The Use of Customer Profiles for the Personalisation of User Interfaces

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Abstract

Businesses increasingly obtain data and information from customers in order to conduct customer profiling. On-line customer profiling has provided many benefits, including increased sales and the creation of personalised user interfaces. Customer profiling also provides the opportunity to provide product recommendations to customers and to improve customer relationships. Personalised user interfaces or product information displays (presentation modes) used on e-commerce websites are important factors that influence a customer's buying decisions. The provision of the most appropriate product information display, based on customer product knowledge can increase customer satisfaction and loyalty. Using customer profiling to personalise product information displays with Service Oriented Architectures (SOA) and Cloud Computing is increasingly being used by businesses which provide the ability to purchase products and services on-line.

In this research study an e-commerce website was designed and implemented using web services. The primary objective of this research was to determine whether a relationship exists between a customer's product knowledge level (novice, intermediate, expert) and a product information display preferred on an e-commerce website. The three most commonly used product information displays used are list, commented list and matrix layouts. The customer's product knowledge levels were determined using a decision model which was linked to the three different product information displays. The results indicated that a relationship exists between a customer's product knowledge level and the product information display preferred. The research findings supported related research indicating that customers with a novice product knowledge level prefer a matrix product information display which contained a large amount of detail.

Keywords

E-commerce, customer profiling, user interfaces, product information displays.

1. Introduction

Businesses today face many challenges in maintaining and sharing their product and customer information across different business units and subsidiaries, mainly because business units are located in different geographical locations (Han and Kamber, 2006). The Internet has however, changed the way people conduct business activities (Schneider, 2007). A popular trend in e-commerce is customer profiling, specifically integrating customer profiling with Customer Relationship Management (CRM) (Liu *et al.,* 2001). CRM is used by businesses to create personalised

relationships between the business and the customer in order to improve customer loyalty and satisfaction (Liu *et al.,* 2001; Turban *et al.,* 2006).

A customer's knowledge of different product categories may vary significantly. This requires that the user interface and information provided about the product on the e-commerce website has to be adapted according to the customer's product knowledge. Product information displays or product presentation modes, such as product catalogues, should include more or less detail, based on the customer's product knowledge, as these factors may influence the customer's buying decision. Considering the available customer information in a customer profile, it is often difficult to determine the most appropriate product information display for a customer (Schafer, Konstan and Reidl, 2001).

Businesses increasingly use new technologies such as SOA and cloud computing in the e-commerce environment. In this research study, an e-commerce system was implemented using Service Orientated Architecture (SOA) principles, such as Web services for flexible and modular re-usage of computing services. This research designed and implemented an e-commerce website selling three different product categories (wine, groceries and electrical products) for three different business units. The three product categories were selected based on research conducted on the most popular products sold on the Internet (Ntawanga, Calitz and Barnard, 2008). It further used three different product information displays identified in literature, namely list, matrix and commented list to display the product information to customers, based on their product knowledge levels. The research implemented a stand-alone desktop application and then an e-commerce website with a Web service in a cloud service application. This used the Windows Azure environment for business units to maintain information using the desktop application.

In this research paper the background and related research is discussed in Section 2 and the focus of the research is presented in Section 3. The methodology followed in this research study is discussed in Section 4 and in Section 5 the evaluation procedure and results of the research are discussed. The research is then concluded in Section 6, where this section also highlights possible future research.

2. Background

E-commerce applications which use customer profile information to provide personalised services to customers have their own components. Using this customer profile information should make the product information displays on the e-commerce website more informative. Customer profile attributes are updated as the customer interacts with the website. This section discusses research related to the above mentioned terms, where customer profiling in e-commerce is highlighted.

2.1. Customer profiling in e-commerce

E-commerce is buying and selling products, services and information by using Internet technologies and electronic systems (Schneider, 2007). E-commerce has provided a way to build personalised relationships with customers by using a customer profile. A customer profile is a snapshot of the customer which provides

customer information and specifically customer buying behaviour (Adomavicius and Tuzhilin, 2005). The demographical information about a customer includes attributes such as the customer's age, gender, name and geographical location. Behavioural information is captured while a customer is performing certain tasks on the website (Adomavicius and Tuzhilin, 2005). In this research, a customer profile, consisting of demographical information and the product knowledge levels was implemented. A customer's product knowledge level (novice, intermediate, expert) for each product category (wine, groceries, electrical products) was recorded according to the method used in the research conducted by Ntawanga, et al. (2008). The customer's product knowledge level is used in order to present a product information display (matrix, list, and commented list) for a product category whenever the customer chooses to view a product of a specific category.

