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A Review of Usability and Security Evaluation Model of E-commerce Website

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Abstract

Electronic commerce (E-commerce) websites have grown significantly over the years. However, due to security and usability issues, only 29% of users convert their online search into a purchase. The aim of this study is to provide an overview of the strengths and weaknesses of the existing evaluation models in the aspect of usability and security dimensions for an e-commerce website. This study reviewed the evaluation models that have been applied to E-commerce from the year 2000 to 2018. The study reviewed 11 models and listed the usability and security elements evaluated by each model. The strength and weakness of each model was highlighted. This study found that there is a lack of one comprehensive model that is able to measure all the usability components together with the security components. There is a need to design an evaluation model that will be able to evaluate usability and security together for e-commerce website in order to improvise the e-commerce website.

Keywords: E-commerce; usability; security

1. Introduction

The advancement of technology in the 21st century have given rise to the usage of the Internet for commercial purposes [1]. Many industries are utilizing the Internet as a retail channel, which has made electronic commerce (E-commerce) evolve.

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E-commerce can be defined as usage of computer networks and the Internet to conduct process such as purchasing, selling, transfer and exchange of services, product and information [2]. Since 1994 E-commerce has grown rapidly. It has been forecast that by the year 2050, all commerce will be e-commerce [3]. There are many works had been conducted in relation to usability and usable security which indicates the needs of further evaluation within this domain [4, 5, 6, 7, 8, 9, 10, 11].

The main principle of E-commerce design is usability [12]. Usability measures how easy is it to use an interface. Nielsen listed five quality elements which are "satisfaction, efficiency, memorability, learnability, and error [4]. Usability is the degree that an item or service can be utilized with satisfaction, efficiency and, effectiveness to accomplish a particular goal by a specific user in a specific context of use [13]. In another light, usability is mentioned as a number of individual quality components such as satisfaction, memorability, and efficiency, all or some measured together [14].

This paper is organized as follows. Section 2 explores the related works on human-computer interaction and usability and security of e-commerce websites. Section 3 of this study provides an outline of the usability and security evaluation models that have been employed. These usability aspects captured by these models were analysed and section 4 describes the strengths and weaknesses of each model. Section 5 provides useful discussion and finally ending with a conclusion in Section 6.

2. Usability and security of e-commerce

2.1. Human-Computer Interactions (HCI)

states that although the trend of online shopping has shown immense growth, there is still a low number of online purchases conducted when compared to the expected number [15]. E-commerce's first law mentions that a user will not buy a product that they cannot find [4]. To increase the rate of conversion of visitors to become a buyer, the usability of an e-commerce site must be addressed [5]. Only websites that are well structured and websites that make the process of information finding easy for the consumer can attract consumers to use them [16]. Perceived usability is directly proportional to trust generated towards e-commerce websites [17].

In addition to usability, security and privacy are also one of the paramount factors that ensure the success of e-commerce [18]. E-Commerce security is the principles that guide harmless electronic transactions, allowing the buying and selling process through the Internet with protocols established to provide safety not only for the consumer but also the service provider. E-commerce security includes multiple dimensions such as safety, integrity, repudiation, authenticity, confidentiality, privacy, and availability [19]. A successful e-commerce website largely pivots on the customer's trust that there exist is strong security over the website. Consumers show an unwillingness to transact online predominantly due to the existence of security and privacy concerns [20].

2.2. Usable security

Usable security can be defined as improvising a system's security while taking into considerations on how consumers interact with the system. Usability and security come hand in hand, and both are interrelated to one another. Measuring usability also measures security as both are not mutually exclusive. A system with high-security results in a usable system [21].

Both usability and security are a multidimensional concept which makes evaluating usability and security a very challenging task [22]. Website usability and security can be determined using diverse interconnected factors at individual and organizational levels [23]. Merging different aspects such as website security, website quality, satisfaction, and learnability in one framework results in a model. Several prior evaluation studies had made an attempt to evaluate the usability and security of e-commerce using models [24].

