A Qualitative Analysis to Evaluate Key Characteristics of Web Mining based e-Commerce Applications

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***Abstract*—E-Commerce applications are playing vital role by providing competitive advantage over business peers. It is important to get interesting patterns from e-commerce transactions to analyze customer experience, customer likelihood. For this, web mining based e-commerce applications are being developed for various e-businesses. There are different characteristics like user interface and interactivity, which can make these applications more efficient and effective. Well-defined criteria are needed to prioritize key characteristics of these applications. The primary intention of this work is to identify and prioritize the key characteristics and their impact on designing these applications. This paper provides a qualitative survey based evaluation and prioritization of key characteristics.**

***Keywords*—Web mining; e-Commerce applications; user interface; interactivity**

I. Introduction

Due to the growing popularity and accessibility of internet, web has emerged as a popular source for information distribution, retrieval and analysis in recent years. Web is the data repository containing huge volume, variety and velocity of data [1]. Users are facing different problems for searching required information from different e-commerce websites. There should be an efficient mechanism to provide desired information to the user. For this purpose, web mining can be used for the extraction useful information for the users using different tools and technologies. Fig. 1 shows web mining classification [2]. Web mining can be classified into four categories based on content, structure, usage, and user profile.

E-commerce applications can take advantage of data and web mining for improving the user experience. Web mining and data mining is often used to provide products and user interface according to user preferences. These applications are usually known as web mining based e-commerce application. Many researchers have already identified different characteristics for efficient and practical designing of web mining based e-commerce application [3, 4]. Some of the characteristics (what are different characteristics). However, nobody has explicitly researched the key characteristics of web mining based e-commerce applications.

The focus of this study is to identify, evaluate, and prioritize the basic characteristics for web mining based e-commerce applications. In this research we will address following hypothesis:

H_o: Age is associated with user interface

H_1: Age is associated with navigation

H_2: Age is associated with data placement

H_3: Age is associated with convenience

H_4: Age is associated with interactivity

H_5: Gender is associated with user interface

H_6: Gender is associated with navigation

H_7: Gender is associated with data placement

H_8: Gender is associated with convenience

H_9: Gender is associated with interactivity

The rest of the paper is organized in different sections. Section 2 presents the related work. Section 3 discusses proposed methodology. Results and discussions are described in Section 4. We conclude the outcomes with future work in Section 5.

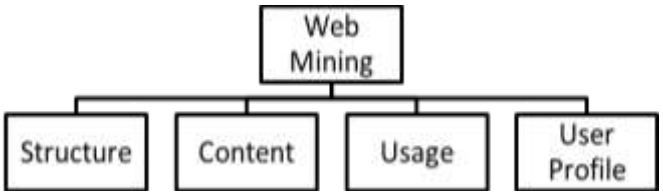

Fig. 1. Web Mining Classification.

II. Literature Review

A lot of work and analysis is done on World Wide Web. Web is a collection of inter related web pages and files that are stored on web servers. A large amount of data is stored on those servers that can help in growing a business. Web mining helps business owners to take new decisions for the growth of their business. The task can only be possible by using web mining applications in the context of E-commerce [5]. The key idea in the web mining tools is based on the statistical analysis, knowledge discovery and prediction model. Firstly, work start with statistical analysis, in which data analyzed by using

different mathematical models and tools. Secondly, in knowledge discovery, developers use navigation tools to analyze the data before mining according to business rules and facts. In last, the model predicts consumer behavior by analyzing the hypothesis that has been made from the previous two steps. This model is efficient for E-commerce data analysis [3].

A performance measurement evaluation matrix for the development of complex products and systems (PMEX) is proposed that will help in the performance of the product development process. PMEX is based on different phases. The product development starts with planning. The second phase is implementation that works under important success factors for performance in the product development planning. In last the verification of PMEX is performed on the basis of critical success factors as well as with case studies. PMEX may be used as a tool for performance measurement system [4]. It also illustrates what is measured and helpful for adding new changes. Moreover it measures what is important in company's perspective in the quest for a more successful product development.

New information technologies allow computers to extract meaning from unstructured information. Benefits of web mining and data mining are also identified by researchers [6]. Data mining is the extraction of hidden data from large databases. Different data mining applications are introduced by researchers as well as their analysis is also available. As a result organizations get competitive benefits from the analysis of data mining applications [7]. Several problems are analyzed and solutions are also proposed. A complete functional matrix is proposed to analyze managerial functions. The existence of a data warehouse for customers and activity of competitors is the ideal starting point for the application of data mining [4]. This type of analysis of data mining applications ultimately gives us an opportunity to achieve better financial results in business.

Websites are the mostly used medium through which transactions are carried out in electronic business. Customers expect that the websites are designed according to the customer facility and easiness. A multi category analysis is made for the most successful websites. The most popular websites are different from the old websites because of their functionalities and purpose [8]. The characteristics are evaluated with their performance. The analysis was carried out for the top 40 websites that is a biased thing. Similar analysis was carried out for the 40 unsuccessful websites that gave us a clear idea for making a successful websites. A successful website can be made by giving relevant purpose, functions, reliability, and usability [9-11]. Websites are also heavily used nowadays as a surveys tool [12].

The researchers also examined design constructs of Information Content, Navigation Design, Visual Design mapped to the trust of website and user satisfaction about website design. They are also interested to determine the strong gender differences in countries with higher masculinity and weak gender differences in the countries with lower masculinity [13, 17].

Behavior of online consumer is often distinguished by both measuring user engagement and the detection of common sequences of navigation patterns, using an innovative new technique that combines footstep graph visualization with sequential association rule mining. It is also observed that sessions taken by using mobile devices are usually of task-oriented behavior on the other hand sessions conducted through PC devices are classified as exploration-oriented browsing behavior [14].

The researchers investigate the impression usability before actual use, preference, task completion time and the effects of design attributes for e commerce web site. Also the user's psychological characteristics are evaluated by conducting experiments on e-commerce website. The researchers proposed four hypotheses [18]. Firstly, task completion time is correlated with pre-use usability positively. Secondly, the relationship among user preference and pre-use usability is greater than that between and user preference task completion time. Thirdly, design attribute assessments after actual use are highly correlated. Fourthly, user's preference is more correlated with aesthetic quality than layout and organizational structure. In order to test these hypotheses, nine online book stores were chosen with ten participants [19, 20]. It is also identified that there were some limitations of the work like design attributes were classified as content organization, visual organization, navigation system, color, and typography, according to the categorization of based on McCracken and Wolf [21, 22]. Researchers are of the view that to achieve a more refined analysis, visual aspects and functional features of web designs should be categorized more specifically and concretely [15, 16].

III. Methodology

Survey research is a mostly used method of gathering information about a specific population of interest. There are different types of surveys and also there are different methods used to administer those surveys, there are also a lot of methods of sampling. There are two main aspects of survey research i.e. questioner and sampling. A questioner is designed for performing a survey from the users. A standardized series of questions is used to collect information from participants. The survey is based on closed ended questions because answers of the questions are provided to the clients so that they select the answers from the given options.

Every characteristic is divided into five questions. The questions are more focused and designed according to the user satisfaction, uniformity of data and layouts, and visibility.

For the purpose of gathering data we have suggested some significant and diverse platforms. A famous web mining based e-commerce platform Daraz.pk [1] from the perspective of Pakistan is considered, two more web mining based ecommerce systems Amazon.com [2] and EBay.com [3] are conceived as depicted in Fig. 2, 3 and 4, respectively.

Presently, we don't have any explicitly recommended technique for the development of efficient web mining bases e-commerce applications and important characteristics of web mining based e-commerce application are also not even

[1] https://www.daraz.pk
[2] https://www.amazon.com
[3] https://www.ebay.com

proposed by researchers which can help in making efficient data mining applications. We are using the following characteristics of web mining based e-commerce application: user interface, navigation, interactivity, data placement, and convenience. We have also evaluated the survey results which are attached below.

We collected the survey results from the IT-professionals, researchers and software engineers. The survey results sum-up that by using these characteristics a developer can build-up efficient e-commerce applications.

