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Research paper

Ease of use and Usefulness Evaluation of Medical Family Tree Data Visualization

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Abstract

Ease of use and usefulness are two of the evaluation methods that are used frequently to evaluate software or visualization tools. It is used to investigate user acceptance and usually requires a model explaining people's attitudes and behavior as well as reliable and valid measurement instruments. Family trees on the other hand have many potentials to be explored for research purposes, especially medical family tree data or genogram. However, some limitations exist while using family tree or genogram, namely problems in visualizing the wealth and complexity of the information represented once a family tree gets bigger and more complex. Hence, a framework for exploring medical family tree data is proposed. This paper focus on the evaluation part that has been done in order to evaluate the ease of use and usefulness of the proposed visualization framework. The results will be helpful in understanding the potential and limitations of the proposed approach.

Keywords: *Ease of Use, Family Tree Visualization Evaluation, Medical Genogram Data, Usefulness.*

1. Introduction

Generally, visualization is the transformation of data and information into pictures. One definition of visualization is to form a mental vision, image or picture of (something not visible or present to sight or of an abstraction); to make visible to the mind or imagination. The visualization of the data allows the user to gain insight into the data and come up with new hypotheses.
This research focuses on visualization interaction and understandability factors in medical family tree data. The object of interest for this research is medical genogram (medical family tree data). The main challenge of this research is how to visualize the medical genogram in order to increase user understanding, through improvement of interaction, which leads to a better understanding of medical family tree data especially medical genogram. Hence, this research attempts to address the scalability and clustering issue by proposing a visualization technique to improve interaction and understandability.

2. Visualization Framework

The proposed framework follows the design of advanced graphical user interface guide which is the Visual Information-Seeking Mantra "Overview first, zoom and filter, then details-on demand", proposed by Shneiderman in 1996 [1]. The frequent use of the mantra is evidence in which many practitioners find it helpful in different design scenarios [2]. Figure 1 shows the overall process of the proposed visualization framework.
The first step involves process of entering the medical family tree data using medical genogram. Medical genogram is selected to represent the process because one of the advantages using medical genogram is that all data can be displayed in only one diagram. In addition, it focuses more on the display of generational relations that enable analysis of family's medical data over time.

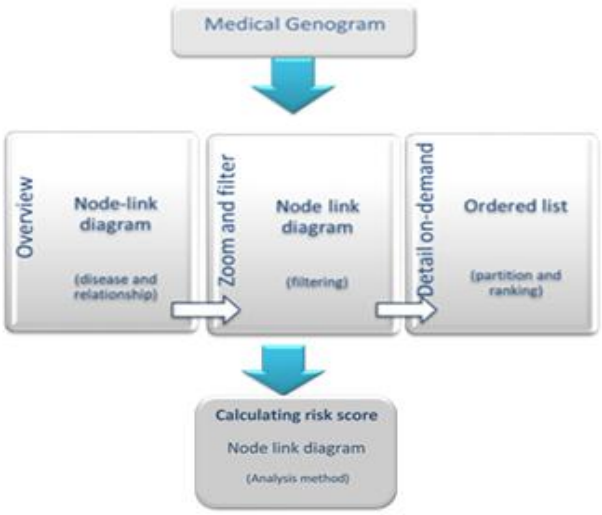

Fig. 1: The Proposed Framework Design

Next, the visualization approach is applied in, which medical genogram will be visualized using one of visualization tree techniques known as node-link diagram and this process is known as "overview". Node-link diagram makes use of links between items to depict their relationship. Therefore, the advantage is this approach focus more on relationship of every node, which cannot be described well by medical genogram.
The second technique is zooming and filtering in which both technique involve reducing the complexity of the data representation by removing extraneous information from view and allowing for