3. Usability and security evaluation model of E-commerce

In earlier days, the success of the information system (IS) was measured using a model developed by Delone and McLean (1992) [25]. The model was revamped in 2003 and the application of the model was extended for e-commerce websites [26]. The new extended model can be utilized to assess the effect of e-commerce not only for an individual user but also for group users, organization and for a whole industry. The revised model measures six features of quality.

A vast number of researches in the past evaluates the usability and security of E-commerce websites by applying the "Technology Acceptance Model" (TAM). TAM is chosen as a research model for the adoption of E-commerce due to its vast capability to display the gap that exists between behavioural intention and the real behaviours of consumer [25]. TAM measures how user-friendly an interface is and how useful an interface is. These two determinants are very significant in investigating behaviour related to computer acceptance.

Several satisfaction models have been created to prove that usability and security is directly proportional to satisfaction. Szymanski and Hise [27] proposed a model which is the E-satisfaction model, to study satisfaction among e-commerce website users. This model measures the effects of product information, convenience, financial security, product offerings, and site design to satisfaction. By employing the regression method, the study found that convenience and financial security affect the level of satisfaction of users the most, followed by the three other elements that exist in the model.

Similarly, McKnight et al. [28] proposed a web-customer satisfaction model. Four high-level constructs are highly related to trust are measured by this model. These four constructs are then further categorized into 16 measurable sub-constructs. Results found that web experience, personal innovativeness, and website quality strongly affect the consumer's trust and buying action on an e-commerce website. Another study by Devaraj et al. [29] developed a model that included 'supportability' as a determinant to measure consumer's satisfaction. The study employs the Service Quality (SERVQUAL), Transaction Cost Analysis (TCA) and Technology Acceptance Model (TAM). This model finds that the usefulness and consumer's idea on the user-friendliness of a website directly affects consumer's level of being satisfied and determine their attitude towards the website. McCloskey [30] presents a theoretical model that measures differential relationship among antecedents and consequence related to satisfaction, the e-satisfaction, and the online purchase intention.

Recently, a conceptual model on E-loyalty has been developed [31]. Results from path analysis show that e-commerce's user satisfaction is most affected by technological factors whereas online trust depends on the organizational factors. Lim et al. [32] extended the TAM by integrating the security element to the model to measure e-commerce usability. This study develops three models that measure the correlation between perceived usefulness, enjoyment, security and usability. Al-Dwairi and Kamala [33] also attempted to extend the TAM model by including more significant factors such as website quality, e-vendor factors, and consumer's factors.

In another study employing TAM to measure the usability and security of an e-commerce website, the study determined precursor to measure trust, how useful and how user-friendly is an e-commerce website [34]. TAM has ambiguous determinants thus the relationship between several website usability and e-commerce variables were analysed with design as well as perceived risk, intention to complete a transaction and trust. [35] and [36] utilized a concept similar to the "Direct Impact Model" to find the determinants that affect the usability of e-commerce. The model measures safety, enjoyment, user-friendliness of the website and how useful the website is. [37] evaluated an e-commerce website by applying the revamped DeLone and McLean's model. The model provides a measure of satisfaction, information, service and system equality, intention return to use and perceived value. Results manifest that the relationships between the determinant in the model affect the usability of e-commerce. Similarly, another model was developed from DeLone and McLean IS success model 2003 but adding on two important constructs which are Privacy and Trust [38]. Seven interrelated dimensions of e-commerce were examined by the extended mode. The results show system quality, service quality, trust and privacy are indicated as directly related to user satisfaction. Table 1 presents the taxonomy of several models that have been employed for measuring the usability and security of e-commerce websites:

Table 1. Taxonomy of usability evaluation models.