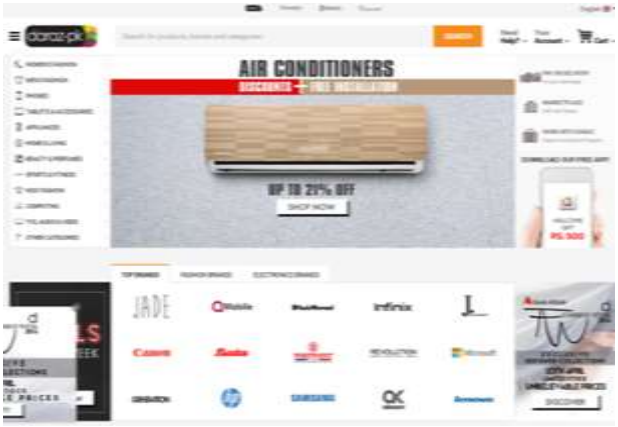

Fig. 2. Popular E-commerce System Daraz.pk.

Fig. 3. Popular E-Commerce System EBay.

Fig. 4. Popular E-Commerce System Amazon.

IV. Results and Discussions

A survey was designed to learn about the significance and correlation of characteristics of web mining based e-commerce applications. The survey consists mostly of Likert-style questions. People from different walks of life are considered for this survey. The survey was intended for respondents who are computer literate and must have experience with online shopping system. Moreover, it was also ensured that respondents are from geographically distinct locations to improve the quality of the results. Questionnaire was distributed to different mailing groups and academic institutes.

For the purpose of gathering user responses, distinct e-commerce platforms are considered which use web mining to provide better user experience. The total number of respondents to the survey was 160, of which approximately 68% were male respondents and 32% were female respondents. The respondents were assured to maintain the confidentiality of the responses. Respondents of the survey think user interface is most significant (36%) and data placement is least significant (4%). Fig. 5 provides more detail.

Moreover, responses are analyzed on the basis of the age group and gender. We have considered three age ranges, i.e., 18-25, 26-45, 46 or above. First, we have evaluated the gender wise responses of user interface characteristic as shown in Fig. 6 and 7. Majority of female respondents think user interface should be easy to perform and quickly adoptable. For male respondents, clarity is more desirable in user interface and they don't want the page to be overcrowded which may distract them while shopping.

Fig. 8 and 9 shows responses of female respondents toward navigation. Navigation is not a significant point of concert to these respondents but logo navigation might be. Majority of the female survey results conclude disagree for navigation except facilities characteristic. This survey result may not be reliable because most of the people are not familiar with navigation as well as its characteristics. On the other hand, males majorly record their results in the favor of navigation and think that it is important for websites success and majority of male respondents are in the favor that navigation links should be consistent and easy to identify while shopping. On the other hand substantial numbers of female respondents endorsed the click and tap facility to the navigation links. The characteristics are important like consistency, logo navigation and easy to search, for users attraction on the website that will ultimately increase the success of a website.

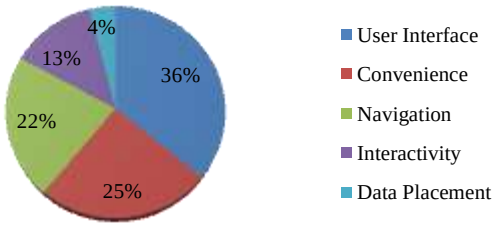

Fig. 5. Responses of all users in Percentage.

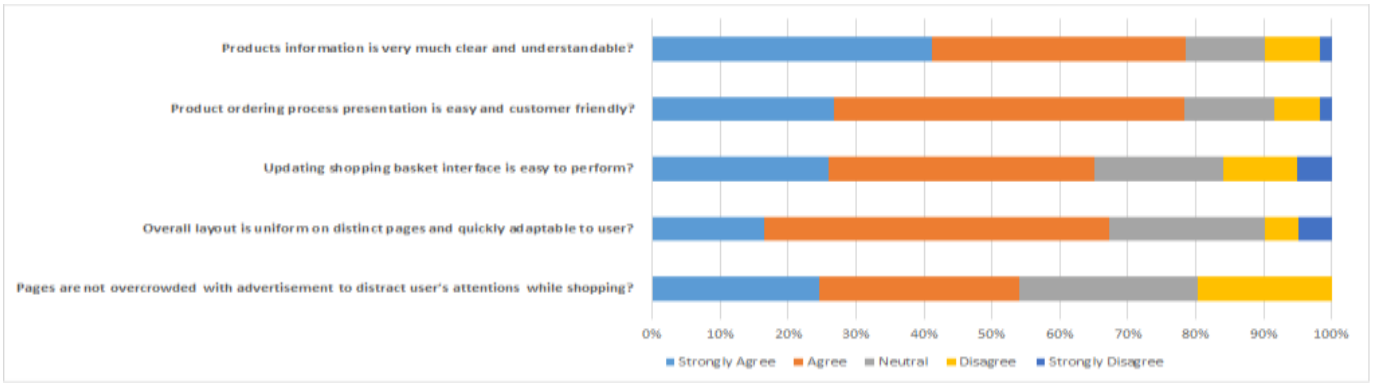

Fig. 6. Male Response to the user Interface Characteristic.

Fig. 7. Female Response to the user Interface Characteristic.

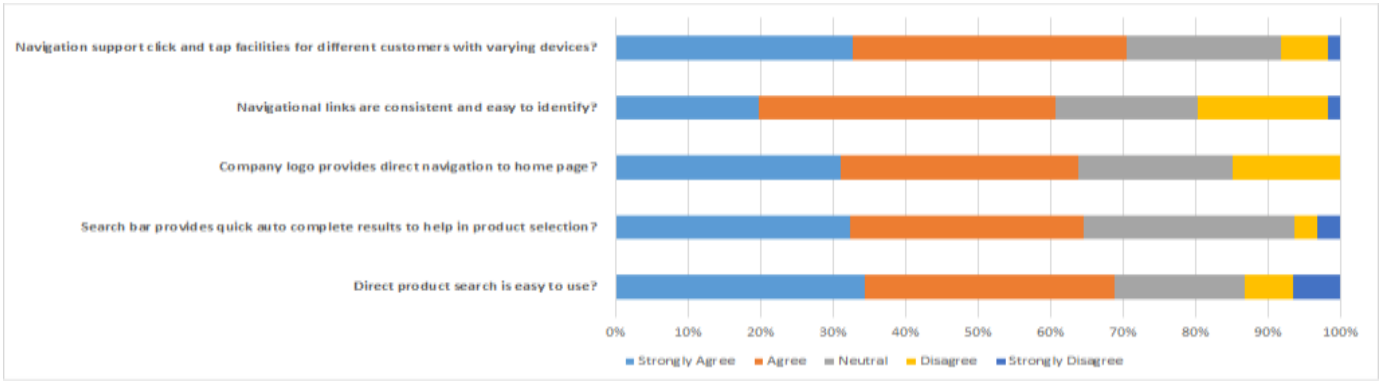

Fig. 8. Male Reponses to the Navigation Characteristics.

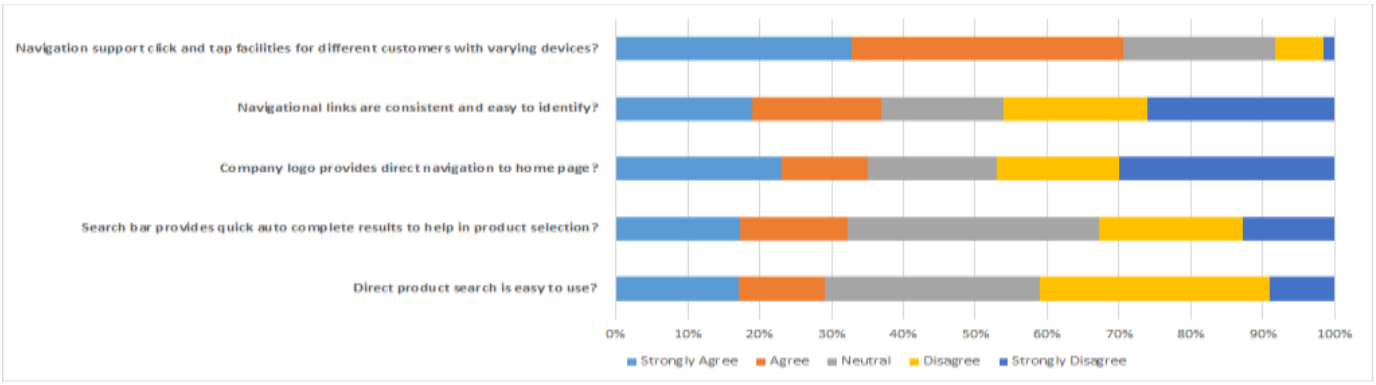

Fig. 9. Female Reponses to the Navigation Characteristics.

