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A REVIEW OF 'HUMAN-COMPUTER INTERACTION' INFLUENCE TO HOME NETWORK: A REVIEW OF HCI INFLUENCE TO HN

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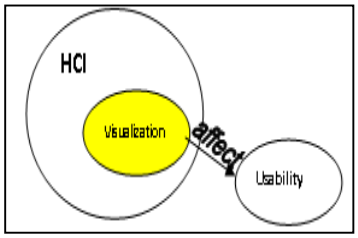
Graphical abstract



Abstract

There has been a number of researches carried out on Human-Computer Interaction (HCI) impact to home networking. Many researchers have stated that the HCI elements are the most important aspects to be considered in making user understand some of issues concerning the Home Network. This paper reviews the existing research related to Human-Computer Interaction, Home Network and Network Management. This paper seeks to identify the effectiveness of existing Network Management Tools and the importance of HCI in dealing with it. In addition, this paper looks into the potential future work that could be done in order to archive desirable goals of Home Network.

Keywords: Home network, network management, human-computer interaction, visualization

1.0 INTRODUCTION

Since the advent of the Internet, computer network are growing exponentially [43]. Computer network is no longer exclusively for experts as it has also become the basic needs for every member of society. This development proves that computer networks are vital to life and their uses are increasing every day.

Computer network, commonly referred as a network, is a collection of hardware components and computers interconnected by communication channels that enable the sharing of resources and information [8], [9], [25]. Networks are widely used in various activities including home computing [4], [9], [17], [18], [25], [42]. Network, regardless of where it is implemented, must depend on management to gain stability, accountability and security [9], [12], [25]. There has been a considerable emphasis placed on conducting and managing business and office networks compared to Home Networks. The fact is that the Home Network is also important because of the critical activities performed by Home Network users.

The display of data networks is purely statistical and line oriented [11]. It can be understood by Network Manager but not to ordinary user. This present situation needs improvement as the need for assess is shared by anyone with a computer connected to the Internet [20]. Thus, important features including Human-Computer Interaction (HCI) elements should be included into the Network Management application to suit human characteristics. With informative and powerful visualization techniques, existing data can be better understood by all users of the network.

'Home Area Network' or 'Home Network' describe as a residential Local Area Network (LAN) that serves as a platform of communication between digital devices [17]. The important function of Home Network is to provide access to the internet via broadband services such as Digital Subscriber Lines (DSL) or mobile broadband services supplied by Internet Service Providers (ISP). Recently, Home Network's have become popular and expanding [4]. On this basis, managing network appears to be significantly important to the Home Network. The knowledge of Network Management should be

mastered by Home Network users to ensure that the Home Network operates in a good, stable and secure environment.

1.1 The Importance of HCI to Network

Network has been a major focus of empirical studies related to HCI. Including studies on understanding of how network technologies can be applied to everyday life [18], [25], [41]. These studies focus on network infrastructure and the work involved in developing and maintaining the network [18], making the work of Network Monitoring become routine [41] and the extent of understanding to the use of Home Network [36].

Visualization is the key element that allows a system and applications to be well-understood by users. Visualization is a tool that able to provide a holistic understanding to perception, and also experimental evidence of scenarios that take place in a network. It is also present the accurate and detailed picture of the process [29]. Although it is highly dynamic, visualization techniques have the ability to describe what goes on. Dynamic network visualization could delegate from time to time and able to provide graphical visualization of the network, give users the opportunity to interpret and store and manipulate graphic elements that appears. Visualization is also able to put pressure on the observer perception. The changes in layout and visual are important to focus on their mental model for the appreciation of more important elements [37].

1.2 Usability of Network Management Tool

Usability involves the measurement of performance and behavior of users to work on the application including matters pertaining to the ease of use, time usage, user experience and perception of Network Monitoring Tools [28]. In addition, visual observations of user may provide additional information on usability testing [24]. Research has also shown that the sense of sight is very focused on what is being displayed [24]. In the area of Usability Engineering, research focuses on the eye tracking software that could help designers to evaluate the usability of the screen layout [24]. The results of an eye tracking test in the evaluation of software usability can provide additional knowledge to the needs of the software usability [22].