Models	Usability and Security Attributes Measured
1. E-satisfaction Model Szymanski and Hise (2000)	Innovations, benefit offered, item offered, security, product information, design of website
2. McKnight *et al.,* (2002)	Trusting behaviour
3. Devaraj *et al.,* (2002)	User friendliness, functionality
4. McCloskey (2003, 2004)	Ease of use, usefulness, Safety
5. The 'Direct Impact' model, Pikkarainen *et al.*, (2004)	Perceived security, perceived ease of use. usefulness,
6. Lim *et al*., (2005)	Safety, user friendliness, perceived functionality, enjoyment
7. Dwairi and Kamala (2009)	Privacy, satisfaction, propensity to trust, online experience, ddemographics, security, design, content, risk
8. Green and Pearson (2010)	Download time, interactivity, user-friendliness and functionality, download delay, interface credibility, content, nnavigability, rresponsiveness, ssatisfaction, threat, customers believe, intent to purchase
9. Chong *et al., (*2010)	Quality of information, system and service, perceived value, intention to repeat use, satisfaction
10. Safa and Ismai (2013)	System and information quality, usefulness, perceived ease of use
11. Ali *et al*., (2018)	Satisfaction, trust, privacy, system and service quality.

4. Approach of study

Based on a review of the models listed in Table 1, a comparison was derived to determine the dimensions of usability and security that is measured by each model. The attributes measured by each model were mapped into dimensions of usability and security through systematic search and thorough readings of the existing literature. Each attribute was matched to the dimension of usability based on the definition of each dimension given by Nielsen [4]. Whereas the attributes listed in Table 1 is mapped to security elements based on the definition of privacy and safety given by Prasad et al. [19]. The mapping was conducted to analyse the strengths and weaknesses of each model in term of how many elements included in its evaluations and whether the model provides a complete evaluation of an e-commerce website usability and security. Fig. 1 below shows the approach used in this study.
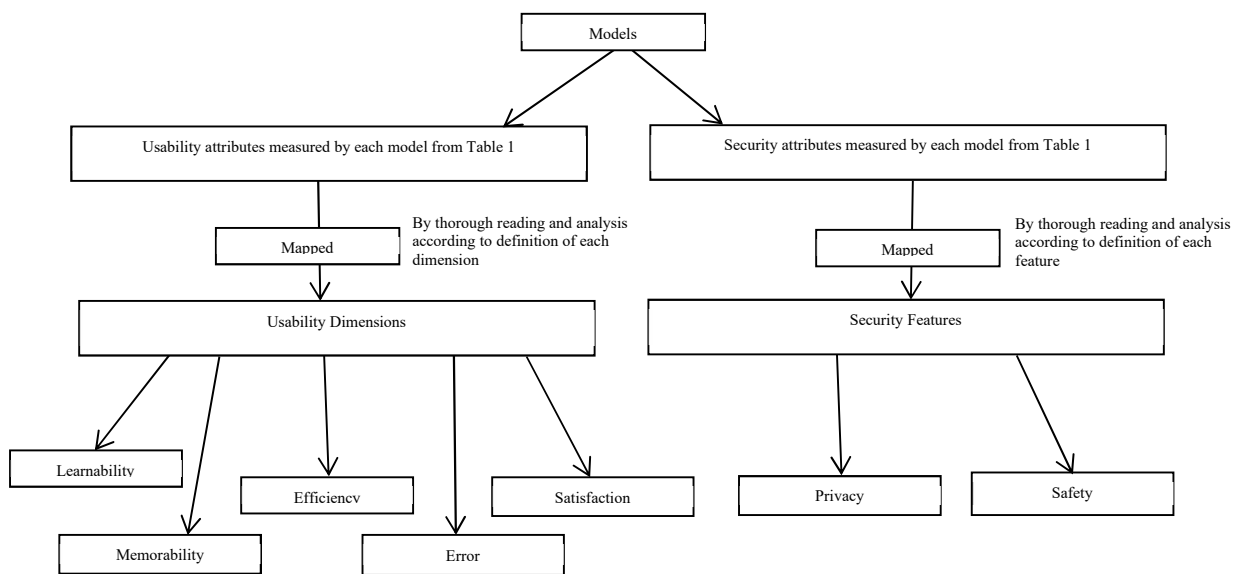

Fig. 1. Mapping usability and security attributes.