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further data organization [2]. However, this method by design typically leaves significant background space empty and therefore may encounter scalability problems when applied to larger graphs. Therefore, this visualization technique is applied.
Details-on-demand technique provides additional information on a point-by-point basis, without requiring a change of view. Therefore, ordered lists are one of principles of information visualization that enable user find outliers in the networks. Meanwhile, rankings are a popular and universal approach to structure otherwise unorganized collections of items by computing a rank for each item based on the value of one or more of its attributes [3]. Therefore, combination of attribute ranking and partition, ordered list and colour coding, allow users to systematically examine the breadth of structural measures on a network besides it helps to evaluate the performance of nodes relative to each other and prioritize it base on the ranking.
Calculating risk score functioned to compute the probability score of family history (inherited diseases) by using suitable network analysis method in order to study the correlation of node properties and network structure by using visual patterns. The statistical result then being visualized into node-link diagram and with the help of visualization technique colour and size of node that permit the visual summary of lots of information.
The visualization framework was implemented as a prototype tool known as VisualGENO which is to be used to measure its effectiveness in improving interaction and understandability of medical family tree data. The details of our proposed framework and its implementation can be found in [4], and [5].

3. Evaluation Procedure

This section provides explanation on the procedures that were carried out in evaluating the proposed visualization framework, namely the case study, designing questionnaire, selecting sample, collecting data and last but not least analysis of the collected data.

3.1. The Case Study Evaluation

Case study is one of twenty visualization evaluation patterns and it was chosen in this study to evaluate the visualization framework. This is because case study is useful for testing whether scientific theories and models actually work in the real world [6]. Therefore, it is suitable with the goal of the evaluation procedure conducted procedure to evaluate the effectiveness of the visualization framework (prototype tool).
The first foundation of the case study is the subject and relevance. Case study using a small set of participants yields realistic and believable narratives for real users interacting with the visualization tool without requiring massive time [7]. Therefore, ten respondents participated in this case study and they have a profile similar to the target users. Data collection procedure was conducted at three different locations in Penang.
Firstly, respondents were briefly explained on the research objectives so that respondents would have idea on what they would go through during the experiment. Then, respondents are asked to explore the prototype tool using provided and little guidance from the researcher. Once, the respondents have completed the exploration task, they are required to answer the assessment question on the tool themselves to evaluate on the effectiveness of the tools in helping the respondent to get the correct answer in a shorter time. With a case study, it is important for the researcher to be passive and each case must be treated individually and then cross case conclusions can be drawn [5].
Then two methods are applied in order to evaluate the effectiveness of this framework, which are questionnaires [8] and Open-ended Strategies [9]. An analysis of the data was conducted based on the user's answers regarding the usefulness and ease of use of the VisualGENO to address the study and it was necessary to make sure that all collected data is relevant.

3.2. Sample Selection

Ten respondents participated in this case study. No classification was made on the randomly picked respondents as this group of respondents made no assumption on the users' experience level. All users are treated as beginners regardless the users' background knowledge on family tree and genogram.
There are two groups of respondents in which the first group is the expert group such as healthcare providers, which is believed to have potential users for this system. The second group is consisting end users i.e., individuals or patient.
Each subject is approached by setting a schedule for individual appointment. All respondents are given the description of this study and the tool involved before answering the questionnaire based on the tool.

3.3. Questionnaire Design

The structure of the questionnaire is based on the model of usefulness, ease of use and self-predicted future usage, which are based on research on self-efficiency theory, research on the cost-benefit paradigm from behavioral decision theory, and research on the adoption of innovations (Figure. 2). There are three variables in this model: perceived usefulness, perceived ease of use, and self-predicted future usage [8] as defined previously. However, this questionnaire only adopts two variables: perceived useful-ness and perceived ease of use, which are aligned to the research objectives as evaluation was carried out to determine the usefulness, and the ease of use of VisualGENO.
The questionnaire is divided into three sections. Section 1 is for demographic section which is used to gather respondent information (age and job). Section 2 contains assessment questions that respondent have to answer based on their experience using VisualGENO. The last section which is section 3 contain questions to evaluate the proposed framework based on two variables that have been selected which are perceived usefulness and perceived ease of use. This questionnaire is for both groups of respondents who interacted with VisualGENO.