A customer profile is established by implementing implicit and explicit feedback by on-line businesses (Jokela *et al.,*2001). Explicit feedback is simply determining factual information by asking customers to register their details on the website through the usage of an on-line questionnaire. Implicit feedback is completed by capturing information about the customer as he or she interacts with the e-commerce system. Well-known techniques are weblog mining and web cookies. The customer profile is then updated using the weblog files and by applying a decision model on the information captured. The potential uses of customer profile information in e-commerce are personalisation, customisation and recommendation (Hofgesang, 2007). Personalisation consists of the following phases: data collection, analysis of data and deciding the action (Eirinak and Vazirgiannis, 2003). Customisation is used for customers to receive a sense of ownership when obtaining a customised product or service. Recommendation is used to assist customers in their buying decision; by making suggestions about products they can purchase (Chang, Changchein and Huang, 2006).

2.2. Product information display interfaces

A customer who needs to purchase a product has many external and internal factors affecting the purchase decision. Information processing in the customer's memory plays a large role in the decision whether to acquire a product or not (Biiehal and Dipankar, 1983). Customer information processing (CIP) differs in the way in which product information is organised. Product information can be represented by brand or by product attribute, but product catalogues of e-commerce on-line stores should include more detailed information about products (Koenemann and Belkin, 1996). The three most commonly used product information displays used in e-commerce are:

- List layout (Figure 1) - contains a list of products with little detail about a product and is mostly used by e-commerce websites because the layout is easy for browsing (Hong, Thong and Tam, 2004).
- Matrix layout (Figure 2) - contains products which are displayed in a grid, where this layout contains a large amount of product information. This layout is mostly used to display technologic products and for searching (Hong, Thong and Tam, 2004).

- Commented list layout (Figure 3) - this is a layout which contains a list of products with a brief amount of product detail, and it is most often used in e-commerce for customers to add comments about products.

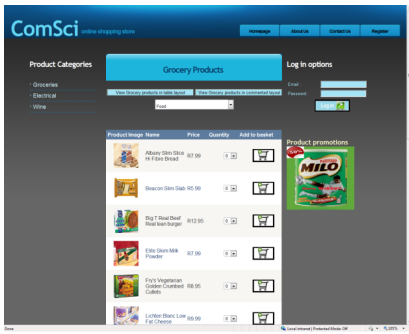

Figure 1: List layout used

Figure 2: Matrix layout used

Figure 3: Commented List layout used

The presentation modes used could also contain image-based and text-based modes, where image-based has an image representing the product and text-based contains only textual descriptions of the product. Text-based is mostly used on sites accommodating users with low bandwidths. The research implemented the three product information displays and used them to present a product information display for the three product categories, namely wine, groceries and electrical products. These product categories selected, based on the research conducted by Ntawanga, et al. (2008), where the research highlighted that these product categories are popular products sold on e-commerce websites. The product information displays used play a large role in the focus of this research.

3. Focus of Research

E-commerce and customer profiling have opened the doors to the personalisation of relationships between customers and businesses. The customer profile information, consisting of many attributes, creates this possibility. A business can now provide each individual customer with a unique form of the current webpage being viewed based on the individual customer profile. Many challenges have been identified, as it

is difficult to determine when a customer profile should be updated and what the decision model should be utilised. Another challenge is that some customer profile attributes are very personal and the receipt of this information illegally can lead to fraudulent activities. Further, it is hard to determine how to personalise the webpage perfectly for a specific customer. The presentation of the webpage plays a major role in a customer's buying decision. This research implemented an e-commerce customer profile website containing different product information displays; a web service using SOA techniques within a Windows Azure cloud environment and a desktop application linking it to the website using the web service. The paper will only focus on answering the following research questions which apply to the limitation discussed above:

Does a relationship exist between a customer's product knowledge level for a specific product category and the product information display layout which the customer prefers when purchasing products from this category?