4.1. Strength and weakness of the existing model

Mapping the attributes measured by the models into usability dimensions and security features gives an overview of the strengths and weaknesses of each model. It describes whether the current existing models for e-commerce can capture all dimension of usability and security altogether in one model. Based on the mapping, Table 2 presents a review of the models to identify whether the models can capture all the dimension of usability according to Nielsen and to identify whether security elements were included in each model's evaluation.

Table 2. Strength and weakness of existing usability model.

Model	Usability Attributes Measured					Security Elements	
	Learnability	Efficiency	Memorability	Error	Satisfaction	Privacy	Safety
Szymanski and Hise [27]	√				√	√	
McKnight et al. [28]					√		
Devaraj et al. [29]	√	√			√		
McCloskey [30]	√	√			√		√
Safa and Ismail [31]	√	√					
Lim et al. [32]	√				√		√
Al-Dwairi and Kamala [33]	√				√	√	√
Green and Pearson [34]	√			√	√		
Pikkarainen et al. [35], and Dillon and Reif [36]	√	√				√	
Chong et al. [37]	√	√	√		√		
Ali and Raza [38]	√	√	√				

From all the model presented above, only the element learnability and satisfaction were predominantly measured by most of the models. None of the models were able to capture all the dimensions of usability and security altogether. McCloskey [30], Al-Dwairi and Kamala [33], and Chong et al. [37] evaluated the most usability and security elements. [30] measured learnability, efficiency, satisfaction and, security. While Chong et al. [37] measures learnability, efficiency, satisfaction and, memorability. Al-Dwairi and Kamala [33] measured learnability, satisfaction, privacy and, security. Only Szymanski and Hise [27], McCloskey [30], Lim et al. [32], Al-Dwairi and Kamala [33], and Pikkarainen et al. [35] added the element security in their model.

5. Discussions

This study adapted the approach of [6] to classify models and compare the strengths and weaknesses of each model based on the dimensions of usability and security measured by each model. By analysing the strengths and weaknesses of each model, it is clear that there is lacking in one comprehensive model that is able to evaluate the usability and security of e-commerce website. Without a comprehensive model which includes usability and security elements, evaluation of e-commerce model is not effective and would not be able to provide a complete insight for improvement. The goal of usability evaluation is mainly to detect areas that call for improvement and then to enhance the problems for a usable product/service. The existing evaluation models do not fulfil this goal as most of the current models only evaluate certain individual attributes of usability rather than addressing all five usability components with security elements in a model. None of the existing models captures all five usability components and together with the security elements. While each of the models mentioned above made notable contributions but there is still no one model that

has integrated the all five usability attributes with the security elements into one extensive model. This study underlines the gap existing in the current e-commerce evaluation model. Thus, a future research area that should be given attention to, is designing one comprehensive model that will be able to evaluate all the usability dimensions together with security elements. A comprehensive model that integrates all the usability component together with security elements can provide a complete measure on usability and security a website to enhance the website.

6. Conclusion

A vast number of studies has been conducted over the years to expound only general model that evaluates the success of an information system. This study reviewed 11 models which have been employed in the past to evaluate usability and security of E-commerce website. Most of the current approaches just provide an overview measurement of a website's design, while a limited number of studies are specifically developed for evaluation of e-commerce websites. There have been some researches that created models for the analysis of the features of e-commerce websites, but they provide limited insight and do not include all usability and security components in the model. Usability and security are a multidimensional concept thus a model should be able to relate and connect all the multiplex layers of usability and security components to get a full evaluation of a website. This study highlights that there is a lack of one comprehensive model that connects all the dimensions of usability and security. Most existing models focus only on a few dimensions of usability. Existing literature has given emphasis mainly in dimensions such as learnability, satisfaction, and usefulness. Factors like security and privacy issues have been disregarded. Therefore, potential research direction is to bridge the aforementioned gap to produce one comprehensive model respectively. On the other hand, the limitation of this study is that the number of models reviewed is quite small, which is 11. This is due to the time frame that the study had selected. Over the years 2000-2018, only these models were applied on E-commerce websites. For the betterment in the future, more studies can be added and in fact a thorough timeframe can be proposed.

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