4. Usefulness and Ease of use of VisualGENO

In this case study, users have to answer all usefulness and ease of use questions and based on their views VisualGENO. The questions on the usefulness and ease of use are based on research on self-efficiency theory, research on the cost-benefit paradigm from behavioral decision theory, and research on the adoption of innovations.
Perceived usefulness is "the degree to which a person believes that using a particular system would enhance his or her job performance." This follows from the definition of the word useful: "capable of being used advantageously." Hence, a tool high in perceived usefulness is one for which a user believes in the existence of a positive use-performance relationship.
Perceived ease of use, refers to "the degree to which a person believes that using a particular system would be free of effort." This follows from the definition of "ease": "freedom from difficulty or great effort". A tool that is easy to use is more likely to be accepted by users.
To measure the concepts of usefulness and ease of use, no objective measures are available. Hence, a Likert or "summative" scale [10] is applied as it gives a global view of subjective assessment. One may also use the term "linear composite" to designate such a scale. In brief, Likert scaling may be described in the following manner:
A set of items, e.g. questions of a questionnaire, consisting of a set of statements is given to subjects. They are asked to respond to each statement in terms of their own degree of agreement or disagreement. All questions derived will reflect the objective of this

study. Each question is a statement rating on a five-point scale from "Strongly Disagree" to "Strongly Agree".
A score is assigned to each response and the scores belonging to a particular concept are combined so that subjects with the most favorable attitude will have the highest concept score while subjects with the least favorable attitudes will have the lowest concept score. Table 1 presents the scale items that were considered for the usefulness and ease of use concept.

5. Analysis & Findings

This section comprises results obtained from the case study. All participants answered the entire question based on their experiences in interacting with the prototype tool, which was used in the case study. This section also provides a detailed explanation on the result and discussion of the questionnaires on the usefulness and ease of use of the visualization framework.

5.1 Evaluating the Usefulness

A score that is close to the value 5 contributes to a better result. All participants have to respond to all usefulness questions. Comparison between the score mean is depicted in Figure 3.
According to the bar chart all participant found that VisualGENO is very useful in helping to predict the risk score since all items recorded the highest mean score, which is between 4 to 5.
Furthermore, all of them affirmed that VisualGENO makes their job clearly easier (U5) (mean of 5). VisualGENO allows a subject to view all the data clearly without having to remember the specific rule in depicting information so that they understand the medical family tree better.
VisualGENO makes this information available by applying visualization techniques such as zoom and filtering which only displaying the required information, and avoid unnecessary information to increase the effectiveness of the tool (mean of 4.9). The reduction of searching effort and the easy point- and click-facilities reflected in the fact that our subjects affirmed VisualGENO makes their work more comfortable and is very useful (mean of 4.8) for facilitating their work. By reducing time taken in completing task, it allows them to perform their job more quickly (mean of 4.8) and resulting in increasing job performance (mean of 4.8).
The results of the productivity items reveal that one respondent is of the opinion that VisualGENO only slightly increases productivity. The possible explanations why the subjects scored lower than the other ones because when the task is complex, they get confuse when they have to combine more than one visualization technique in order to completing the task. Comparison between score mean of usefulness for expert group and end user group is illustrated in Figure 4.
According to the mean score in the bar chart there is not much different between the two groups. Therefore, it can be concluded that both group agreed that this prototype tool is useful in improving their understandability on medical family tree data by providing an interactive visualization tool. Each group has their own interpretation of usefulness. As for expert group this prototype tool may be benefit them in term of increasing their job performance by facilitate (make job easier) and accelerate (quickly) their daily task.
Meanwhile for end user group this prototype tool is effective in term of make their job easier since this prototype tool provided medical family history and by knowing their family hereditary diseases it benefits them to take preventive steps from it. Figure 4 illustrate the mean score of usefulness for expert and end user group. All metric recorded average score of 4 and above for both group.

5.2 Evaluating the Ease of Use

All participants responded to all the usefulness questions. The score mean of ease of use is depicted in Figure 5.
E2, E4, E5, E6 (clear and understandable, skilful, remember and easy to use) show higher scores mean for ease of use factor. Respondents claimed that VisulizeGENO is easy to use since there is no complex step required in completing the tasks. Furthermore, they confirmed that by using VisulizGENO, it is easy to become skilful since this prototype tool is clear and understandable as all of them managed to answer all the questions correctly. The questions that has been created to measure this metric require respondents to use all visualization techniques applied in this prototype tool while completing the tasks in order to describe the functional purpose of each visualization technique.
E1 (easy to learn) recorded low score mean (4.1) since few respondents claimed they have problem to remember the function of each visualization technique in helping them to complete their tasks.
Furthermore, as a first time user learning new thing in shorter time is impossible. From the issue, it does affect respondent learning process but this issue was resolved when they use the provided manual and with some guidance from the researcher. Figure 6 shows comparison between score mean of ease of use for expert group and end user group.
The results show that all metric recorded high average score of four and above for both group. So, this proves that both group agreed that this visualization prototype tool is ease to use as the result show that not much different of score mean between two group. Expert group claimed that this prototype tool is clear and understandable and easy to remember as both metric got the highest score of 5. This is due to no complex step required to interact with the protype tool. End user claimed that is easy to become skilful but it requires some time to learn and familiarize with the new thing.