4. Research Methodology

Researchers have identified many development methodologies in software development. This section discusses how the system was implemented and how the incremental prototyping methodology was used. This methodology was used because each component of the system was developed as a working prototype and then added to another, to form a working system. The system was developed on a Windows Azure platform.

4.1. E-commerce system

An online e-commerce website was developed and implemented as a *Web-Role (in Windows Azure.)* This was completed in order to capture the customers' profiles. It was then used to identify which attributes of the customer profile customers are willing to share on-line, in this environment. The customer profile was later used to determine whether product information displays on e-commerce websites have a relationship with customers' product knowledge levels. The e-commerce website was used to sell three categories of products, namely wine, groceries and electronic products. Each product category contained individual products, categorised into sub-categories. Each product contained product descriptions and other attributes which were mapped onto each of the three product information displays, namely list, matrix and commented list. The product information displays were then mapped to a customer's product knowledge level for the product category being viewed.

After completing an initial questionnaire, the customer's product knowledge levels for each product category is established. For example, a customer's product knowledge classification could be intermediate for groceries, novice for electronic goods and expert for wine. The mapping of the product knowledge levels, to product information displays, is as follows and the relationship between these will be evaluated:

- A Novice product knowledge level is mapped onto the Matrix layout which is shown in *Figure 2.* This includes the most detail about a product;
- An Intermediate product knowledge level is mapped onto the Commented List layout which is shown in *Figure 3.* This includes a fair amount of product detail and allows customers to view comments other customers made about the product being viewed*;*
- An Expert product knowledge level is mapped onto the List layout which is shown n *Figure 1.* This includes limited detail about a product, but includes the most important information about a product such as price, name and an image.

After the mapping, customers can change the product information display to view the same product's information in a different display mode. For example, if the customer needs more product information, he/she can change from a list layout to a matrix layout. The initial product knowledge levels for customers are assigned by the customers answering a product knowledge questionnaire based on the three product categories during the registration process. The questionnaire is based on research conducted by Ntawanga, *et al.* (2008). The product knowledge levels are then updated using the decision model previously developed and evaluated by Ntawanga, *et al.* (2008) with amendments to the number of products needing to be purchased and time spent on a product category.

4.2. Business unit application

A desktop application was developed for each particular product category, namely wine, groceries and electronic goods, to maintain product information and to retrieve relevant customer information. Each product category can be associated with an individual business unit to represent a real life business scenario. The three business units will then be able to see the entire customer's generic profile information. Where customers prefer information to be private, it will only be viewed by a specific business unit if the unit has a transaction history with the customer. This property is controlled by a flag attribute activated if a customer has purchased a product from a business unit before or not. The functionality of the business application was implemented as a web service within the cloud service of the e-commerce website, whereas the business unit application connected to this service and used its functionality through a web service.

5. Analysis and Results

5.1. Evaluation procedure

The evaluation of the proposed system was an ongoing process; in accordance with the incremental prototyping methodology selected. The user testing was completed in order to arrive at the answers to the research questions. User testing consisted of three tests. The first was completed to determine whether users find the different product information displays useful. The outcome was that they are useful except for the commented list layout. The second test was completed in order to test whether the system architecture can support this application. Expert users confirmed that the Window Azure environment can be used for this application. The third evaluation was a conducted on a convenient sample of 31 potential on-line customers. The

participants consisted of male and female, undergraduate and postgraduate students, university staff and users in industry. Each participant was presented with a user test consisting of 5 Sections A to E. In Section A the researchers obtained basic demographical information of the participants, Section B computer experience and Section C on-line shopping experience. The tasks to be performed, namely purchasing of products, were presented in Section D. The post-test questionnaire was completed at the end of the session, acquiring information on participants' presentation layout preferences and product knowledge levels. The post-test questionnaire measured the various criteria using a 5 point Likert scale. The scale was represented as 1- Strongly disagree and 5- Strongly agree.

The researchers further tested the following hypotheses:

- H_0: No relationship exists between a customer's product knowledge levels and product information displays.
- H_1: A relationship between a customer's product knowledge levels and product information displays exists.

The convenience sample of participants consisted of at least 80% with computer experience of more than 6 years, 70% with Internet experience more than 6 years and 90% who spend an hour on the Internet per day. The participants (n=31) in the research study consisted of participants with a *novice* product knowledge level for wine (n=23), an *intermediate* product knowledge level for groceries (n=19) and electrical products (n=12) with only a limited number of participants being *experts* for the three product categories.

