

# A Framework for Investigating Mobile Web Success in the Context of E-commerce: an Analytic Network Process (ANP) Approach

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This study proposes a framework to investigate the factors of mobile web success in the context of e-commerce, and the relative importance of these success factors in selecting the most preferred mobile web. First, the Updated Delone and Mclean IS success model (2003) is chosen to extract significant mobile web success factors in the context of e-commerce. Second, it is extended through applying an Analytic Network Process (ANP) approach for investigating the relative importance of each factor and ranking alternative mobile webs in the context of e-commerce. The choice of success measure is a function of the context, which is the objective of this study. Thus, the present study is aimed at evaluating the success of an e-commerce mobile web by customizing measures of the Updated Delone and McLean IS Success model according to the context.

Key Words: Mobile Web Success, E-commerce Success, Analytical Network Process

## 1. INTRODUCTION

Today, the vision of the telecommunication market is to have access to information at any time and in any place [Sheng-Tzong et al. 2002]. Mobile devices such as cell phones can be utilized by the users for performing electronic commerce activities on the World Wide Web. The development of internet technology has intensified online competition, as simply as a simple mouse click to select a new provider. Thus, it has

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become crucial to investigate website success for e-businesses to develop a website that would decrease customer churn rate. As acquiring online customers is expensive, startup companies could remain unprofitable for at least two or three years. However by retaining just 5 percent more customers, online companies could boost their profits in the range of 25 percent to 95 percent [Reicheld and Schefter 2000]. Mobility is becoming the need of the hour for the users, and individuals prefer access to e-commerce activities at any time. Thus, individuals use cell phones to access e-commerce websites for performing e-businesses.

A remarkable change has been brought by mobile web commerce in the way relationships are built and maintained with customers. Online services are fast replacing traditional high contact services in brick and mortar companies. Lack of direct human interaction in online channels entails the use of each service element as an opportunity to reinforce or establish quality perceptions for customers [Broderick and Vachirapornpuk 2002]. Since the costs of comparing alternatives are relatively low in online environments, service quality is a key determinant in differentiating service offers and building competitive advantages [Gronroos 2000]. Retailers that sell only services have little to offer if their service is poor [Berry and Leonard 1986]. Mobile web is a competitive environment for e-commerce companies, since the cost and time for finding alternative e-commerce websites is relatively low for users.

A wide gap between the anticipated and actual achievements from e-commerce systems [Marshall et al. 2000] has motivated researchers to update the information system success model according to the advent and explosive growth of e-commerce systems [Delone and McLean 2003]. An example of advent e-commerce systems is the e-commerce websites that are designed for mobile phones.

## 2. RESEARCH PROBLEM

There is widespread deployment of websites commercially [Liu and Arnett 2000; Robbins and Stylianou 2003]. Sufficient anecdotal evidence suggests that the internet is an effective tool for commercial purposes [Huizingh 2000]. However, merely undertaking online businesses does not guarantee competitive benefits. The success of e-commerce firms depends on people visiting their sites, purchasing their products, and, most importantly, becoming repeat customers [Smith and Merchant 2001]. At the same time, customers have several alternative websites that they could use. There are almost no barriers to switching to other web sites if the performance of any is unacceptable [Bhatti 2000].

While sizable investments are being made in developing websites, there is no clear information on which factors contribute to successful e-commerce. Considerable research is being done to measure the initiatives of internet based e-commerce [Irani 2002; Thornton and Marche 2003; Zhu et al. 2003].

In some preliminary studies, Marshall et al. (2002) indicated a wide gap between anticipated and actual achievements from e-commerce systems [Marshall et al. 2000]. Thus, there is an urgent need to help decision makers gain a better understanding of the perceptions of online customers for more desired websites. A number of studies have been undertaken to identify factors that inhibit or facilitate e-commerce success [Turban and Gehrke 2000].

Future computing environments promise to liberate the user from the constraints of stationary desktop computing. The current use of mobile technology shows a gradual evolution from the current desktop paradigm of computing [Gregory et al. 1997]. Yet relatively few researchers are investigating the factors that contribute to the success of the mobile web. Thus, to ensure effective use of wireless-based applications in a mobile web environment, we need a better understanding of the factors that influence a successful implementation.

This research is aimed at determining a framework for investigating the factors that influence mobile web success in the context of e-commerce. In addition, the research is aimed at defining an approach to identify the relative importance of the factors contributing to mobile web success in the context of e-commerce. Identifying the relative importance of each success factor and the priority of alternative mobile webs would help in selecting the most preferred mobile web. Furthermore, prior to any empirical evaluation of the proposed model, measures of the model could be customized according to the context of the study.

### 3. LITERATURE REVIEW

Effective measurement of information system (IS) success is vital for both practitioners and researchers to understand the value of IS management activities and IS investments [Delone and McLean 2003; Delone and McLean 1992].

It appears that IS success is one of the controversial issues that has eluded IS researchers. The problem is compounded as success is a multidimensional concept that can be assessed at different levels such as technical, individual, group, organizational. Further, it can be assessed using a number of not necessarily complementary criteria (such as economic, financial, behavioral, and perceptual), where even various stakeholders could have different opinions about the success of the same information system [Delone and McLean 2003; Delone and McLean 1992; Molla and Licker 2001]. According to Nidomolu, from the developer's perspective a successful IS may be one that is completed on time and under budget, with a complete set of features that are consistent with specifications and that function correctly [Nidomolu 1995]. He further argued that from an innovator's perspective, a successful system is one that attracts a large, loyal, and growing community of users. Jiang et al. (2002) identified a set of critical success factors contributing to system development including clearly defined goals, top management support, sufficient resources, competent team members, and adequate communication [Jiang et al. 2002]. From a management perspective, a successful system may be defined as one that reduces uncertainty of outcomes and thereby lowers risks, and leverages scarce resources. From the end user's perspective, a successful system may be seen as one that improves the use's job performance without inflicting undue annoyance [Chien and Tsaur 2007].

From the 1980s, one of the main goals of IS research has been the explanation of IS success [Cerveny and Sanders 1986]. The measurement of IS success or its effectiveness has been widely investigated by the IS research community [Counihan et al. 2002; Murphy and Simon 2002; Shang and Seddon 2002]. Theorists are, however, still grappling with the question of which factors construct and best measure the IS success [Rai et al. 2002; Garrity and Sanders 1998].