6. Discussion

The findings of this study on usefulness show that this framework is effective in helping users to improve their comprehensive in understanding genogram and aid in predicting risks score. There were small differences between participants in terms of speed, and because of the small number of participants, the results are not statistically significant.
There were small differences in the time taken to complete the assessment. As the size of the trees grows, visualization appeared to play a much more important role in helping the users to visualize and locate the information needed easily.
All participants were able to answer the assessment question appropriately. The results were sufficient to show that the proposed framework have somehow helped the users in understanding the medical family tree better. For the more difficult exercises, it was expected that some participants would take some time to complete the exercise, as it requires extra time for first time user to adapt with the new things.
Additional evaluation that is using concept of open-ended question namely open-ended strategies successfully proved that the visualization approaches used in the proposed framework is effective in term of improving user interaction and understandability medical tree data.
All participants agreed that without this proposed framework they might counter a problem to interpret the genogram. Furthermore, this proposed framework can pre-sent the big data in a fully interactive environment conducive to exploration data with use of social network analysis approach in calculating health risk score which also allows users to gain insight about their medical tree data.

7. Conclusions

In this paper, an evaluation has been conducted to measure the ease of use and the usefulness of the proposed visualization approach. Based on the result obtained from the evaluation process, VisualGENO, which employ the proposed visualization technique, is proven to be a better medical family tree visualization tool in term of usefulness and ease of use to help user understand the medical family tree better and aid in predicting health risk score. In conclusion, the visualization techniques applied in the VisualGENO are useful visualization techniques to improve comprehension on medical family tree and aid in predicting risk score.

There are a few possible threats to this study. The first threat is on sample size. Due to time constraint, the sample size is small since only a doctor, two nurses and five students were involved in this study. However, this study is not about comparing the result statistically, it is about to gaining users/respondents opinion on the effectiveness off the tool after using it. Furthermore, as mentioned earlier, each subject is approached by setting a schedule for appointment through individually so that it can minimize nonresponse bias.

Another potential threat to this study is on user's experience in the level of efficiency using a computer and medical family tree data (genogram). The result of this study could be influenced by the subjects' experience with both issues. This threat is eliminated by making an assumption on user's experience level. Users are treated as a beginner regardless of the users' background knowledge. Therefore, by giving brief explanation on the research, that is by giving simple introduction and manual on how to operate the tools helps the user's to interact with the tool. Users would appreciate more the help and guidance made available to them when using the new tool.

Overall, the evaluation suggests that the proposed framework and visualization techniques will help the users such as healthcare provider and end user to easily understand and interpret their data. Although the techniques have been developed specifically for medical family tree data, many of these techniques could also be applied to other domains that use similar tree structures.