The participants evaluated the e-commerce application, completing the required tasks in their work environment. In order to eliminate prior learning the authors created two systems, A and B. Half of the sample used System A first and the remaining group, System B first. The difference between System A and B was that System A presented users with a default product information display when viewing products in a product category. System B presented a product information display based on the customer's product knowledge level for that specific category. The customers using both systems still had the freedom to change and choose a product information display of their choice when purchasing products in specific product categories. The task lists consisted of 9 tasks for each, which were basically, purchasing three products from each product category. The data collected by the application recorded the products purchased and which products the customer viewed using different product information displays. The data were finally used to determine which product information display is preferred by a customer with a certain product knowledge level.

5.2. Results

5.2.1. Task list results

The results shown in Table 1 are task success and task time for the activities for Systems A and B.

Task success			
System	**Observed count**	**Expected count**	**Chi-squared p-value**
A	229	237,5	0.44
B	246	237,5	

Table 1: Task success information (n=31)

The results tabulated in *Table 1* were calculated using the Chi-Squared test where the value obtained ($t_{30=}p=0.44$), using a 95% confidence interval, shows that there was not a significant difference between the task successes for the two Systems. In *Table 2* the task times were measured as interval data in seconds. In this table the data are represented as numbers 1-5 where 1 is < 30 sec, 2 is 31-60 sec, 3 is 61-90 sec, 4 is 90-120 sec and 5 is > 120 sec. The average time to complete tasks for System A was 2,63 seconds and 1,61 seconds for System B. When t-test on the task times were conducted, the following values were calculated ($t_{30} =14.66$, $p < 0.01$), this indicated that the task times were significantly different. The difference could be attributed to the learnability of the system or that the users performed better on System B which presented a product information display based on the customer's product knowledge level for that specific category. The average task time for system A's task 2 was the highest overall where this task was to purchase an electrical product. This can be because the users did not change the layout to the appropriate layout on in time. As the product category was electrical, it required a large amount of information and the product category could have influenced the preferred layout.

Task	Mean A	Mean B	Median A	Median B	Std.Dev A	Std.Dev B
1	2.81	1.97	3.00	2.00	0.91	0.80
2	2.90	1.77	3.00	2.00	0.79	0.80
3	2.71	1.42	3.00	1.00	0.78	0.62
4	2.71	1.42	3.00	1.00	0.69	0.67
5	2.61	1.65	3.00	1.00	0.92	0.75
6	2.68	1.58	3.00	1.00	0.75	0.67
7	2.26	1.42	2.00	1.00	0.73	0.62
8	2.45	1.87	2.00	2.00	0.77	0.72
9	2.81	1.45	3.00	1.00	0.98	0.72

Table 2: Task time information (n=31)

5.2.2. Post-test questionnaire results

The questionnaires were based on the evaluation of the system's metrics. *Table 3* indicates that participants were satisfied with the system and the product information displays with which they were presented. The direct comparison of System A and B illustrates that participants preferred to use System B which provided a product information display according to their product knowledge level. This illustrated that participants prefer a presentation which is personalised.

Question		Mean	Median	Std.Dev
Strongly disagree	**Strongly agree**			
1. The system speed was slow/fast?		4.68	5.00	0.48
2. I had enough information available to decide my purchase?		4.45	5.00	0.81
3. The layout of the product information matched my product knowledge level in System A?		3.42	3.00	1.03
4. The layout of the product information matched my product knowledge level in System B?		4.13	4.00	0.76
System A	**System B**			
5. I prefer System A which had default displays or System B which had a display according to my product knowledge level?		4.45	5.00	0.85
6. I enjoyed using System A or System B because it was easier to find the product I had to purchase?		4.26	4.00	0.77

Table 3: Post task questionnaire replies (n=31)

The analysis of the results indicated that participants mostly preferred the list layout when viewing grocery products. This could be due to the fact that most participants had an expert or intermediate product knowledge level for groceries. Comments made by participants were that, when they purchase groceries, they know what they need to purchase and do not require detailed product information.

After the completion of the post questionnaire, participants were requested to indicate which customer profile information they were willing to share. Twelve participants indicated that they were willing that their profile data, relating to product information display, be shared among business units. The participants generally felt that they would not want to share their contact number, email address, address, credit card number, passwords and identity number among business units.