Huff et al. and Zisman described the evolution of IS over time [Huff et al. 1988; Zisman 1978]. They stated that there is a pattern of organizational learning in applying new technology, and organizations go through several distinct stages to exploit this new technology. Owing to an alteration in the role played by information systems, several firms have successfully positioned and deployed systems to compete in the electronic marketplace. Web based information systems represent a new cutting edge frontier for businesses trying to establish an online presence where consumers are free to shop in more efficient “friction free markets” (Tenenbaum 1996) [Tenenbaum 1998].

New applications of information systems have brought about a radical change in global marketplaces and have redefined the expectations of individuals in accessing information or services. People are no longer willing to stand in long queues, hold on the line, or get stuck in traffic to get something that could be easily obtained by the click of a mouse. People deal with an organization through electronic information exchange. Electronic information exchange could either be financial or non-financial transactions (such as customer request for further information).

Recent developments in Mobile computing and web technologies have caused an increase in the number of people using mobile computers to access the e-commerce websites to do their business. The advent of mobile technology and the need of individuals to access the World Wide Web to perform e-commerce activities at any time and in any place makes mobile web a competitive environment.

“Moment of truth between a company and a customer is the Web site” [Iwaarden and Wiele 2003]. This indicates that customers can freely interface with sellers in cyberspace through the seller's website and there is no requirement for human interaction or contact between a company and its customer.

The internet has given birth to a new competitive environment for businesses to operate, rethink, and adapt technology to increase the effectiveness and efficiency of their processes. Most of the brick and mortar organizations have successfully changed and adapted their business operations to partial or pure e-commerce by developing websites and making use of the mobile technology.

It is crucial for businesses to evaluate their website success to sustain profitability in the competitive marketplace. If companies focus on the factors which contribute to their success in a competitive environment, they could become more profitable. However, companies making large investments in e-commerce applications are hard pressed to evaluate the success of these e-commerce systems [Delone and McLean 2003].

Sinnappan et al. (2004) implied that the dynamics of website development is based on the literature concerning both the information system and the service field. Literature concerning information system success and service success will be discussed in the following sections [Sinnappan and Carlson 2004].

### **3.1 Review of Information System Success Literature**

Delone and McLean believe that “the evaluation of IS practice, policies, and procedures requires an IS success measure against which various strategies can be tested” [Delone and McLean 1992].

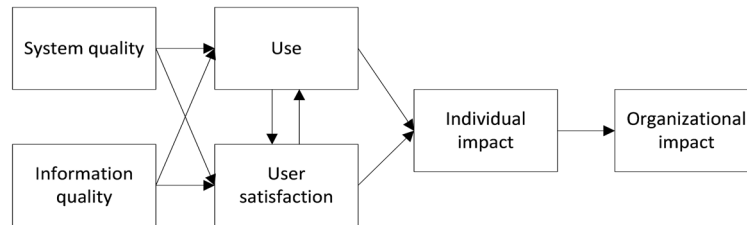


Figure 1. D&M IS Success Model [Delone and McLean 1992].

There are various measures of IS success outlined in the literature, depending on which aspect of IS the researcher has focused his or her attention. D&M fit the previous conceptual and empirical studies into the category or categories of the model as shown in Figure 1.

The extensive body of IS research was organized on a retrospective basis, and various measures of the previous studies were categorized into six major categories of the Delone and Mclean IS Success Model (1992) as shown in Figure 1.

Delone and McLean describe the six categories as follows:

- System Quality - the measure of information processing system itself
- Information quality - the measures of information system output
- Information use - the recipient consumption of the output of an information system
- User satisfaction - the recipient response to the use of the output of an information system
- Individual impact - the effect of information on the behavior of the recipient
- Organizational impact - the effect of information on organizational performance

However, different researchers presented different descriptions of measures for each category of IS success. Delone and McLean suggested that no single variable is intrinsically better than another, and thus, the choice of a success variable is often a function of:

- the objective of the study,
- the organizational context,
- the aspect of the information system which is addressed by the study,
- the independent variables under investigation,
- the research method, and
- the level of analysis, i.e., individual, organization, or society [Molla and Licker 2001].

Delone and McLean remarked that different levels of the Delone and McLean IS Success Model (1992) have causal and temporal influences on each other; hence, the success model is a process construct [Delone and McLean 1992]. According to this process model, System Quality and Information Quality singularly and jointly affect both Use and User Satisfaction. In addition, the amount of Use can affect the degree of User Satisfaction, positively or negatively. The reverse also holds good. Use and User Satisfaction are direct antecedents of Individual Impact, and further, this impact on individual performance should eventually result in some organizational impact.

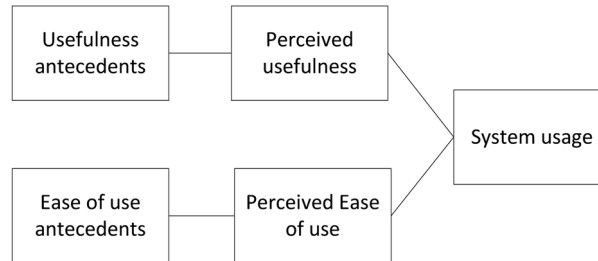


Figure 2. Tam and Website Usage [Albert et al. 2000].

The future success of an IS can be predicted based on the impact of each category on the other one where all the variables are dependent.

Delone and McLean stated that this IS success model obviously requires further development and validation before it serves as an appropriate and suitable measure of IS success [Delone and McLean 1992]. In 1998, Garrity and Sanders extended the original Delone and McLean model and proposed an alternative model in the context of organizational and socio-technical systems [Garrity and Sanders 1998]. Their model identifies four sub dimensions of User Satisfaction, namely:

- Interface Satisfaction,
- Decision Support Satisfaction,
- Task Support Satisfaction, and
- Quality of Work Life Satisfaction.

The four factors correspond with three viewpoints of information systems;

- the organizational viewpoint that views IS as a component of the larger organization system,
- the human machine viewpoint, which focuses on the computer interface and the user as components of a work system, and
- the socio technical viewpoint, that considers humans as also having goals that are separate from the organization and whereby the IT or technical artifact impacts the human component in this realm [Garrity and Sanders 1998].

