstrated by a significant decrease in search amount, further supporting stimulus-based recognition of relevant product options independent of the availability of prior product-related knowledge (research question 1). As a consequence, the cognitive costs participants incurred for selecting and evaluating relevant product options during information search sank due to the availability of expert-knowledge that was used for pre-grouping products according to their fit with different target groups. This led to a significant decrease in search effort (research question 2). The study further illustrated that the modeled product target groups are satisfactory for advising consumers on cameras in navigating an online shop.

Online vendors benefit from the deployment of ontologies in online shops more broadly. Ontology-based databases for online shops (i) support advising processes for new products in the product catalogue without the cold-start problem of recommendation systems as the product attributes are modeled in the ontology; (ii) the vendor can therefore phase out additional recommendation systems, (iii) allow improved (B2B) communication with other vendors when they use the same ontology by having a common vocabulary.

Our study is subject to several limitations. First, we used only one product category and cannot predict the transferability of our results to other product categories. Second, lab experiments have a high internal validity but might lack external validity. Applied to our experiment, this may mean that some participants might not have been serious in their search operations. Finally, our prototype offered very limited functionalities to the participants. However, this was done on purpose as we wanted them to concentrate on the main search feature navigation. Our research methodology used log files for inferring on consumer behavior as only source for empirical validation. The integration of subjective and survey-based measures was excluded in this presentation although it generally enhances validity of results.

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