The ability of Network Managers to assess the effectiveness of the network infrastructure is enhanced by statistical visualization representation related to the use of network and which directly relates to network information [13]. The availability and capability of Network Monitoring Tool's to generate data, and make informative decisions, have increased. However, the ability to access and analyze information in making decisions is not yet clears [39]. Therefore, there is a need for research to enhance, facilitate and support the data visualization and decision-making related to network monitoring.

Since everybody are using network nowadays, everybody have the ability to monitor network. Whoever has a host that connects to the network must able to monitor network activities themselves. Unfortunately, this does not happen and typically, users let their host free without control. This leads to the following questions that need to be addressed - What is the impact of this situation? Do users simply refuse to do the monitoring activities on their network? Are they unaware of the existence of Network Monitoring Tools? Or are the Monitoring Tools not user-friendly that cause them to ignore these critical activities?

Responding to this issue is my hypothesis that the Human Computer Interaction, through certain techniques, able to build a better understanding to the Home Network and possible in allowing user to utilize network.

The effectiveness of home networking depends upon its level of usability. It entirely depends on how much it is used and understood by user. An optimum home networking requires a full user understanding and efficient network management in terms of performance and security. All of this could not be achieved if the Home Network is still used with very minimal knowledge. This situation has arisen due to some problems with the network itself. As such, the objectives of this study are:

i. To review the problems of the Home Network,
ii. To explore the relationship between HCI and Home

Network Management to improve Home Network usability.

2.0 METHODOLOGY

This study employed content analysis technique. Content analysis is a technique used to gather and analyze data that is obtained from texts [2]. It is a series of activities of analyzing and summarizing scientific data that has been produced by previous research [26]. The 'data' refers to any forms of spoken or written production, visual images or pictures, words, symbols, meanings, ideas, diagrams, or any message that can be analyzed [3].

In this study, the data was gathered, reviewed and later analyzed from the selected papers. It commenced with a review on research carried out on home networking. The focus was to identify the methods and techniques used, the future of home networking, the problem regarding its usage, and whether HCI elements including usability and visualization are the important factors in ensuring that the home networking achieves its objectives. From that, the theory was elaborated, assumed and reviewed and as a result, this study was able to highlight recommendations for future work.

3.0 DISCUSSION

The discussion of this initial study is divided into four sub-topics including Network Management, Home Network Management, Human-Computer Interaction, and the relationship between HCI and Home Network. Based of the previous studies, some important criteria could be integrated into the problem-solving process. Hence, a conceptual model illustrating the means of achieving effectiveness of Home Network is proposed and outlined at the end of this paper.

3.1 Network Management

Network Management refers to methods, activities, and procedures related to the operation, administration, maintenance and provision of network system [14], [15], [17], [25]. It is important to ensure that networks are always in good condition, efficient and credible. Network Management Tool is a tool that used to manage the activity in a network including security, performance, and reliability matters [15].

Generally, there are three types of Network Management Tools including diagnostics equipment, monitoring tools and performance tools [14]. It could be used to understand the problem and overhead of the network [4]. It is also classified as a tool to set up and maintain network [17], [25] and used to deal with network connectivity, security, access authentication, monitoring and troubleshooting [42]. Network Management Tool is also a platform that could help users to overcome every problem that might occur in network [9], including diagnostics equipment, monitoring and performance tools [4], [9], [14], [17], [25], [42].

3.2 Home Network Management

Home networking needs supports from network solution [17] and has slightly different management activities from office and business networks including connectivity configuration, security and access control, network monitoring and troubleshooting [4], [9], [35], [42].

Many studies focused on getting information of householders in terms of their knowledge, experience and practice in daily home networking [25]. There are research discussed the reasons and styles of home network usage [4]. Some focus on the ethnographic study looking at the use and management of Home Networks and the reasons behind it [9] while some others look thoroughly into the Network Management Tools that were currently being used at home, and the usability problems of it.