The measures of the Garrity and Sanders Model (1998) are consistent with the Technology Acceptance Model (TAM). TAM was conceived by Davis to explain and predict the individual's acceptance of information technology [Davis 1989]. Davis suggested that the actual use of technology could be predicted by the user's behavioral intention and his or her attitude towards its use. This in turn is influenced by a technology's perceived ease of use and usefulness [Davis 1989]. Davis describes TAM variables as follows:

- Perceived usefulness - refers to the degree to which a person believes that using a particular system would enhance his or her job performance
- Perceived ease of use - in contrast, refers to the degree to which a person believes that using a particular system would be free of effort

Davis indicated that perceived usefulness and ease of use are influential factors affecting the decisions made to use information technology. Thus, they are important

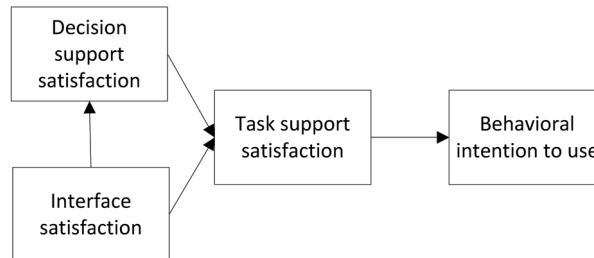


Figure 3. Web Based Information System Success Model [Garrity et al. 2005].

in designing and implementing successful information systems [Davis 1989].

The Garrity and Sanders model measures the fit with the system, the user, and the task, and is consistent with the Technology Acceptance Model [Garrity and Sanders 1998]. Garrity et al. confirmed that task support satisfaction and interface satisfaction are closely related to the TAM's perceived dimensions of usefulness and the perceived ease of use [Garrity and Sanders 1998].

With the emergence of web based information technology, the TAM model was validated with the Web as the user's application [Albert and Lederer 2000]. This model identified ease of use and usefulness of Web as antecedents of website success. Thus, the features of the web that might contribute to its ease of use and usefulness were identified. Albert et al. acclaimed that the new model suggests that the web site developers should provide ease of use and usefulness for their web sites to encourage people to revisit their websites. By applying TAM, the groundwork for understanding antecedents that might affect web usage is prepared [Albert and Lederer 2000].

In 2005, Garrity et al. proposed a new model based on the IS success models of Delone and McLean (1992), TAM (2000), Garrity et al. (1998) to examine web based information systems success and to discover important underlying factors that would help to explain the success of web based information systems. Garrity et al. believed that the web based information system success deals with the reciprocal relationship between user satisfaction and system use [Garrity et al. 2005].

The web based information system success model assesses user satisfaction with web based information systems in the context of the purchasing activities of the consumer [Garrity et al. 2005]. The nature of a consumer purchasing web based system is closely tied to providing decision support capabilities to aid consumers in product and service purchase decisions [O'Keefe and Mc-Eachern 1998].

Four dimensions of the web based information system success model (2005) are illustrated as follows:

- Decision support satisfaction assesses the support provided by the Web based information system in the context of decision making tasks
- Task support satisfaction assesses the overall support for the purchasing task, which takes into account the overall design of the software and its usefulness
- Behavioral intention to use a system effectively mediates the effect of user satisfaction on actual systems use
- Interface Satisfaction (this dimension may be thought of in several ways) provides

an assessment of the design of the hardware and software interface and is closely related to the Ease of Use dimension.

Garrity et al. stated that the construct used in the web based information system success model is more context based than the IS Success model of DeLone and McLean (1992) [Garrity et al. 2005]. They further argued that the web based information system success model has a more goal oriented perspective and asserted that a system of high quality should support users in performing their task related responsibilities.

Thus, in brief, the focus of a web based information system success model is on how well the system supports workers in the accomplishment of their goals.

Garrity et al. explained that if systems are tools to help workers accomplish tasks, then a well designed tool should be made in such a way that it is easy and efficient to use [Garrity et al. 2005]. Further, the interface is also the focal point of interaction between individuals and information systems. Thus, Information Quality can also be explained by Interface Satisfaction, where the system for presenting the information cannot be separated from the information itself [Nielsen 2000].

This section presented a review of the literature highlighting the success of information systems. However, for measuring the success of the website, another aspect, namely, service success, should be considered.

### 3.2 Review of Service Success Literature

As stated, the technicalities of a website are based on the literature concerning both the information system and service fields. In the previous section, highly cited information system success models were reviewed; in this section, the literature of success will be reviewed from the aspect of service quality.

Although companies attempt to emulate human behavior using technology on the web sites, the interaction somehow remains different because some aspects of human interaction cannot be replaced with technology [Cox and Dale 2001; Cox and Dale 2002]. Better performance on other quality factors should be able to compensate for the absence of certain aspects of human interaction (such as face to face relationships) through which quality can be delivered to customers.

The SERVQUAL model has emerged from the service success literature as one of the dominant theoretical models to assess the quality of the website. In order to improve service quality, it must be reliably assessed and measured [Parasuraman et al. 1988]. According to the SERVQUAL model (1988), the commonly used approach for measuring service quality is comparing customers' expectations before a service encounter with their perceptions of the actual service delivered [Parasuraman et al. 1985]. Service quality can be measured by identifying the discrepancies between the customers' expectations of the service to be rendered and their perceptions of the actual performance of the service. Service quality can thus be defined as the difference between the customer expectations of service and the perceived service. If expectations are greater than performance, then perceived quality is less than satisfactory and hence customer dissatisfaction occurs [Parasuraman et al. 1985]. Parasuraman et al. stated that five dimensions of the SERVQUAL model measure the difference between objective and perceived quality [Parasuraman et al. 1988]. They are:



- Tangibles - Physical facilities, equipment, and appearance of personnel
- Reliability - Ability to perform the promised service dependably and accurately
- Responsiveness - Willingness to help customers and provide prompt service
- Assurance - Knowledge and courtesy of employees and their ability to inspire trust and confidence
- Empathy - Caring and individualized attention that the firm provides to its customers.

Parasuraman et al. suggested that research is required whether the definitions and relative importance of the five service quality dimensions change when customers interact with technology rather than with service personnel [Parasuraman et al. 1985].

In 2000, Zeithaml et al. developed e-Servqual for measuring service quality on websites [Zeithaml et al. 2000].

Zeithaml et al. pointed out that encouraging repeat purchases and building customer loyalty would require a shift from focusing on e-commerce to e-service [Zeithaml et al. 2000]. They further illustrated that e-service quality could be defined as the extent to which a Web site facilitates efficient and effective shopping, purchasing, and delivery of products and services [Zeithaml et al. 2000].

E-Servqual (2000) has seven dimensions, namely, efficiency, reliability, fulfillment, privacy, responsiveness, compensation, and contact. Four dimensions, namely, efficiency, reliability, fulfillment, and privacy are used to effectively measure the customers' perceptions of the quality of service delivered by online retailers. These dimensions include the criteria that customers use to evaluate the routine online services when they experience no problems in using the site. Zeithaml et al. also found that three dimensions, namely, responsiveness, compensation, and contact become salient only when the online customers have queries or run into problems [Zeithaml et al. 2002].