Fig. 10 and 11 illustrates interactivity is utmost important thing in websites for getting more and more traffic. As the females are interested in shopping and purchasing more and more products, they usually gave high rating of feedback for products which have rating options. After viewing the rating of a product, a person can easily make a decision for purchasing it or not. All the males survey and approximately females survey results is in agree side that interactivity is important, in the success of a website. In addition, females didn't think that interaction is important for the success of a website. It can also be seen that about equal number of male answerers are agree to the near to natural interactions to the product during shopping activity. On the other side, female participants are strongly agreeing to the option "support different customers differently on varying devices".

Fig. 12 and 13 depicts the responses of female respondents; how they feel more convenience of shopping through online mode. As it is very much clear that significant number of females feel strongly admire the transactional security. Majority of the females put their feedback in disagree and strongly disagree side except for option guest user facility and shipping flexibility. Normally it is noticed that females demands convenience for shopping. Even though they are disagree for payment methods because they even don't bother about payment security. On the other hand, Males mostly agree with all the characteristics of convenience especially with transactional security and payment methods. Females are mostly dependent on males because of this males are more concerned for payment related characteristics. Most of the males consider that convenience is playing a vital role in the success of a web mining based e-commerce applications. As it can also be clearly seen in Fig. 9 that significant percentage of male responses are agreeing to the availability of variety of payment methods. Despite to this, majority of female respondents are neutral toward shipment tracking process, respectively.

Fig. 14 and 15 illustrates responses of female respondents; how well they are satisfied with data placement in e-commerce websites previously discussed. As it is quite clear that significant number of female respondents are strongly agree with data organization used in these platforms. This feedback includes agree and strongly agree side with high ratings. Data placement always considered an important key attribute either from male or female side but according to the survey reports most of the males think data placement is important for the success of the website especially information visibility is the most important characteristic of data placement. Meanwhile female's feedback is not in the favor of data placement and majority of male and female participants are agree and disagree to the question that information about individual product is visible where they want to be while shopping in respective manner.

Fig. 16, 17 and 18 depicts the responses about convenience of using web mining based e-commerce application from the respondents on different age groups whether they feel more convenient of shopping through online mode. An interesting pattern is identified that the people aged 46 and above are very much interested in the fact that check out process in e-commerce systems should be very easy and continent. On the other hand, young respondents of age 18-25 are more concerned about the shipping tacking facility offered by e-commerce website.

Fig. 19, 20 and 21 depicts data placement based upon distinct age groups of respondents. On the basis of distinct age groups, majority of respondents of first age group are agree to flexible and ease in shipment tracking process. Second age group is showing its strong favor toward robust transaction and ease in shipment too.

Normally it is considered as the core component in the data mining. Data placement survey includes information visibility, data organization, content structured, links accessibility, data retrieval as complete pack under data placement. Data organization and links accessibility got more than 40% above and 38% rating in the survey respectively. This is a good approach towards web mining based e-commerce applications that information must be provided in easy way so that user will get his/her required information in less time and fulfill his/her desires.

Meanwhile, according to the age groups below 46, they are mostly agree and strongly agree for the fact that data placement plays an important role in the efficient usage of a website. We can take their views most probably correct because they are putting their reviews according to their experience. On the internet the majority of the internet users are below 46 years of age. As majority of respondents of first age group are strongly agreeing that shopping basket information is well-organized. Second age group is agreeing toward the overall structure of content. The third age group is showing neutral response to the same aspect of structure of content.

Interactivity is a concept that deals with the interaction of computer with human beings and computers. Interactivity is also divided into five components that are interaction, product rating, easy feedback, visibility, and supportability can be seen easily in Fig. 22, 23 and 24. Easy feedback, supportability, and interaction got the highest percentage in the 26-45 age group. Easy feedback and interaction for the users attract the audience of the website. Both of these things give a deep impact in the success of the website. The two senior age groups approximately agree and strongly agree for the contribution of interactivity in the success of a website. As majority of respondents of first age group are strongly disagreeing to the supportability of different types of customers on different devices. The third age group showed mixed response on all the options.

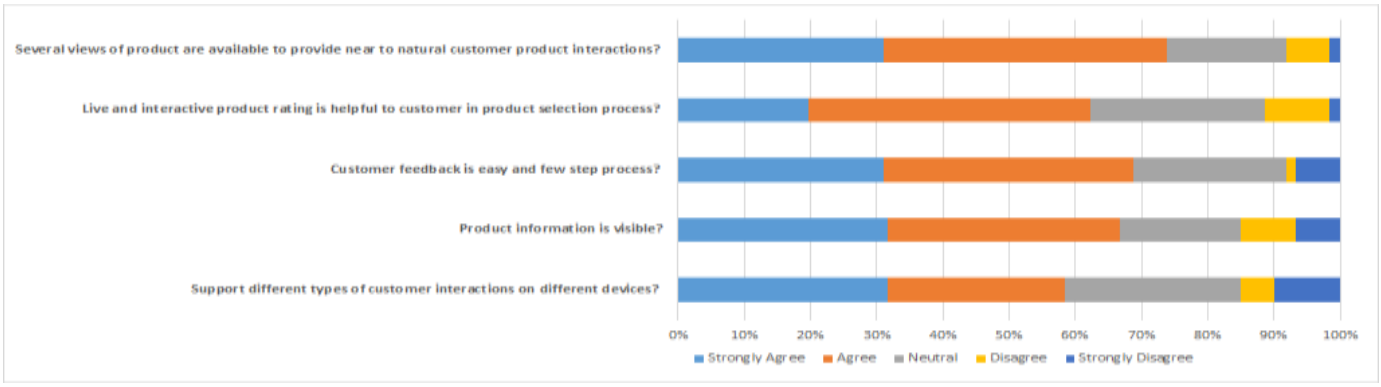

Fig. 10. Male Reponses to the Interactivity Characteristics.

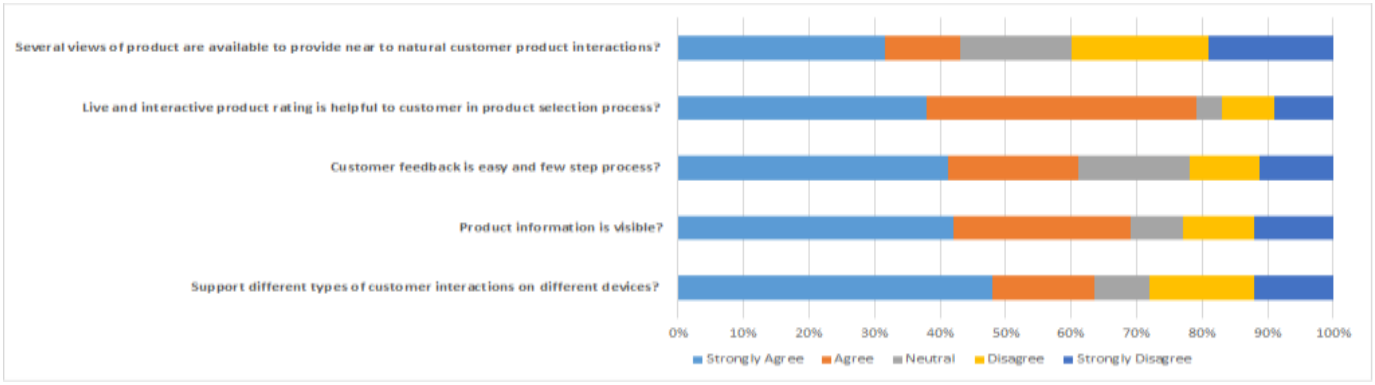

Fig. 11. Female Reponses to the Interactivity Characteristics.

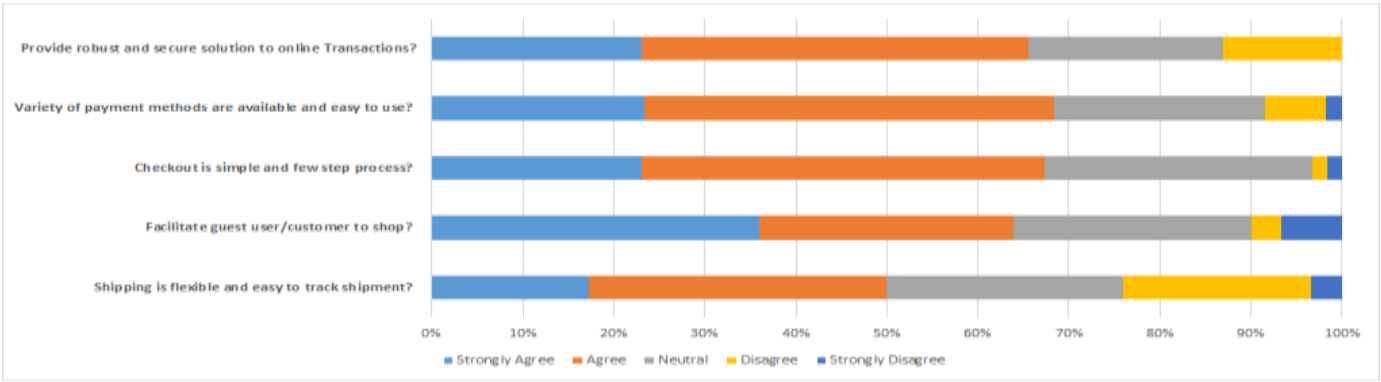

Fig. 12. Male Reponses to the Convenience Characteristics.