Acknowledgement

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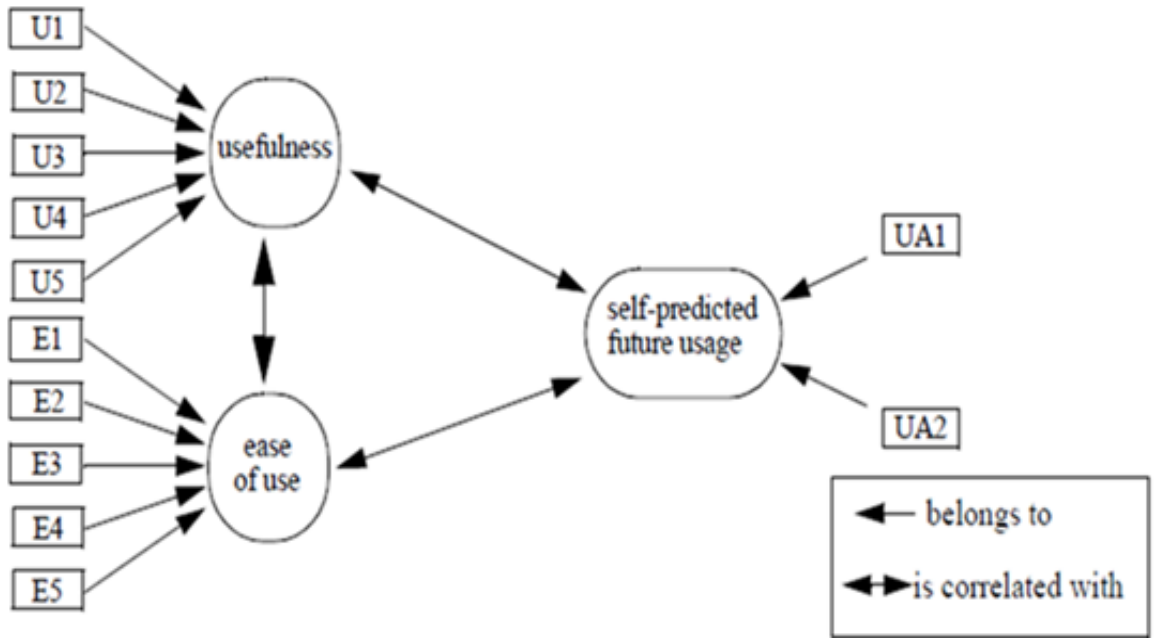


Fig.2: Model of Usefulness, Ease of Use, and Self-Predicted Future Usage

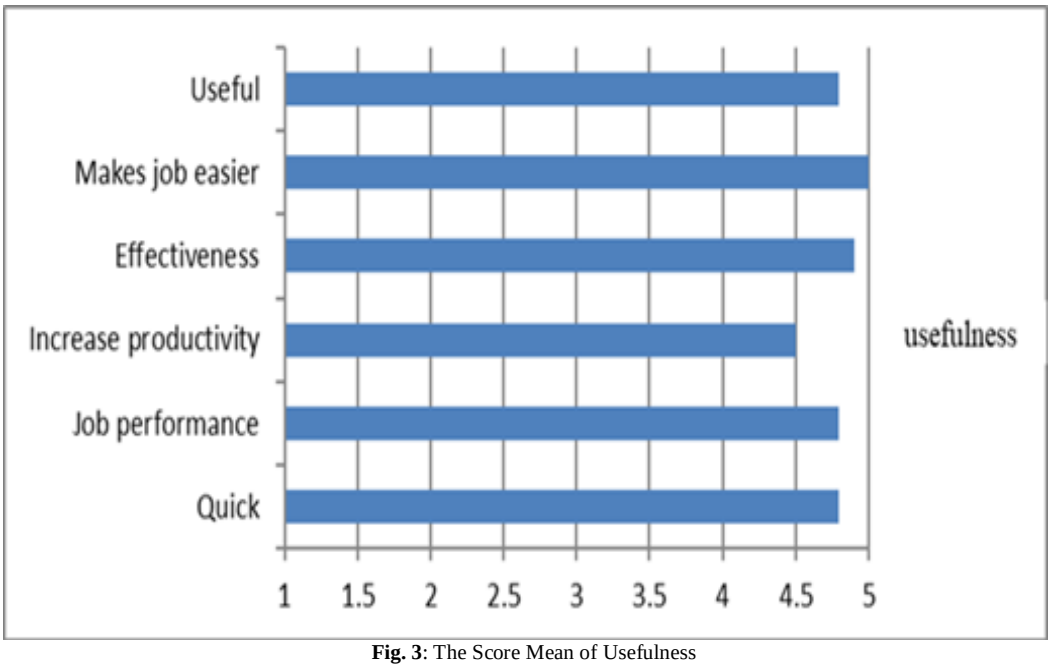
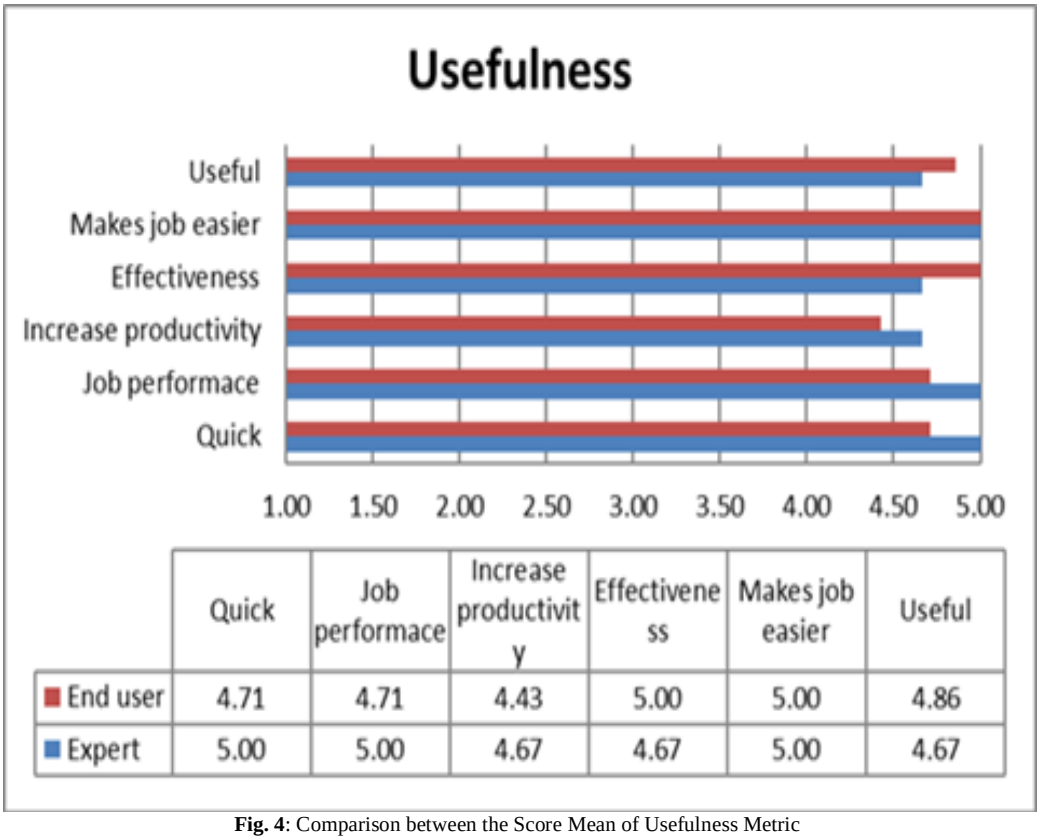