In comparing the dimensions of SERVQUAL (1990) with the dimensions of e-service quality (2000), Zeithaml et al. found out that half of the dimensions of SERVQUAL are used by consumers when they evaluate e-service quality. However several new dimensions also emerged as important when assessing e-service quality [Zeithaml et al. 2000]. Some of the perceptual attributes of reliability and access dealt with online attributes not present in SERVQUAL. Thus, even though some e-service quality dimensions are similar to those of service quality, others are entirely new and unique to the context of websites.

Liu and Arnett identified service quality as an important measure of web site success. In their study, service quality was measured as responsiveness, assurance, and empathy [Liu and Arnett 2000]. These measures are the dimensions of SERVQUAL.

In 2002, Iwaarden et al. conducted a survey to identify the most important factors affecting quality on websites [Iwaarden and Wiele 2002]. Their questionnaire was utilized based on the SERVQUAL instrument. The results indicated that the quality dimensions found applicable in the service sector are also applicable on the website.

### 3.3 Review of Information System and Service Arena Literature

Delone and McLean justified the information system research progress as a result of

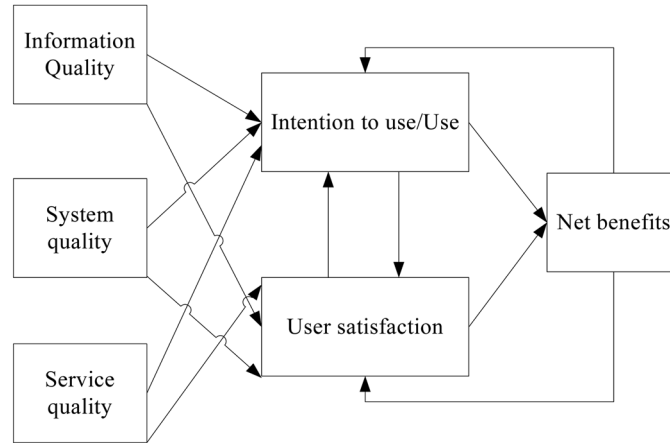


Figure 4. Updated D&M IS Success Model [Delone and McLean 2003].

the tremendous progress of the impact of Information System on business and society [Delone and McLean 2003]. They further claimed that a change and progress in the role of information system from 1992 has resulted in a similar progress and has led to an academic inquiry into the measurement of information system success over the same period. The Delone and McLean IS Success model (1992) has been updated in view of the dramatic changes in IS practice, especially in the initiation and explosive growth of e-commerce [Delone and McLean 2003].

The Updated Delone and McLean IS Success model is a process and causal model. According to a temporal or a process model, lower levels of the model result in higher level categories of the model. In contrast to a process model, there is a causal relationship among different measures of the model in a causal or variance model. Unlike the process model, which merely states that B follows A, a causal model postulates that A causes B, that is, increasing A will Cause B to increase (or decrease). According to Delone and McLean, the process model has just three components:

- the creation of the system,
- the use of this system, and
- the consequence of this system use [Delone and McLean 2003].

They further argued that all of these dimensions are necessary, but not sufficient for the resultant outcome, and that a variance model is also needed to achieve the consequences.

Some categories were added to the original Delone and McLean IS Success Model (1992). System use was added as an appropriate measure of success to the original Delone and McLean IS Success Model (1992) [Delone and McLean 2003]. Delone and McLean (2003) claimed that in the causal model, just using this complex variable to show that more use will yield more benefits, without considering the nature of use, is clearly insufficient and problematic. Instead, the nature, extent, quality, and appropriateness of the system use must also be considered [Delone and McLean 2003].

“The emergence of end user computing satisfaction in the mid-1980s placed IS organizations in the dual role of information provider and service provider” [Delone and McLean 2003].

From 1992 to 2003, researchers have argued that the factor of service quality also be added to the success model. They have applied the SERVQUAL measurement instrument in the field of marketing and IS success [Delone and McLean 2003].

Delone and McLean agreed that the SERVQUAL metric needs continued development and validation. However if service quality is adequately measured, it deserves to be added to system quality and information quality as a component of IS success [Delone and McLean 2003]. Thus, service quality measure was added to the measures of information quality and system quality as a crucial component in evaluating website success.

Delone and McLean also updated the original information system success (1992) by combining the consequences of system use, individual impact and organizational impact, into one category, namely, net benefits. According to Delone and McLean (2003) the choice of where the impacts should be measured is dependent on the system or systems being evaluated and their purposes [Delone and McLean 2003]. Therefore, it is important to recognize from whose interest the IS impact is being measured. Thus, Delone and McLean decided to group, all the Impact measures into a single impact category called Net Benefits [Delone and McLean 2003] rather than complicating the model with numerous success measures.

The complete functional use of an e-commerce system should include informational use, transactional use, and customer service [Young and Benamati 2000].

The updated Delone and McLean Information Systems Success Model considers the combination of information system and customer service field, which can be tailored to the measurement challenges of the new e-commerce world [Delone and McLean 2003]. Delone and McLean implied that the updated model could be utilized to measure the e-commerce system [Delone and McLean 2003].

#### 4. FRAME OF REFERENCE

The objective of this study is to build a fitting frame of reference for investigating the factors that influence the mobile web success in the context of e-commerce. Another objective is to define an approach to determine the relative importance of the factors of mobile web success in the context of e-commerce. This would help in selecting the most preferred mobile web by identifying the relative importance of each success factor as well as the priority of alternative mobile webs.

Based on the literature review, it is known that the e-commerce website is based on a literature concerning both information system quality and service quality. Thus, both of these aspects should be considered while investigating the factors influencing mobile web success in the context of e-commerce.

Several models have been developed from the 1980s for investigating information system success, or broadly, website success. However, few studies considered the amalgamation of information system quality and online service quality variables as components of website success.

As illustrated in the literature review, Delone and McLean updated their original

information system success model (1992), according to the advent and dramatic changes in information system practices. This was especially done because of the explosive growth of e-commerce and as a result of the evolution of the impact of Information System on business and society [Delone and McLean 2003].

The emergence of end user computing in the mid 1980s placed IS organizations in the dual role of information provider (producing an information product) and service provider (providing support for end user developers) [Delone and McLean 2003].

The updated Delone and McLean IS Success Model (2003) (hereafter referred to as the “Updated D&M IS Success Model”) is one of the vastly cited models which concerns both IS and Service quality as antecedents of website success. This model can be adapted to measure the challenges of the new and emerging e-commerce world [Delone and McLean 2003].