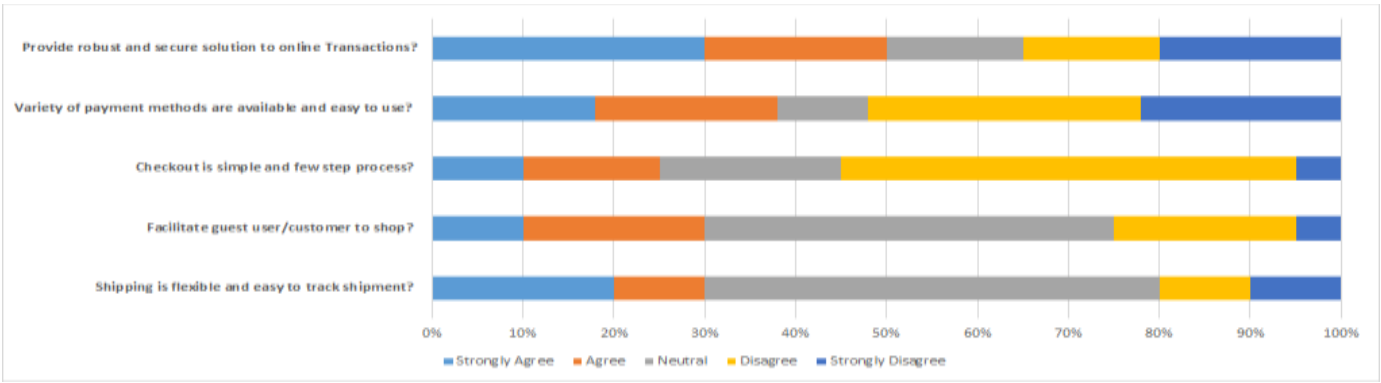

Fig. 13. Female Reponses to the Convenience Characteristics.

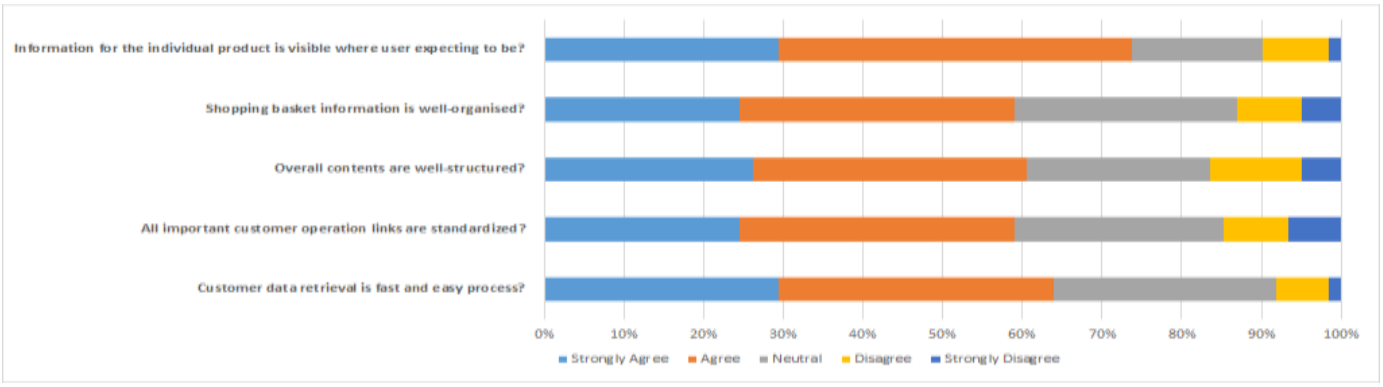

Fig. 14. Male Reponses to the Data Placement.

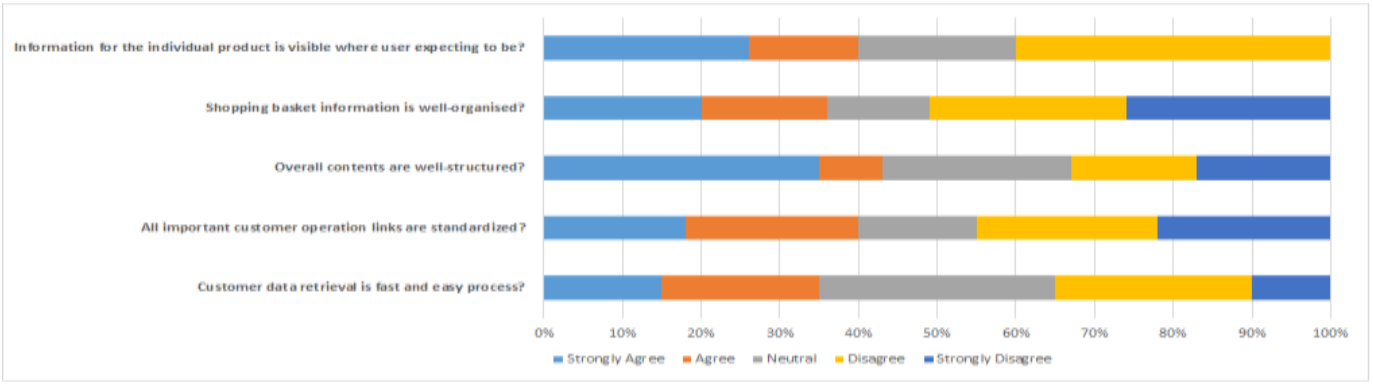

Fig. 15. Female Reponses to the Data Placement.

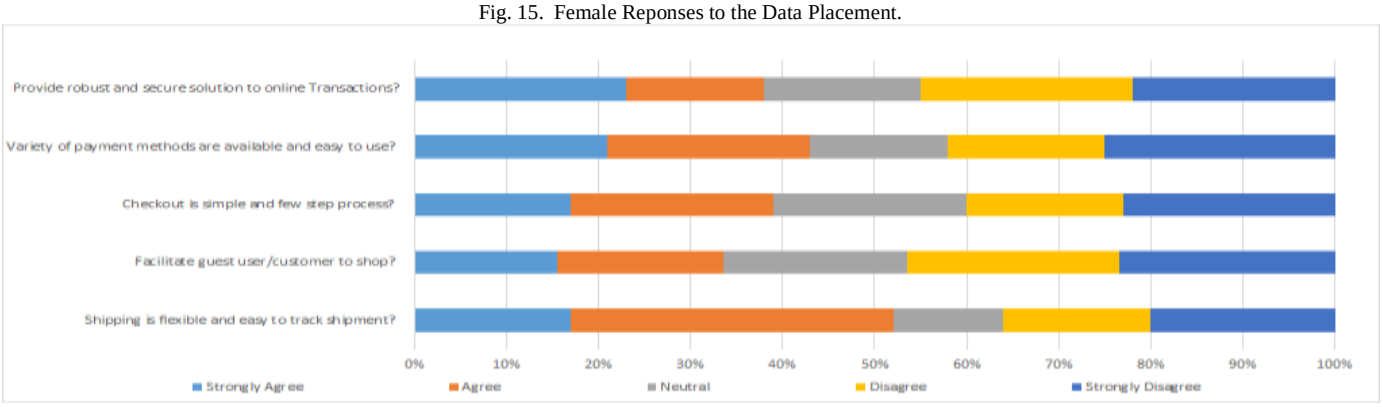

Fig. 16. Age 18-25 Reponses to Convenience.