The post-test questionnaire contained a section asking users whether they agreed with the updated customer profile attributes after interacting with the system. Table 4 indicates that users were satisfied with the updated profiles generated.

Product Category	Mean	Median	Std. Dev
Updated Grocery product knowledge	4.096774	4	0.83
Updated Electrical product knowledge level	3.967742	4	0.98
Update Wine product knowledge level	4.580645	5	0.62

Table 4: Satisfaction with updated product knowledge levels (n=31)

5.2.3. Participant interaction results

The results presented in this section are presented to support the goal of this research. Figure 4 (a) indicates that the 19% of the participants who were classified as novice for groceries, preferred the matrix layout for grocery purchases. Half of the 61% percent of the participants, classified as having an intermediate knowledge level for

groceries, preferred the matrix layout. The 20% of participants that were classified as having an expert knowledge level for groceries were fairly evenly distributed between the three user interfaces.

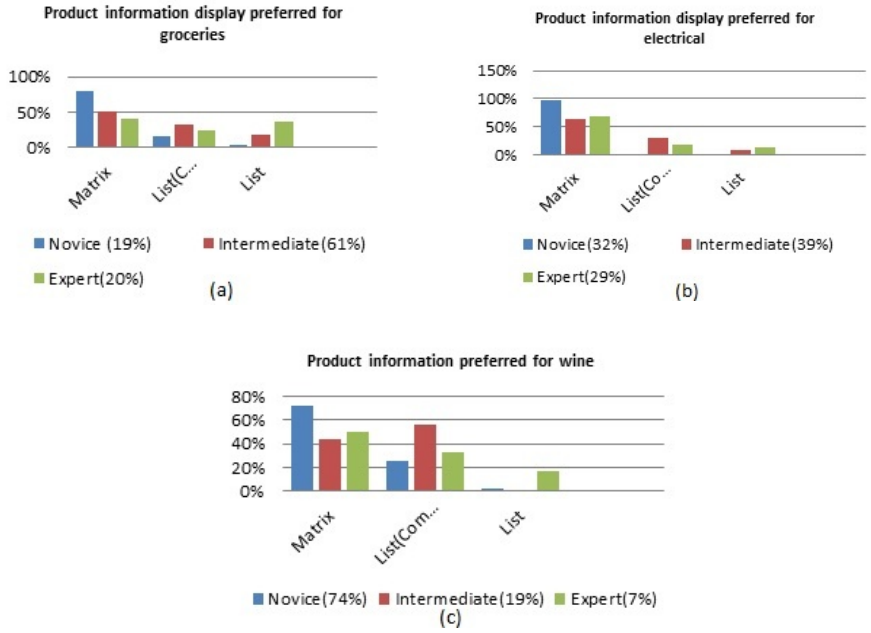

Figure 4: Preferred layout for product category (a-c) (n=31)

Figure 4 (b) indicates that for electrical products, regardless of their product knowledge classification, participants preferred the matrix layout to provide detailed information. Figure 4 (c) indicates that the majority of the 74% of participants that were classified as having a novice product knowledge level for wine, preferred the matrix layout. The participants, classified as having an intermediate product knowledge level for wine, preferred the commented list layout and the expert wine participants also preferred the matrix layout which provided a fair amount of product information. The reason for this could be that experts enjoy having a fair amount of information about the wine category, as wine drinkers enjoy seeing the most information possible about what they are going to be purchase.

In order to conduct data triangulations of results, a process and Apriori algorithm used in the evaluation of data mining results, was applied. The algorithm is presented with a rule and the support and confidence thereof is calculated. The strong support and confidence for *Rule 1in Table 5* emphasises that participants with novice product knowledge prefer the matrix layout.

Rule	Support	Confidence
1. A Novice product knowledge level implies that purchases will be completed in the Matrix layout.	42%	82%
2. An Intermediate product knowledge level implies that purchases will be completed in the Commented List layout.	38%	36%
3. An Expert product knowledge level implies that purchases will be completed in the List layout.	20%	22%

Table 5: Data Mining Rules (n=31)

The following tables *Table 6 to 8* tabulate the results of the Chi-squared test with a confidence interval of 95% on the data. The tables below show a statistically significant difference between the layout preferences for each class of participants. This is indicated by the p-values for the Chi-square tests being less than 0.05 for all classes of participants. Participants preferred a layout that was not equally split between the three layouts.