This model consists of six success categories. Each of these success categories consists of different success measures or variables.

Delone and McLean stated that “no single variable is intrinsically better than another, so the choice of success variables is often a function of the objective of the study, the organizational context...etc. [DeLone and McLean 1992]” Moreover, Jiang and Klein found that users prefer different success measures depending on the type of system being evaluated [Jiang and Klein 1999]. Seddon et al. proposed a two dimensional matrix for categorizing IS effectiveness measures based on the type of system under study and the stakeholder for whom the IS is being evaluated [Seddon et al. 1999]. Therefore, in order to evaluate the success of an e-commerce website, the following factors should become more specific:

- the element of the website;
- the context; and
- those whose perception is important in evaluating the success of the website.

Delone and McLean organized various success measures by reviewing different IS and e-commerce literature to make the model a parsimonious framework [Delone and McLean 2003].

Pitt et al. observed that “Commonly used measures of IS effectiveness focus on the products rather than the services of the IS function” [Pitt et al. 1995]. Thus, there is a danger that IS researchers will wrongly measure IS effectiveness if a measure of IS service quality is not included in their assessment package. Delone and McLean claimed that the need to assess service quality has become even more apparent and important with the advent of e-commerce and the demand of customers for support from their Web providers [Delone and McLean 2003]. Thus, service quality measure is also added to the original model of Delone and McLean IS Success Model (1992).

By adding the “Service quality” variable to the model, Delone and McLean suggested that the “Service quality” is the most important variable in measuring the overall success of the e-commerce website [Delone and McLean 2003]. They further argued that that SERVQUAL (1988) metric needs a continued development and validation. However, they believed that “service quality,” if properly measured, deserves to be added to “system quality” and “information quality” as a component of IS success [Delone and McLean 2003].

According to Delone and McLean, regardless of whether the overall support by the service provider is delivered by the IS department, a new organizational unit, or outsourced to an Internet service provider, the "Service quality," is of paramount importance [Delone and McLean 2003]. Its importance is highlighted more than before since the users are now customers and poor user support will rapidly translate into lost customers and lost sales.

Although the original SERVQUAL instrument comprises of tangible, reliability, responsiveness, assurance, and empathy variables, the Updated D&M IS Success Model only considers three variables of this instrument in the Service category. These variables include the assurance, empathy, and responsiveness measures. Since the tangible measure includes only the physical facilities, equipment, and appearance of the service provider personnel, it is not considered in the service category of the Updated D&M IS Success Model. Reliability measure is also considered in the System quality category of the Updated D&M IS Success Model [Delone and McLean 2003].

Parasuraman et al. defined empathy as the act of providing compassion and individual attention to customers [Parasuraman et al. 1985]. Zeithaml et al. stated that while customers seek understanding, reassurance, courtesy, and other aspects of personal attention in offline contexts, these service requirements did not seem to be key issues on the website [Zeithaml et al. 2002]. Further, it is also argued that empathy is required only when the customers experience problems.

Iwaarden et al. applied SERVQUAL to websites and emphasized that empathy could be provided to website users with the use of a virtual assistant [Iwaarden and Wiele 2003]. The virtual assistant can suggest products or services that might be of interest to a customer. The only purpose of a technological gadget would be to add one of the Web's key missing ingredients: warmth [Economist 2001].

Nagata however believes that virtual assistant communication via a mobile web could be an interruption that unnecessarily prolongs the performance time of any web task [Stacey 2003].

Responsiveness is the willingness to help customers and provide prompt services [Parasuraman et al. 1985].

Iwaarden et al. confirmed that one of the key aspects in the responsiveness factor on the website is "giving prompt service" [Iwaarden and Wiele 2003]. Further, the time taken to download a Web page is an important factor to the users of the Internet.

When web page download time delays exceed 12 seconds, a staggering 70 percent of users leave a Web site [Cox and Dale 2001; Cox and Dale 2002].

On the one hand it is important for organizations to have a web site that is quick, but on the other hand, users expect web sites to be visually appealing. As the number and size of animations, pictures, and sounds increase to make a web page visually more appealing, the time it takes to download that web page also increases. This draws negative reactions from the users. Hence, there is a trade-off between the appearance of a web site and the speed of that site [Iwaarden and Wiele 2003].

Han et al. discussed that extensive download time of mobile web pages makes the viewing of Web Pages very cumbersome [Han 1998].

Parasuraman et al. defined assurance as the knowledge and courtesy of employers and their ability to inspire trust and confidence [Parasuraman et al. 1985].

However, as it was mentioned before, Zeithaml et al. stated that courtesy is not an online service success variable from the perspective of the website users [Zeithaml et al. 2002].

One important aspect in the assurance factor in e-commerce websites is the experience report of other customers [Daughtrey 2001].

Meanwhile Parasuraman et al. believed that the success of an e-commerce website cannot be assessed by considering the website as one dimensional and using a SERVQUAL instrument [Parasuraman et al. 1985]. As it is apparent in the Updated IS Success Model (Figure 4), besides system quality and information quality categories, service quality is also used for measuring website success.

As it was mentioned, the Updated D&M IS Success model is a process model which consists of three levels, namely,

- the creation of a system,
- the use of the system and,
- the consequence of this system use.

Creation of the system consists of information quality and system quality besides service quality.

“System Quality” in the Internet environment measures the desired characteristics of an e-commerce system [Delone and McLean 2003]. The system quality measures that have been applied in the e-commerce environment are customization [Palmer 2002], ease of navigation [Palmer 2002; Molla and Licker 2001], privacy [Molla and Licker 2001], and security [Molla and Licker 2001].

According to Nokia, the need for text entry in mobile services should be minimized for ease of navigation, since it is relatively difficult to write text using a normal phone keypad [Nokia Corporation 2002].

Privacy and security are two key criteria for evaluating online services [Culnan 1999; Culnan et al. 1999; Weiss et al. 2000]. Though related, these two criteria have still been distinguished from each other. Privacy involves the protection of personal information, not sharing personal information about consumers with other sites, protecting anonymity, and providing informed consent [Friedman et al. 2000].

Security, on the other hand, involves protecting users from the risk of fraud and financial loss and from the use of their credit card or other financial information. Security risk perceptions have been shown to have a strong impact on the attitude toward the use of online financial services [Weiss et al. 2000].

Ghosh et al. (2002) claimed that new security and privacy risks particular to the wireless medium and devices are abound in mobile commerce applications [Anup et al. 2001].