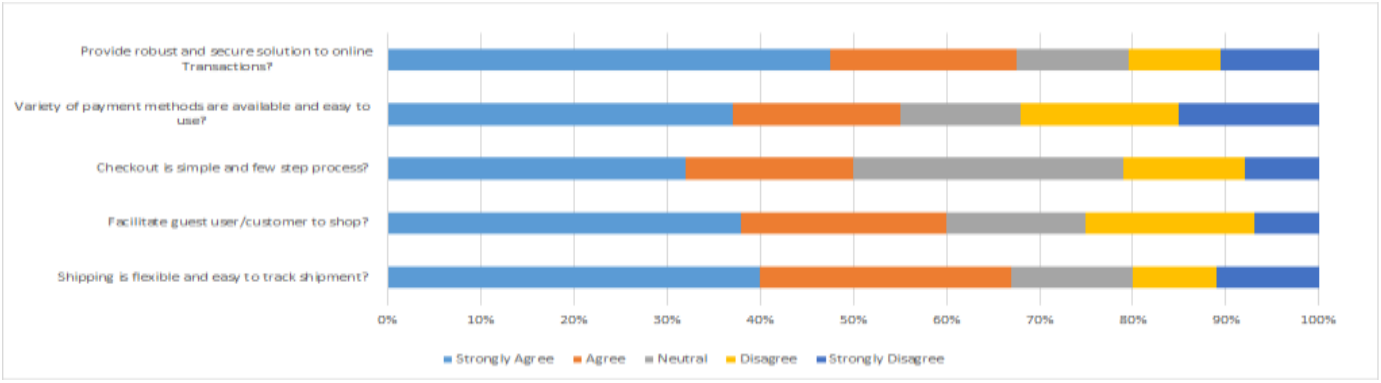

Fig. 17. Age 26-45 Reponses to Convenience.

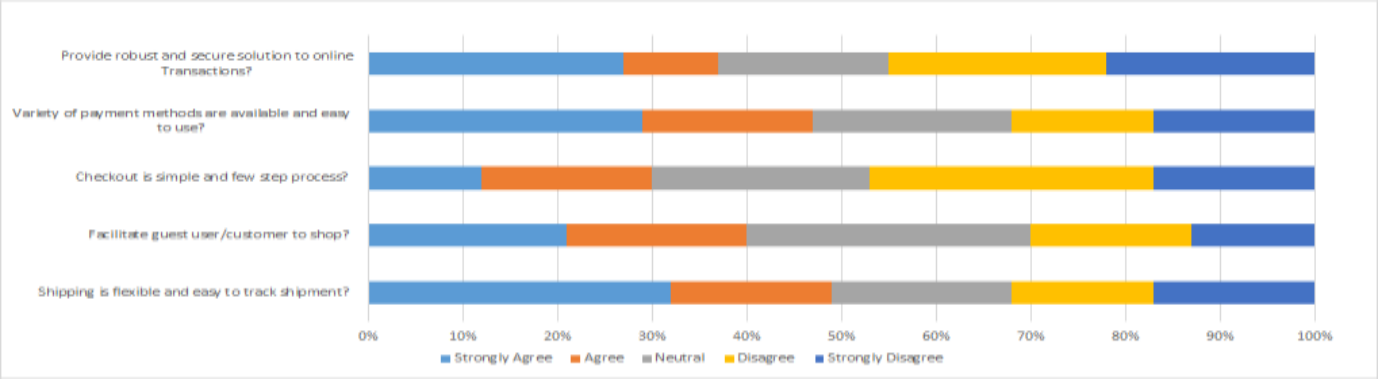

Fig. 18. Age 46 & above Reponses to Convenience.

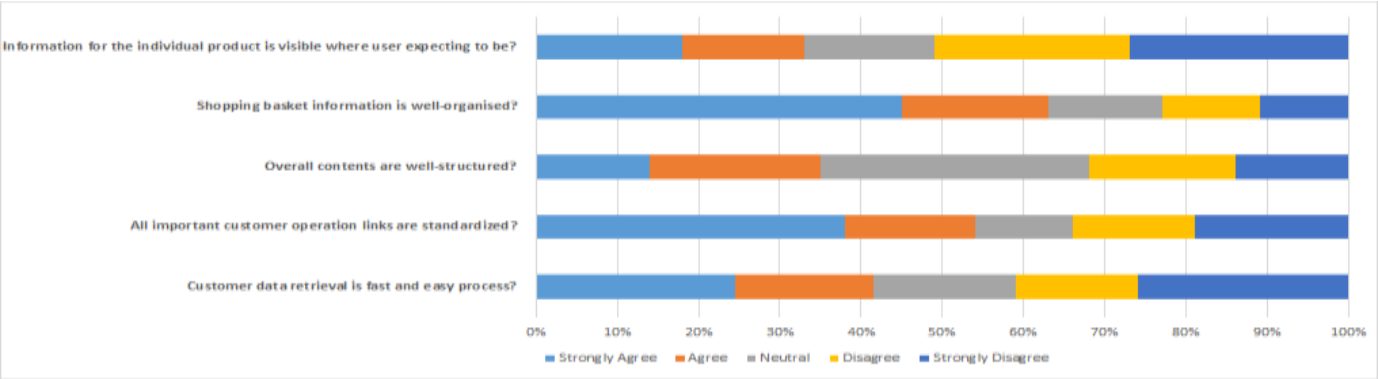

Fig. 19. Age 18-25 Reponses to Data Placement.

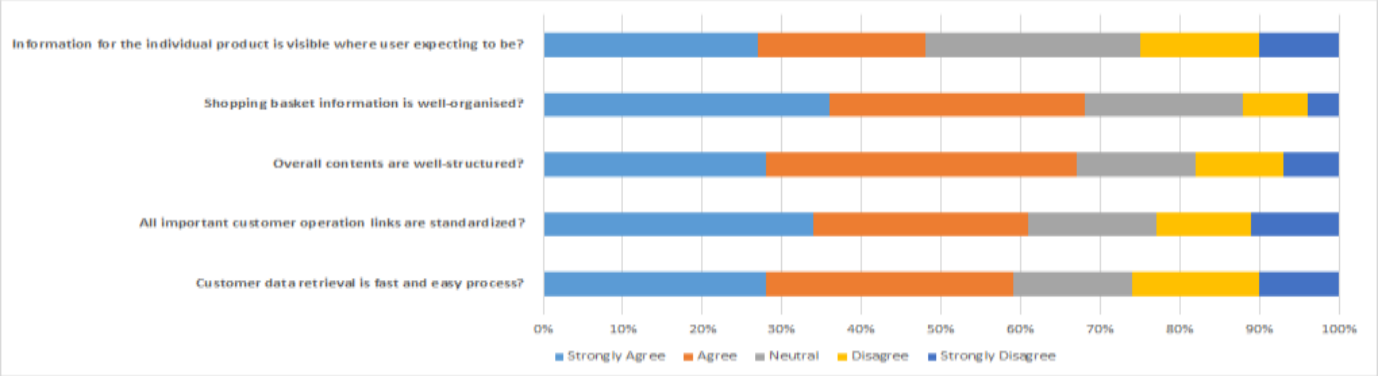

Fig. 20. Age 26-45 Reponses to Data Placement.

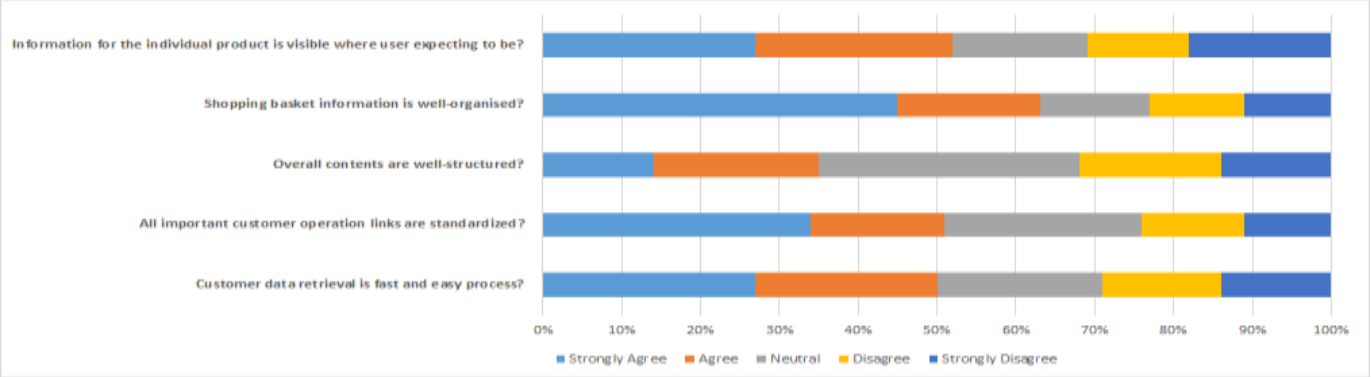

Fig. 21. Age 46 & above Reponses to Data Placement.