The results obtained after the analysis of the data showed clearly that participants preferred the matrix layout. This means that the null hypotheses, stating that there is no relationship between product information displays and customer product knowledge levels, cannot be completely rejected at this stage. The user interaction results section indicates that participants with any product knowledge level, preferred to use the matrix layout when purchasing a product from the groceries and electronic goods categories. This could be because the product category has an impact on the product information display preference. The wine category participants, with intermediate product knowledge levels, preferred the commented list layout for wine. This can be because the details provided about wines, in this product information display, were appropriate for task success.

The results could further indicate that participants with an intermediate product knowledge level had knowledge of the wine to be purchased. The Chi-squared tests used, showed that a significant difference existed between layout choices and that participants preferred the matrix layout overall. It can be deduced that there was a relationship between participants with a novice product knowledge level and the matrix layout. This result again highlights that the null hypotheses presented in Section 5.1 cannot be rejected completely. No statistically significant results have been identified between the other product knowledge levels and product information displays. All participants with the other product knowledge levels showed a preference for the matrix layout. These results indicated that the null hypothesis cannot be rejected as no relationship was found between customer product knowledge levels and all the product information displays, as the product categories could have played a role in the customer's preferences.

Layout	Novice(n=6)		Intermediate(n=19)		Expert(n=6)	
	Observed	Expected	Observed	Expected	Observed	Expected
List	33	33	35	35	17	33
List-com	17	33	24	35	33	33
Matrix	50	33	47	35	50	33
p-value	0.000259287		0.022692648		0.000259287	

Table 6: Chi-squared test for grocery product category (n=31)

Layout	Novice(n=10)		Intermediate(n=12)		Expert(n=9)	
	Observed	Expected	Observed	Expected	Observed	Expected
List	10	33	11	35	33	33
List-com	0	33	16	35	0	33
Matrix	90	33	78	35	67	33
p-value	9.42046E-33		5.18895E-18		1.68814E-15	

Table 7: Chi-squared test for electrical product category (n=31)

Layout	Novice(n=23)		Intermediate(n=6)		Expert(n=2)	
	Observed	Expected	Observed	Expected	Observed	Expected
List	2	37	17	36	0	33
List-com	17	37	8	36	0	33
Matrix	87	37	83	36	100	33
p-value	6.18041E-25		5.87645E-21		1.34796E-44	

Table 8: Chi-squared test for wine product category (n=31)

5.3. Limitations of the study

The system limitations were that the system had to run locally using a Windows Azure development storage account. The efficiency of cloud storage could not be measured accurately as the system was running locally. The evaluation had limitations which are listed below:

- There was no equal distribution of customers in the study with the different product knowledge levels;
- There was a small number of wine experts and those with intermediate knowledge;
- The system was evaluated in an artificial context where participants did not perform as they would have if they had to make real life purchases;
- The order in which the tasks was presented to participants using System A and System B.

6. Conclusions and Future Research

The development of e-commerce and customer profiling has become an integral part of business. The use of customer profiling in e-commerce has brought about personalisation which improves customer satisfaction levels and loyalty. The sharing of information, within a company consisting of various business units, has been challenging. A customer's profile, containing personal information as attributes, cannot be shared freely. The use of product information displays should include enough information to affect a customer's buying decision and lead to increases in sales. It has been identified that it is difficult to determine which product information display is most appropriate for customers. Therefore this research has implemented three different product information displays and used a customer's profile, containing product knowledge levels, to present a product information display relevant to the customer.

The results indicated that customers with a novice product knowledge level prefer a matrix product information display which contained a large amount of detail. The null hypotheses stating that there is no relationship between product information

displays and customer product knowledge levels cannot be rejected. The research further concluded that the reason why there is no statistically significant relationship between product knowledge levels and product information displays is because customers know what products they want to purchase. In addition, there were not a large number of expert participants in product categories, such as wine and electrical products.

Future research to be implemented will include a recommendation for an e-commerce system using a customer's profile and evaluating whether the recommendations are useful. Future research could also implement an e-commerce website which is fully customisable by real-world customers and evaluate if the system increases customer satisfaction which is an important element when conducting on-line business.

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