According to Delone and McLean (2003), “Information quality” captures the e-commerce content issue. Dynamic content [Parsons et al. 1998], content personalization [Barua 2001; Molla and Licker 2001], and variety of information [Palmer 2002] are viewed as e-commerce information quality measures.

Successful websites take advantage of customization, a key website capability, for interacting with website users [Lee and Benbasat 2003].

Customization of Mobile web reduces information load by filtering unnecessary

information. Moreover, m-commerce provides potential for personalization as mobile devices always carry the user's assigned identity [Palmer 2002].

The second level of the Updated D&M IS Success model (2003) is the use of the system. This level consists of two categories: "use" and "user satisfaction".

Since the System use is completely voluntary in e-commerce systems, this variable is considered as an important indication of IS success [Molla and Licker 2001]. Delone and McLean recommended that system use is a complex variable that must be measured with respect to nature, extent, quality, and appropriateness. Further, it is not adequate to simply consider more use as a contribution leading to more benefits [Delone and McLean 2003]. According to Delone and McLean, "Usage" measures everything from a visit to a Website, navigation within the site, information retrieval, and execution of a transaction [Delone and McLean 2003].

In an e-commerce environment, system use is measured as the number of e-commerce site visits, the length of stay, and the number of purchases completed [Molla and Licker 2001; D'ambra and Rice 2001].

"User satisfaction" is an important means of measuring the customers' opinions regarding an e-commerce system and should cover the entire customer experience cycle from information retrieval through purchase, payment, receipt, and service [Delone and McLean 2003].

Reichheld and Scheffer's "e-loyalty" represents a good surrogate measure of customer satisfaction in the e-commerce environment [Reichheld and Scheffer 2000].

Wang et al., introduced the conceptualization and measurement of the mobile web user satisfaction (MCUS) construct. The success of the mobile web is measured with respect to content quality, service quality, appearance, and ease of use [Yi-Shun and Yi-Wen 2007].

Venkatesh et al. pointed out the benefits of understanding and improving the usability and issues relating to the user interface experience in the mobile web business. They further argued that an important prerequisite for the success of mobile web in the context of e-commerce is to ensure that the users' experience satisfies both sensory and functional needs [Venkatesh et al. 2003].

According to the variance model, system use which is the second level of the Updated D&M IS Success model has an impact on the third level which is the consequence of system use. In the original Delone and McLean IS Success model (1992), the consequence of system use was demonstrated by Individual impact and Organizational impact. In the Updated D&M IS Success Model, the Individual impact and organizational impact have been grouped together in one category called Net Benefits. Owing to the continuum of ever increasing entities from individuals to national economic accounts, which could be affected by IS activity, it depends on the study to identify from whose interest the impacts are being evaluated [Delone and McLean 2003].

"Net benefits" is the most important category to measure success as it captures the balance of the positive and negative impacts of the e-commerce on the website users [Delone and McLean 2003]. The net benefits measure could be defined as a means to assess whether the usage of the e-commerce website has saved time and money for the individual consumers. The "Net benefits" measure must be determined by the

context and objectives for each e-commerce investment. Real time marketing offers the benefits of reduced shopping cost [D'ambra and Rice 2001] and improved customer experience [Hoffman and Novak 1996]. These are considered as individuals' net benefits from the e-commerce system.

Payne et al. stated that value assessment should be undertaken by companies, including mobile web commerce, to quantify the customer experience [Payne and Frown 2005]. Moreover, Rao et al. focused on mobile web services that enhanced the customer experience [Rao and Minakakis 2003].

The relationship between different categories of the model is in compile with the variance or causal model as well as the process model. According to the arrows between different categories, one category precedes another category as a result of the process model. Further, any increase or decrease in a category would lead to an increase or decrease in the other interrelated category. For instance, as shown in Figure 4, Use proceeds to User satisfaction according to the process model. However according to the causal or the variance model, a positive (negative) experience in system Use will lead to increased (decreased) user satisfaction. Similarly increased (decreased) User satisfaction leads to more (less) system Use. The same feedback variance or causal relationship is observed between Use and User satisfaction in the second level of the model and Net benefit in the third level of the model. Certain Net benefit will occur as a result of certain Use and User satisfaction. Similarly, positive (negative) net benefits will increase (decrease) use and user satisfaction.

The objective of this study is to investigate the factors that influence mobile web success in the context of e-commerce. Another objective of this study is to define an approach to determine the relative importance of the factors of mobile web success in the context of e-commerce. This would help in selecting the most preferred mobile web by identifying the relative importance of each success factor and the priority standing of alternative mobile webs.

Thus, decision making involves finding out the relative importance of different success variables and ranking alternative mobile webs.

Saaty believes that structures that represent flow of influences are required for making complex decisions. He further defines the basic structure in making decisions as an influence network of clusters and nodes contained within the clusters for the Analytic Network Process (ANP) and a hierarchy for the Analytic Hierarchy Process (AHP) [Saaty 2008]. In ANP and in a particular case, AHP, pair wise comparisons and judgments are used to establish priorities and the relative importance of different variables [Saaty 2008]. Many decision problems involve the interaction and dependence of higher level elements on lower level elements and therefore cannot be structured hierarchically. According to the Updated D&M IS Success Model (2003) shown in Figure 4, feedback loops are present between the IS success variables, and therefore, this model does not have specifying levels as in a hierarchy. Therefore, the Updated D&M IS Success Model (2003) will be developed through the ANP approach to identify the relative importance of the different success variables and to rank the alternative mobile webs in the context of e-commerce.

ANP is the first mathematical theory to deal systematically with any kind of dependence and feedback [Saaty 2003]. The ANP is a new theory that extends the



AHP to cases of dependence and feedback and generalizes on the super matrix approach introduced in Thomas Saaty's 1980 book on AHP [Saaty 1980]. The ANP provides a detailed framework to include clusters of elements connected in a desired way to investigate the process of deriving ratio scales priorities from the distribution of influence among elements and clusters.

According to Saaty, the feedback structure does not resemble the top to bottom form of a hierarchy. It instead looks more like a network, without specifying levels, but with cycles connecting its components of elements [Saaty 2008]. A feedback structure also has sources and sinks. A source node is an origin of paths of influence and never a destination of such paths, whereas a sink node is a destination of paths of influence and never an origin of such paths.

The decision maker will use a series of pair wise comparisons and compare two components at a time with respect to source or parent criterion to elicit preferences of various components and attributes. All nodes that are to be compared pair wise are always in the same cluster and are compared with respect to their parent (source) element, the node from which they are connected. This results in local priorities of the nodes with respect to the source node.