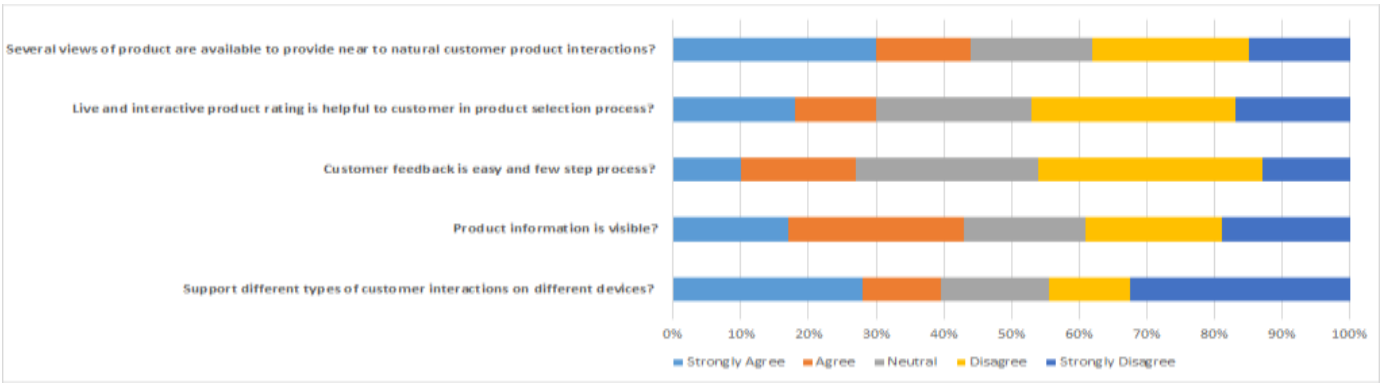

Fig. 22. Age 18-25 Reponses to Interactivity.

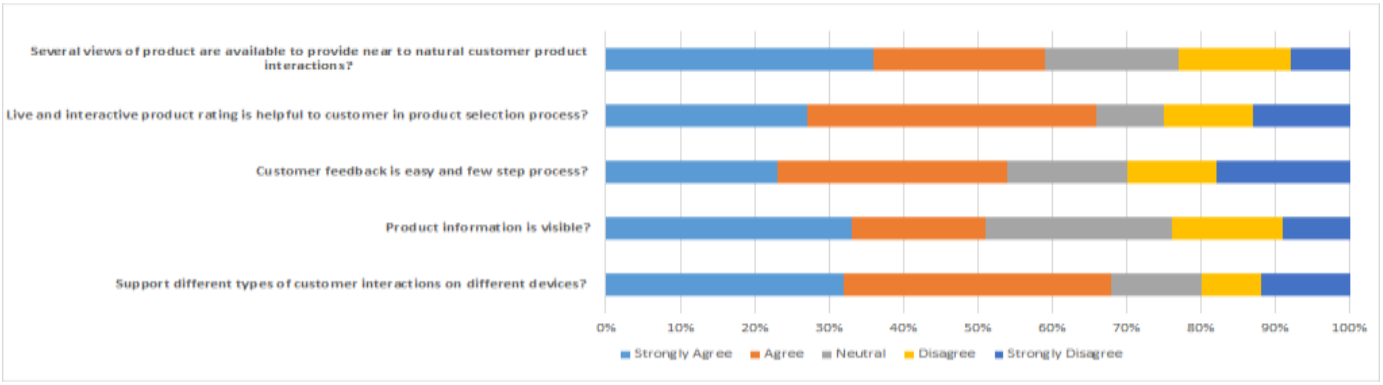

Fig. 23. Age 26-45 Reponses to Interactivity.

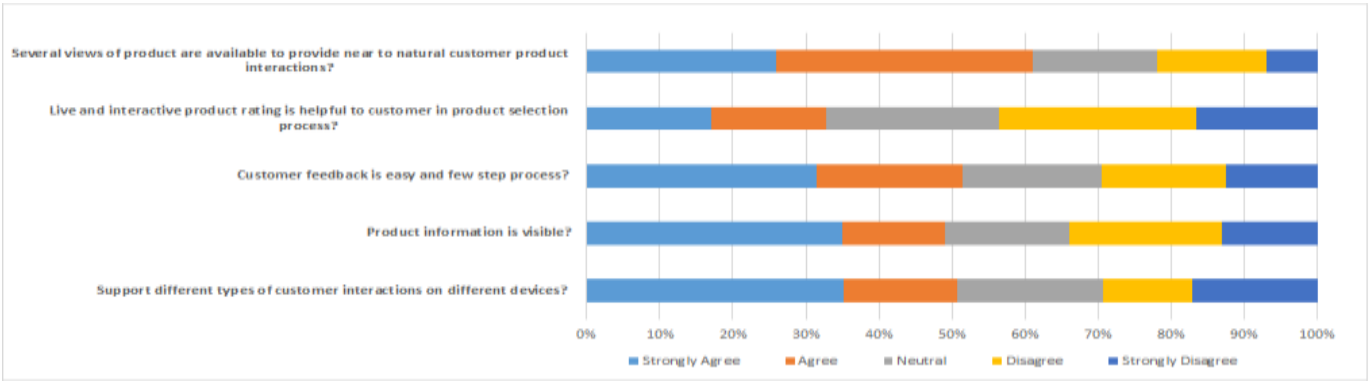

Fig. 24. Age 46 & above Reponses to Interactivity.

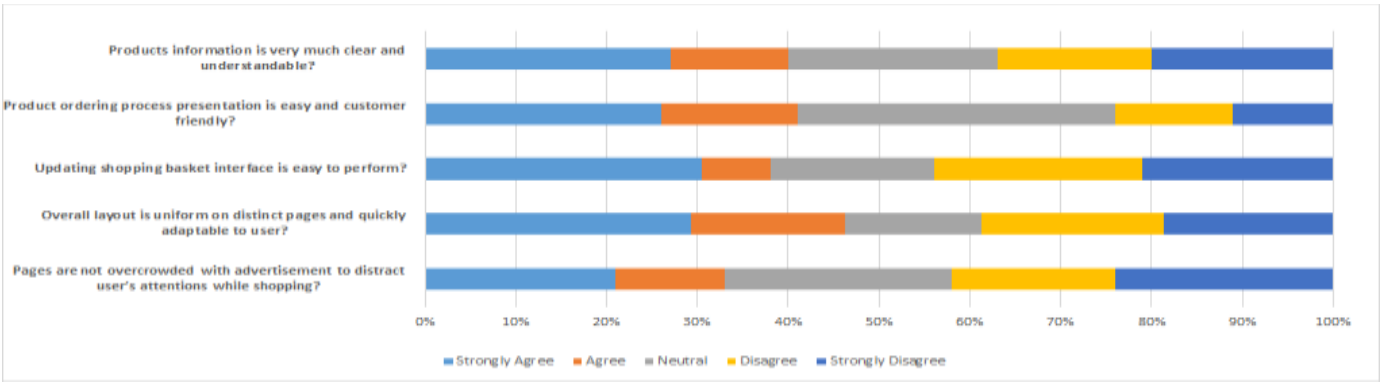

Fig. 25. Age 18-25 Reponses to user Interface.

Responses of users are collected and analyzed which yields following results on the basis of characteristics discussed above. Fig. 25, 26 and 27 shows responses to user interface based upon distinct age groups of respondents. Every characteristic is divided into five categories. User interface is analyzed on the basis of clarity, presentation, easy to perform, quickly adaptable, and fuzziness. Most of the users are in the favor of clarity, presentation and quickly adaptability of the interface that they play a vital role in the success of a website as compared to other two characteristics. This analysis got a quite balanced rating according to agree and disagree but quickly adaptability in the 26-45 age group got the highest rating i.e. 58%. Usually, it is considered that user interface plays a vital role in the success of a website and according to majority of the users' feedback, user interface seem to be important for the success of a website. Majority of respondents of first age group are showing neutral responses toward the product ordering process is user friendly. Second age group is strongly agreeing that overall layout of the platform is uniform and quickly adaptable. Third age group is also either strongly agree or simply agree to the importance of most of the aspects of the user interface.