The data gathering techniques used by most of the above studies are observation, interviews and questionnaire carried out in US, UK and Europe [4], [9], [17], [25], [35], [42].

The ability of network managers to assess the effectiveness of the Home Network Management tools classify into four types including operating system (OS) tools, network hardware tools, vendor utility tools, and freeware tools [42]. The study shows that most home users just deal with the internet services and do not directly care about Network Management Tools.

As a conclusion, Home Network Management problems are including technical problem, human disabilities and tools misunderstanding [4], [7], [9], [17], [35], [36], [42].

3.3 Human-Computer Interaction

Human-Computer Interaction (HCI) is the interdisciplinary field that focuses on the interaction between humans and computer systems, user interface and underlying processes that produce these interactions [32]. Lately, HCI elements in network applications have become vitally important in daily life [38].

The fields of HCI are including psychology, ergonomics and human factors, engineering, design, semiotics and branding, ethnography, sociology, language, and computer science [32]. In terms of this research, design is highlighted as the important aspects to be reviewed more. Design is the disciplines of appearance, usability, reasoning and trustworthy. It's all about how something is visualized making it usable, interesting and reliable [44]. Successful design is the matter of whether the appearance are in good form, functioning, interesting and reliable or else it will look ugly, rubbish, boring and useless. HCI is one of the emerging areas of researches nowadays. It is being done in various fields and recognized as important aspects to be considered [35]. The focus of research in HCI is including the interaction in-between human and computer, and communication and cooperation between humans [45]. Refer Figure 1 to see the relationship of HCI, Design and Visualization in ensuring better interaction in-between user and system.

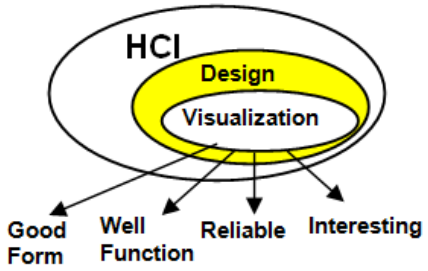


Figure 1 Relationship of HCI, design and visualization

1) Visualization

Basically, visualization refers to the use of visual or graphical technique for presenting information [34]. In computing, there is usually a wide connotation

amount of information in a compact spread through visual dimensional appearance.

The emergence of network technology has produced large and complex network models which might lead to confusion. Thus, visualization can be a powerful tool to understand the activities of a network [33]. Good visualization reveals the hidden structure of the network and strengthens human understanding, leading to new insights, new discoveries and possible prediction for the future [33]. However, the ability to improve and present a complex network structure visually becomes a challenge as the existing appearance only focuses on the network graph data and information line [19]. Visualization and usability relationship can be summed up as shown in Figure 2.

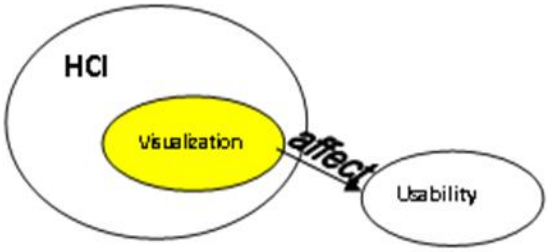


Figure 2 Relationship between visualization and usability

2) Usability

Usability refers to the quality of educational facilities of a related system, ease of use and user satisfaction [30]. ISO 9241 defines usability as the effectiveness, efficiency and satisfaction of specified user to achieve specified goals in particular environments [1].

Usability is very important in ensuring the application meet its own objectives. In other words, high usability quotient applications allow users to use the application and make able to understand what each of the applications represents. Users can spend more time than expected to see a particular screen, without making the appropriate selection to achieve the task [24]. They should also provide with the appropriate button appearance, adequate application components and non-intrusive interface environment in order to enhance usability [24].