The strength of the ANP lies in its use of ratio scales to capture all kinds of interactions, formulate accurate predictions, and make better decisions [Saaty 2003]. The reason for the success of ANP lies in the fact that it uses measurement to derive ratio scales and elicit judgments [Saaty 2003].

As illustrated in the literature review, all the variables are dependent, as different success categories in the Updated D&M IS Success model (2003) have a causal and process influence on each other. Moreover, feedback loops are present between the success categories of the model as illustrated in Figure 4. The Updated D&MIS Success Model (2003) does not resemble a linear top to bottom form of a hierarchy but looks more like a network with cycles connecting its cluster of elements which are not levels.

ANP is the logical method that can be used to find out the relative importance of each variable in the Updated D&M IS Success Model (2003) and subsequently rank alternative mobile webs. Saaty pointed out that ANP is the only tool capable of simplifying and managing complex decision problems involving feedbacks [Saaty 2008].

In the present study, the Updated D&M IS Success Model (2003) is extended through ANP (2008) as shown in Figure 5.

The parent element directs the arrows in the ANP. Different categories in the model are compared pair wise with respect to their influence on the parent element. In the Updated Delone and McLean IS success model, Use and User satisfaction are influenced by information quality, system quality, and service quality. Therefore, in the ANP framework, "use" and "user satisfaction" are parent elements. "Information quality", "system quality", and "service quality" are compared pair wise with respect to their influence on these parent elements. Likewise, other categories in the model are compared pair wise with respect to their parent elements.

Some of the most recent applications of ANP to decision making problems are:

- prioritizing and designing rule changes for the game of soccer [Parotid and

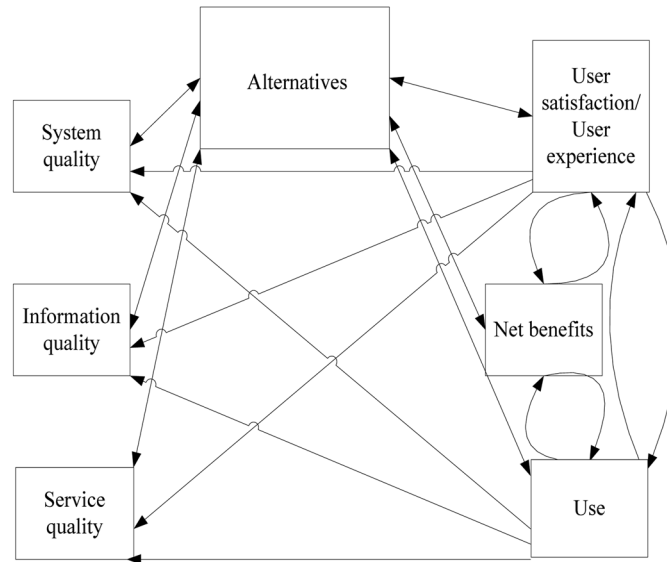


Figure 5. A Proposed Research Framework.

Corredoira 2002];

- contractor selection [Cheng and Li 2004];
- acquisition of new machine tools in a company [Yurdakul 2004];
- financial crisis forecasting [Niemira and Saaty 2004];
- choice of best management alternative of the supply chain in a company [Agarwal et al. 2005];
- product mix planning [Chung et al. 2005]; and
- evaluation of alternative fuels for residential heating [Erdogmu et al. 2006].

There is no report available in the literature for the applications of the ANP to mobile web success variables. The present study has thus made an attempt to fill that gap in the literature.

## 5. RESEARCH METHODS

For providing a proposed framework based on a literature review, a review was conducted of more than 30 information system and website success journal articles from 1985 to 2008, some of which are provided as reference in this article. The review included the *Journal of Information and Management*, *Journal of Management Information Systems*, *Journal of Human Systems Management*, *International Journal of Wireless Communications and Networking*, and the *International Journal of Applied Decision Sciences*. These journals were selected because they are related to topics of management information system, e-commerce websites, wireless communication, and decision making. Other journals could not be reviewed owing to time and resource limitations. Articles were selected if their title, abstract, or key words emphasized verification of quality or success of an information system, e-commerce website, or

mobile web commerce. As the scope of this review is to describe the relative importance of each website success variable and the priority of alternative mobile webs, the following key words were eventually added: alternative selection, preference priority, and decision. Classification of the researched articles was undertaken as a two stage process. At the first stage, the articles related to information system, e-commerce website, and mobile web success were selected by reviewing abstracts and titles. At the next stage, the research was extended to find any study which could have been done on decision making and preference priority area. In this process, the success model was extended so that the importance of each mobile web success variable in the context of e-commerce and priority of alternative mobile webs could be effectively measured.

This article survey was carried out from February to April 2009. A framework for investigating mobile web success in the context of e-commerce was proposed after reviewing the literature and previous studies.

As mentioned in the previous section, no pre-tested measure in the Updated D&M IS Success Model (2003) is intrinsically better than the other measures. Thus, the choice of the success variable is a function of the following factors:

- the study,
- the independent variable under investigation,
- the organizational context,
- the aspect of the information system which is addressed by the study,
- the research method, and
- the level of analysis [Delone and McLean 2003].

Thus, there was a need to be exact in the contextual specification and to determine which success variables were or were not included in the e-commerce mobile web context. The objective was to investigate how the underlying measures of mobile webs in the context of e-commerce were to be evaluated.

A concurrent verbal protocol study was conducted with 12 mobile web e-commerce users in order to elicit the success measures of mobile webs in the context of e-commerce from the users' perception [Ericsson and Simon 1984]. The respondents were sampled for heterogeneity using socio-demographic and mobile web-use characteristics in order to obtain an insight into the factors that affect mobile web site evaluations in the context of e-commerce [Cook and Campbell 1979]. The sample size was in accordance with the case study based research [Yin 1984].

Verbal protocols have proven to be useful for exploratory purposes, theory development, and hypothesis formulation concerning the use of specific information technology. During a concurrent verbal protocol session, participants are asked to "think out loud" while performing a task. Here, respondents, while surfing e-commerce mobile websites, are asked to report their thoughts with respect to the Updated D&M IS Success model categories. If the respondents did not mention the dimensions identified in the previous studies by the end of the session, they were further probed in terms of these dimensions. Moreover, if the respondents did not point out measures related to one category of the Updated D&M IS Success model, they were asked to remark their specific success measures with respect to that

category.

Each protocol, which lasted for approximately sixty minutes, was tape-recorded, transcribed, and subjected to a thematic content analysis using established qualitative coding techniques [Strauss and Corbin 1991].