Web navigation is known as a process of navigating a network of information resources in the websites and also guides the users about the websites. Fig. 28, 29 and 30 shown responses to navigation based upon distinct age groups of respondents. Navigation is categorize in five components that are facilities, consistent, logo navigation, auto suggestion, and easy to search. Unlike user interface, navigation got highest ratings in agree and strongly agree from user's feedback. Users from 18-25 age group submit agree and strongly agree feedback for facilities, consistent (also in 46-above age group) and auto suggestion. The youngsters usually need guidelines, consistency and more facilities for performing their required task in less time and efficiently. So, navigation is another key characteristic in the success of a website. Easy to search in the website for web content is also a key characteristic according to the feedback of 26-45 and 46-above age groups. Moreover, if a website is providing more facilities for the users then it will ultimately attract more users. In the users feedback facilities is not prominent for getting the ratings from the users except the 18-25 age group. As significant number respondents of first age group are showing their vital interest in survey and they are very much comfortable with navigational links as majority of answerers think links are consistent and easily identifiable.

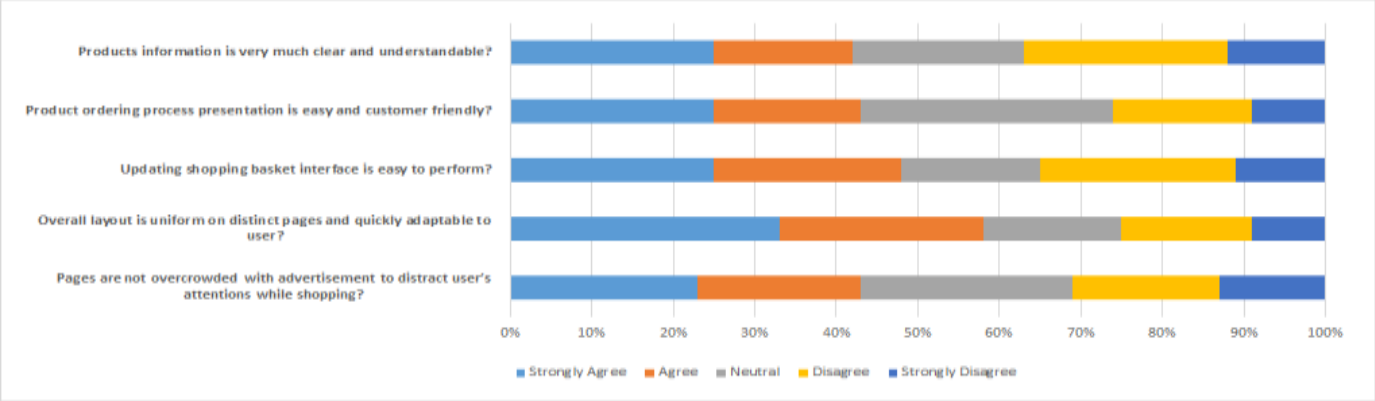

Fig. 26. Age 26-45 Reponses to user Interface.

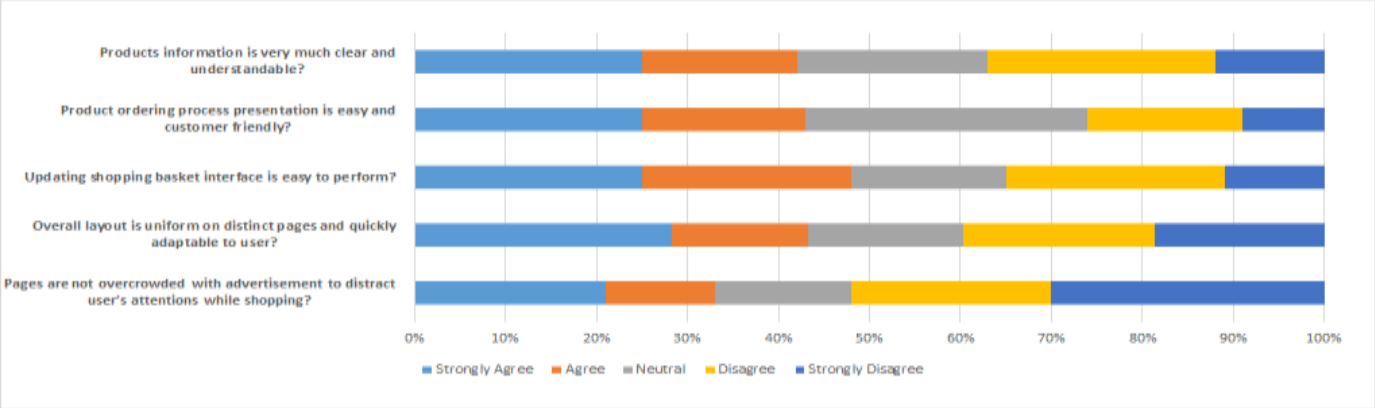

Fig. 27. Age 46 & above Reponses to user Interface.

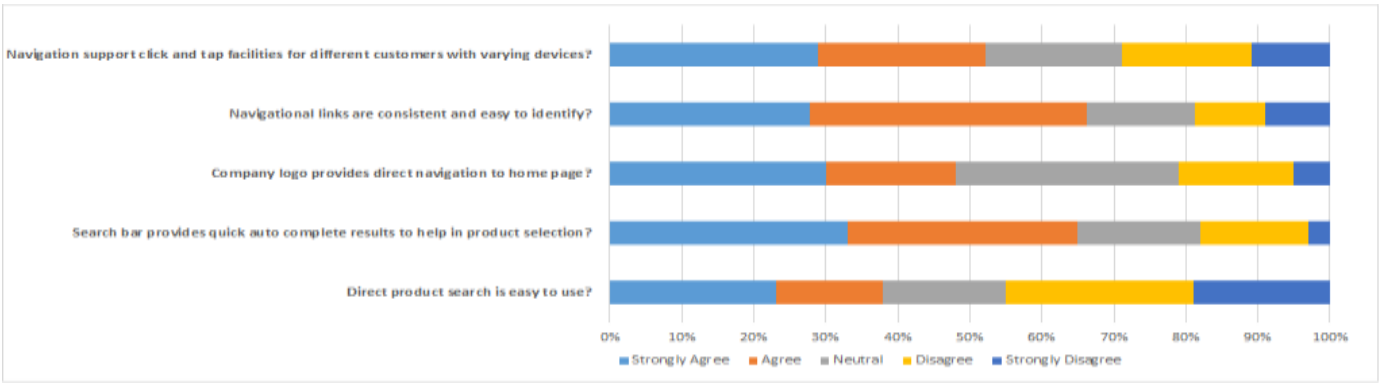

Fig. 28. Age 18-25 Reponses to Navigation.

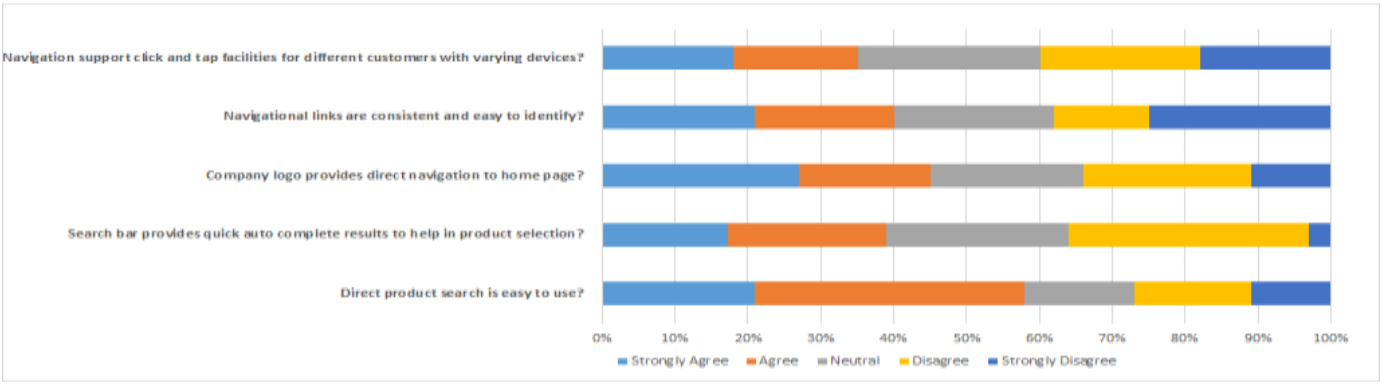

Fig. 29. Age 26-45 Reponses to Navigation.