A good interface should have the essential characteristics of usability involves factors that could lead user to the optimal usage [46]. It is important for the system to have the ease of learning ability, able to increase user productivity, have the interface that easy to remember, minimize user error and increase user satisfaction.

3.4 Relations between HCI and Home Network

Effectiveness of home networking depends upon its level of usability [4], [9], [17], [25], [35], [42]. It depends fully on how much it is used and understood by user. The level of understanding is caused by one of two factors which are either;

i. The technical ability of home network users
ii. The design of utility and application of home network.

An optimum home networking requires a full user understanding, and efficient network management in terms of performance and security. This is required to optimize the usage of home networking. In that regards, this survey reviews the previous studies related to the aspect of technical knowledge, usability and visualization in enhancing Home Network usage.

1) Technical Knowledge affects Usability:

The paper 'Broken Expectation in Digital Home' by Bly discusses 'broken expectation' as the main Home Network problem [4]. The problem is that users already have an expectation of what they could do when using a Home Network. As a result, when users have to face non-expected problems from the Home Network, they are generally unable to resolve technical problems on the network hardware and software. These problems may affect the users physically or emotionally. They would end up just letting the problems resume continuously. Bly suggests a study to be undertaken in order to understand how the expectations are formed and how to fulfill them. Based on the approach, a Home Network that is closer to the user expectation can be displayed, which in turn leads to full utilization of Home Networks [4].

Technical knowledge is very important in determining the applicability of home networking [7], [25], [41], [4]. Home Network reflect to user in an ambiguous and uncertain view [25]. It looks like Home Network implementation is quite technical oriented. Users are not clear about the actual ability of Home Networks and are sometimes frustrated by trivial problems. This strays from the objectives of home networking and as a result, the Home Network usage is very basic and minimal. Solutions of more interactive Home Network Management tools are required and should within consumers reach [25].

2) Design affects Usability:

Developments in social networking and home networking technologies increase the importance of Home Network's. Those developments make home networking evolve in a dramatic scale day by day. Issues arise when users cannot cope with Home Network problems and those problems associated with the usability of the Network Management Tools. It is like that networking technologies including network hardware, network software and network management are not designed to fit in home usage [18]. The design seems to be very complex and suits more to professionals rather than normal home users.

Thus, there is a need for a technical study to understand the Home Network requirements for an appropriate design.

Design is a very important aspect in catalyzing the usage of Home Network [9]. A good design is capable for supporting users in managing the Home Network. Design usability problems may lead to negative perception of users towards home networking. Therefore, Network Management is not merely technical and technological issues; it is actually part of the sociological aspects of everyday life. Users that use and manage their Home Network in a proper way will get the full benefit and support for their daily activities. A review of a good design that will provide a better understanding in using Network Management Tools is needed [9]. Design for software or hardware bears a close relation and affects usability [5], [6], [9], [18].

3) Usability Affects Efficiency:

Usability refers to the quality of understanding of a related system or application, level of ease of use and user satisfaction of usage [30]. ISO 9241 defines usability as the effectiveness, efficiency and satisfaction of specified users to achieve specified goals in particular environments [1]. The design choices in Network Management Tool's for home have led to poor usability [25]. Nowadays, Home Network is an essential part of people's daily life [42]. Home Network is now including the entire contents of the households where there are many common necessities that require frequent and regular use. This highlights the importance of the Home Network and Network Management to support the routine urban lifestyle. Users need to know all aspects of Network Management, including hardware and software configuration, 'network and internet' connection and management.

There are four major usability problems of Home Network Management Tools which are: the difficulty in understanding and using the tools, the inconsistency of Home Network Management Tools user interface, the lack of graphics and visual map, and the difficulty in understanding the manual and instruction tools. It is clear that usability is important in enabling the optimum usage of Home Network [10], [40]. Users have the desire to manage their own network themselves and these urges investigation towards user friendly Network Management Tools for home users.