The coding was conducted independently by the authors and the corresponding coding results were then confirmed. Any discrepancies were resolved through mutual agreement [Miles and Huberman 1994]. As a result, ten measurement items were identified. In addition, five academic researchers and mobile web practitioners evaluated the face and content validity of the dimensions and items identified. These people were asked to assign the individual items to the dimensional constructs of the web site evaluations and to evaluate each item in terms of wording. Items that were consistently classified by all experts and did not pose any wording problems were maintained. In total, five measures regarding “information quality”, “system quality”, and “service quality” were retained.

## 6. CONCLUSION

This study was aimed at determining a framework for investigating the factors that influence mobile web success in the context of e-commerce. In addition, it was aimed at defining an approach to determine the relative importance of the factors of mobile web success in the context of e-commerce. This would help in selecting the most preferred mobile web by identifying the relative importance of each success factor and the priority standing of alternative mobile webs. Furthermore, measures of the model were customized according to the context of the study prior to empirical evaluation of the proposed model.

Amongst the highly cited models which are used to assess the success of an information system and an e-commerce website, a majority of them have originated either from the arena of information system success or service success. However, the mechanics of an e-commerce website is based on both the information system and the service fields. Therefore, mobile web success, in the context of e-commerce, is based on a literature concerning both information system quality and service quality.

The development of information systems over time has changed the role of IS organizations as both information system provider and service provider. The Updated D&M IS Success Model (2003) is one of the highly cited models which includes both IS and Service quality as antecedents of website success. This model can be adapted to measure the challenges of the new and emerging e-commerce world [Delone and McLean 2003].

The Updated D&M IS Success Model (2003) includes three major dimensions, namely, information quality, system quality, and service quality. It is chosen as a framework to investigate the mobile web success variables in the context of e-commerce.

The Updated D&M IS Success Model (2003) was developed through the ANP approach for describing the relative importance of each success variable and ranking alternative mobile webs.

According to Saaty, many problems cannot be structured hierarchically because they involve the interaction and dependence of higher level elements on lower level

elements [Saaty 2008]. Feedback loops present in the structure of the Updated Delone and McLean IS Success Model (2003) cause interaction and dependence between higher level elements and lower level elements and hence cannot be structured hierarchically. Delone and McLean highlighted IS success as an interdependent, complex and multidimensional feature. The ANP approach was chosen to reduce the multidimensional problem structure into a one-dimensional one [Saaty 2008].

The choice of success measures in the Updated D&M IS Success Model is a function of the context and the aspect of the information system addressed in the study. Therefore, significant measures of the model (Figure 5) were extracted accordingly.

The findings show relevant success measures owing to the concurrent verbal protocol that was conducted from twelve e-commerce mobile web users.

According to the definition of e-commerce, different perspectives for e-commerce were considered during concurrent verbal protocol, such as, transactional and information retrieval [Kalakota and Whinston 1997].

A transactional task refers to any task that requires monetary transactions. In contrast, information retrieval involves only searching and browsing for information on the mobile web. Moreover, a complex task could start as an information retrieval task and then turn out to be a transactional task.

“Service quality”- Considering “responsiveness” measure and limited bandwidth prevented fast download of huge amount of information on mobile webs. Mostly, Web pages with a large amount of information or graphics were interrupted by a broken connection.

This problem could be partially caused by the wireless service. Respondents also experienced problems with transactional tasks and extensive information searches. Some transactional tasks, involving data exchange in multiple screens, often failed to connect or were disconnected halfway through. In information retrieval tasks, lengthy pages took a long time to download.

“System quality”- With respect to the “ease of navigation” measure, respondents experienced problems while scrolling. A lengthy Web page would require vertical or horizontal scrolling. While vertical scrolling is not preferred [Buchanan et al. 2001], horizontal scrolling poses problems in viewing the entire web page at first glance.

One of the system quality aspects in the context of e-commerce mobile web is to provide hyperlinks instead of keyword searches. Users believe that predefined options for searches simplify their decisions process, and thus they prefer minimized text input.

Potential threats in mobile e-commerce concern “privacy” issues, intrusion and theft of customer databases, and the unauthorized use of lost or stolen mobile devices. Mobile web e-commerce providers must alleviate consumer privacy fears by implementing secure network and encryption technologies to curb any illegal activity. Further, they should develop clear communication strategies to interact with customers and dispel these fears.

Information can be stolen or altered on mobile webs without the knowledge of the end users.

Transactions can be interrupted and then reinstated, often without reauthenticating principals. Simply “refreshing” a browser to reestablish the connection could inadver-

tently introduce “security” risks.

In the absence of reauthenticating principals, respondents felt uncomfortable with reestablishing connections and transactions.

Most mobile Web sites do not reauthenticate principals or recheck certificates once a connection has been established. This makes the websites vulnerable to attackers.

Another risk unique to mobile devices is the risk of loss or theft. While the data stored on a misplaced device might be irreplaceable or proprietary, other risks of lost Internet-enabled devices include the ability for finders of lost devices to access proprietary corporate systems, including email servers and file systems. One of the key problems with the current generation of handheld devices is the lack of a good mechanism to authenticate a particular user to a particular device.

“Information quality”- regarding “customization”, one target segment can expect customized features or functionality. Customization of mobile web eliminates excess information for the target segments by filtering unnecessary information. The results indicated that almost all of the measures indicated in the literature are found relevant in mobile web e-commerce.

In addition to the academic contribution in the field of mobile web success, the research output arising from the proposed mobile web success model through subsequent empirical studies will be able to provide practical and appropriate suggestions on mobile web success in the context of e-commerce across the globe.

## 7. FURTHER RESEARCH

To further add to the validity of the results of the qualitative analysis, a quantitative study will also be conducted.

According to the proposed framework,, extracted measures in this study will be tested in the next step through a quantitative approach (Figure 5). For the quantitative approach, a questionnaire based field survey for data collection will be conducted to investigate the relative importance of mobile web success factors in the context of e-commerce and to rank alternative mobile webs.

The questionnaire will be developed and pair wise comparisons in ANP will be conducted based on Saaty's scale [Saaty 1980]. Saaty has suggested a scale of 1 to 9 when comparing two components, with a score of 1 representing indifference between the two components and 9 representing the overwhelming dominance of the component under consideration (row component in the matrix) over the comparison component (column component in the matrix) [Saaty 1980]. The decision maker will use a series of pair wise comparisons and compare two components at a time with respect to an upper level criterion to elicit preferences of various components and attributes. Pair wise comparison identifies the relative importance or influence of each variable with respect to this upper level criterion.

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