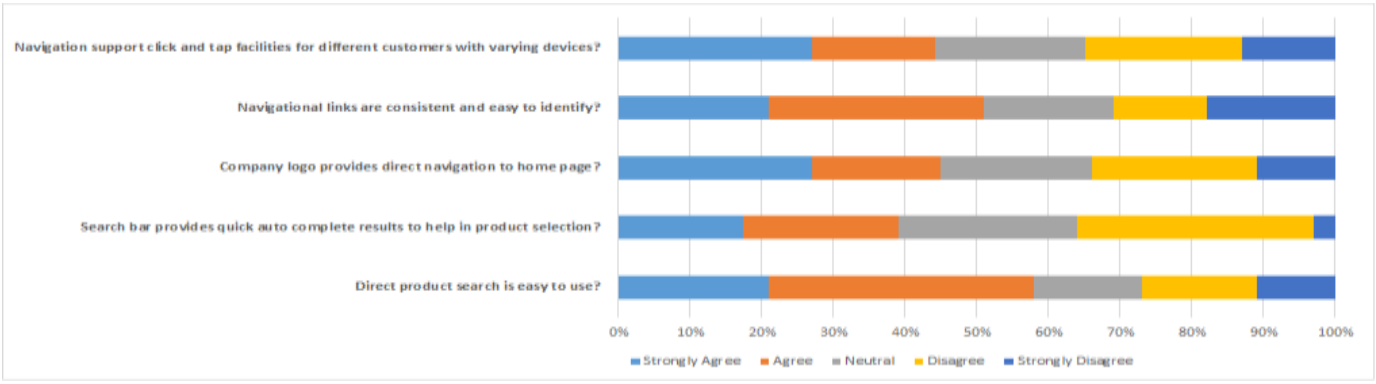

Fig. 30. Age 46 & above Reponses to Navigation.

Table 1 provides some interesting results based on user survey. Age is highly associated with friendly product ordering process, pages are less overcrowded, navigation links are concise and meaningful, click and tap facility provided for links, direct product search is easy to use, quick auto complete results in product selection, logo navigation to homepage, ease in customer feedback, ease in shopping by guest user, product information visibility and moderately associated with clarity and understandability in product information, easily adaptable platform layout, easily identifiable links, better color scheme to isolate components, secure online transactions, availability of varying payment methods, checkout is few step process, well-organized shopping basket, ease in data retrieval of customer and low associated with live product rating process, ease in shipment tracking, standardization in operation links, and having no association between age and updating shopping basket, several product views for selection, overall organization of contents. In short, age is playing most significant role in navigation as compared to convenience, user interface, interactivity and data placement. Secondly convenience is another aspect with great impact on significance. Moreover remaining three characteristics are lying at same level.

TABLE I. ASSOCIATION BETWEEN CHARACTERISTICS OF WEB MINING BASED- ECOMMERCE APPLICATION AND AGE

Statements	χ^2_{cal}	*P-value (two tailed)*
Association of Age and User Interface		
Products information is very much clear and understandable?	22.944	0.001**
Product ordering process presentation is easy and customer friendly?	35.855	.000***
Updating shopping basket interface is easy to perform?	10.532	.104
Overall layout is uniform on distinct pages and quickly adaptable to user?	14.966	.001**
Pages should not be overcrowded with advertisement to distract user's attentions while shopping?	81.028	.000***
Association of Age and Navigation		
Navigational links are consistent and easy to identify?	13.800	.032**
Navigations support click and tap facilities for different customers with varying devices?	24.843	.000***
Direct product search is easy to use?	38.702	.000***
Search bar provides quick auto complete results to help in product selection?	42.796	.000***
Company logo provides direct navigation to home page?	36.881	.000***
Association of Age and Interactivity		
Support different types of customer interactions on different devices?	6.237	.397
Several views of product are available to provide near to natural customer product interactions?	8.075	.233
Live and interactive product rating is helpful to customer in product selection process?	8.932	.063*
Live customer reviews provide a better way to interact with user experiences?	17.629	.007**
Customer feedback is easy and few step process?	27.472	.000***
Association of Age and Convenience		
Provide robust and secure solution to online Transactions?	9.547	0.049**
Variety of payment methods is available and easy to use?	15.657	0.016**
Checkout is simple and few step process?	19.118	.0010**
Facilitate guest user/customer to shop?	27.522	.000***
Shipping is flexible and easy to track shipment?	11.990	.062*
Association of Age and Data placement		
Information for the individual product is visible where user expecting to be?	36.880	.000***
Shopping basket information is well-organized?	17.629	.007**
Overall contents are well-structured?	8.078	.233
All important customer operation links are standardized?	8.932	.065*
Customer data retrieval is fast and easy process?	15.993	.014**

P-value *** < 0.01 Highly Associated
p-value ** < 0.05 Moderately Associated
p-value * < 0.10 Lowest Association

Table 2 shows on the basis of analysis performed it has been extracted some interesting results. Gender is highly associated with easily adaptable platform layout, navigation links are concise and meaningful, click and tap facility provided for links, several product views for selection, availability of varying payment methods, well-organized shopping basket and moderately associated with friendly product ordering process, updating shopping basket, direct product search is easy to use, live customer review for experience, useful color scheme for data isolation, feedback is easy and few step process, secure online transitions, ease in checkout, varying payment methods in use, standardized operational links and low associated with live product rating, facilitate end user to shop, well-structured web contents and having no association between gender and clear product information, easy to locate featured product on homepage, less overcrowded pages, links are concise and meaningful, quick auto complete solution to search product, direct navigation with company logo, responsiveness support for distinct devices, flexible shipping process, information for individual product, data retrieval is fast and easy. In short, convenience and interactivity are greatly affecting genders at same level of significance. Moreover, other researched characteristics are significant too but less significant as compared to above mentioned characteristics. Gender is playing most significant role in our model as compared to age.

TABLE II. ASSOCIATION BETWEEN GENDER AND CHARACTERISTICS OF WEB MINING BASED E-COMMERCE APPLICATION

Statements	χ^2_{cal}	***P-value (two tailed)***
Association of Gender and User Interface		
Products information is very much clear and understandable?	3.77	0.287
Product ordering process presentation is easy and customer friendly?	10.798	0.013**
Updating shopping basket interface is easy to perform?	13.595	0.004**
Overall layout is uniform on distinct pages and quickly adaptable to user?	14.677	.000***
Featured products are easy to locate on Homepage?	1.523	0.677
Pages are not overcrowded with advertisement to distract user's attentions while shopping?	1.395	0.238
Association of Gender and Navigation		
Navigational links are consistent and easy to identify?	26.712	.000***
Navigations support click and tap facilities for different customers with varying devices?	23.851	.000***
Direct product search is easy to use?	12.157	.007**
Search bar provides quick auto complete results to help in product selection?	2.895	0.408
Company logo provides direct navigation to home page?	5.88	0.118
Association of Gender and Interactivity		
Support different types of customer interactions on different devices?	2.319	0.509
Several views of product are available to provide near to natural customer product interactions?	24.617	.000***
Live and interactive product rating is helpful to customer in product selection process?	5.913	0.052*
Live customer reviews provide a better way to interact with user experiences?	15.978	0.001**
Customer feedback is easy and few step process?	9.484	0.024**
Association of Gender and Convenience		
Provide robust and secure solution to online Transactions?	8.744	0.013**
Variety of payment methods is available and easy to use?	33.072	.000***
Checkout is simple and few step process?	8.501	0.014**
Facilitate guest user/customer to shop?	7.056	0.070*
Shipping is flexible and easy to track shipment?	3.573	0.311
Association of Gender and Data placement		
Information for the individual product is visible where user expecting to be?	5.88	0.118
Shopping basket information is well-organized?	24.617	.000***
Overall contents are well-structured?	5.913	0.052*
All important customer operation links are standardized?	15.978	0.001**
Customer data retrieval is fast and easy process?	3.300	0.348

P-value *** < 0.01 Highly Associated
p-value ** < 0.05 Moderately Associated
p-value * < 0.10 Lowest Association

It is identified that the initial part of the survey in which five key characteristics of web mining based e-commerce applications are presented to users, their response showed user interface as most important characteristic and data placement as least important. In second part of the survey, questions related to each characteristic are asked that nearly confirmed the results identified in first part of the survey as shown in Fig. 5 also.

V. Conclusion

According to the findings most of the respondents agree that user interface is most significant and data placement is less important characteristic in web mining based e-commerce application. The results shows the significant role of user interface, interactivity, navigation, and convenience characteristics for the effectiveness and efficiency of the web mining based e-commerce applications. However the results shown here are compiled be conducting surveys from the people who are from Pakistani origin. This research can also be enhanced by performing it on larger group of people and on diverse type of people.

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