In conclusion, Home Network management tools should have the basic features that allow a good level of usability. It must designed to help the network, help user manage their network independently, and able to help communities to help users [35]. Refer to Figure 3 to see the characteristics of Home Network features that meets the usability requirements.

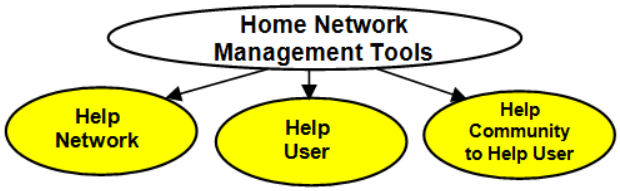


Figure 3 Home network tool features

4) Home Network Efficiency:

Technical ability, design and usability are among the important factors that affect Home Network usage [4], [9], [17], [25], [42]. Technical knowledge is an important aspect that increases usability [25]. Nonetheless, the users are still able to use Home Network in an efficient way with the help of interactive design. These two factors could increase usability and at the end ensures the effectiveness of Home Network usage. The suggested conceptual model of the effectiveness of Home Network usage is simplified and shown in Figure 4.

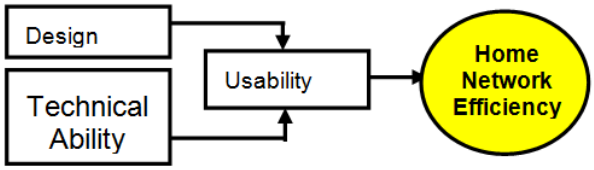


Figure 4 The relations of home network efficiency

4.0 CONCLUSION

Human-Computer Interaction elements of the Home Networks Management Tool have become the focus of this study. From the review above, many researchers have undertaken empirical studies to analyze the patterns of the problems in dealing with technology, hardware and application being used in home networks. The study is conducted to obtain information on whether the Home Network is well managed and fully utilized by user. The usage of Home Network is seen to be domestic routine [17], and understanding the Network Management Tool [27] in dealing with network is deemed to be very important. Surveys focus on network infrastructure and the work involved in setting up, maintaining and administering a Home Network. It seems that, the intermediate elements between the user and the network create problems [9]. Consequently, the interface elements that connect the user and the network should be put into consideration. It is indicative of how it is important for Home Network users to know and understand how to administer and manage a Home Network. This could only be achieved with a higher usability of Network Management Tools.

For HCI specifically, usability serves a perfect answer to overcome problems associated with home networking [35]. Some of the design of existing home

networking creates a gap to the user. It indicates that the gap affects the usability of home network user. Usability is an important aspect to ensure each application meets their objectives. In other words, applications with a high usability level allow users to use and understand the application optimally. Without these, users sometimes spend more time than they should to view a particular screen, without making the appropriate selection to achieve the task [24]. This could drive users to the wrong direction and could affect the efficiency and security aspects of the Home Network.

It is well understood that a good application should provide users with the appropriate button appearances, and understandable views [24]. In HCI, visualization is one of the most important techniques that could be done to achieve usability [35]. Visualization refers to the use of visual or graphical technique in presenting information. In computing, there are usually wide connotations of information that must be simplified to be displayed in a compact area. This could only be done with the right visualization technique in order to cover all of the information.

As per conclusion, there are problems in the use of the Home Network [4], [9], [17], [25], [42]. It shows that, although home networking has spread widely in present day households, it is used in a very limited way and not fully utilized. This condition is attributable to the three major disabilities which are user technical abilities, usability of the Home Network infrastructure and the visualization aspects of the Network Management Tool. This opens to options for future research related to the aspects of HCI and visualization, seeing that usability seems to be able to optimize the use of the home network.

There are significant challenges in obtaining information related to the requirements and needs of the user as far as Home Network application's is concerned. This is due to default appearance to the practice for Network Monitoring Tools. Studies on usability of home networking also indicate that same study need to be done in the local setting [4], [9], [17], [25], [42]. In conclusion, there is a need to conduct a randomized study on a local area to get a better picture of the Home Network usage patterns.

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