Fig. 3: The Score Mean of Usefulness



	Quick	Job performace	Increase productivity	Effectiveness	Makes job easier	Useful
End user	4.71	4.71	4.43	5.00	5.00	4.86
Expert	5.00	5.00	4.67	4.67	5.00	4.67

Fig. 4: Comparison between the Score Mean of Usefulness Metric

Table 1: Scale items of the usefulness and the ease of use concept

Usefulness
U1 Using VisualGENO in my job would enable me to accomplish tasks more quickly (Quick). U2 Using VisualGENO would improve my job performance (Job performance). U3 Using VisualGENO in my job would increase my productivity (Increase productivity). U4 Using VisualGENO would enhance my effectiveness on the job (Effectiveness). U5 Using VisualGENO would make it easier to do my job (Makes job easier). U6 I would find VisualGENO useful in my job (Useful).
Ease of Use
E1 Learning to operate VisualGENO would be easy for me (Easy to learn) E2 I would find it easy to get VisualGENO to do what I want it to do (Clear and understandable). E3 My interaction with VisualGENO would be clear and understandable (Controllable). E4 It was easy to become skilful using VisualGENO (Skilful). E5 It is easy to remember how to perform tasks using VisualGENO (Remember). E6 I would find VisualGENO easy to use (Easy to use).

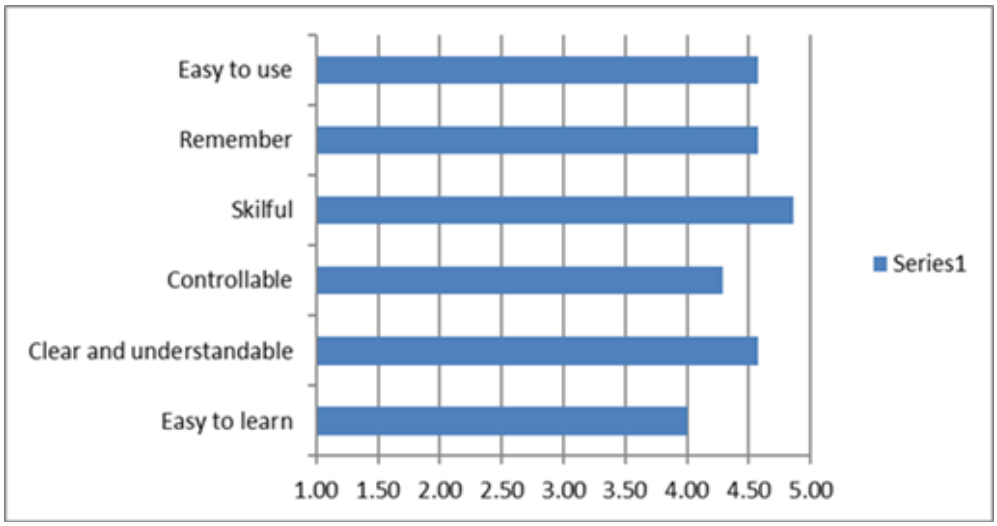
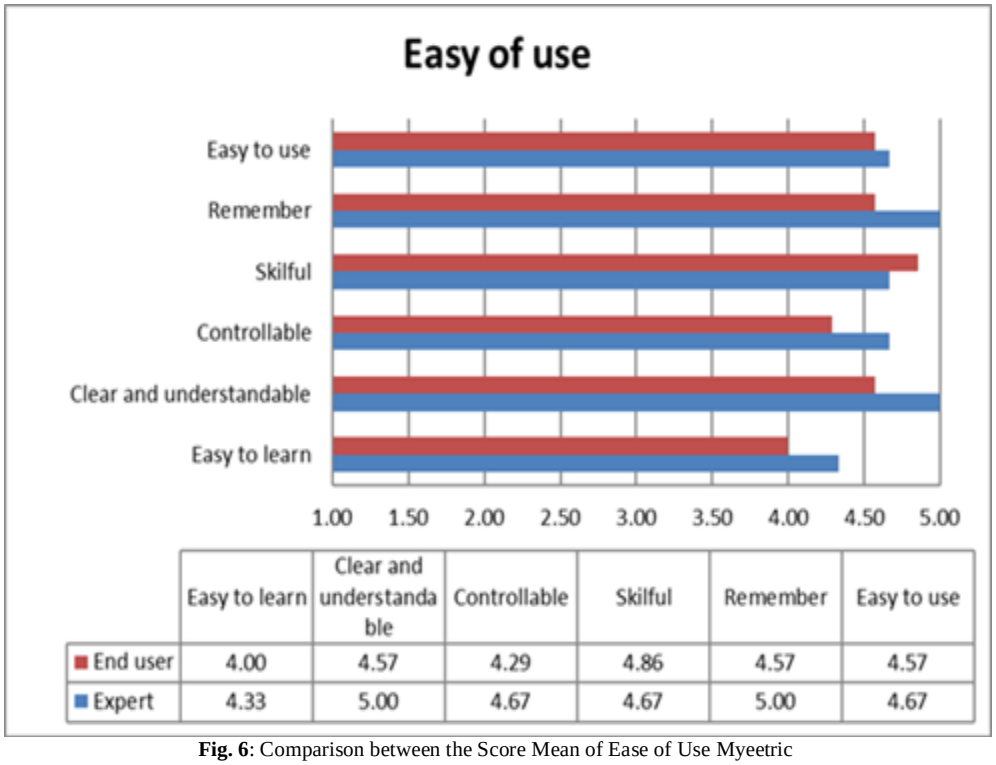


Fig. 5: The score mean of ease of use



	Easy to learn	Clear and understandable	Controllable	Skilful	Remember	Easy to use
End user	4.00	4.57	4.29	4.86	4.57	4.57
Expert	4.33	5.00	4.67	4.67	5.00	4.67

Fig. 6: Comparison between the Score Mean of Ease of Use Myeetric