

A model for assessing the quality of e-commerce systems

Antonia Stefani

Patras University
Department of Mathematics
Patras, Rio, GR 26500
stefani4@otenet.gr

Michalis Xenos

Hellenic Open University
School of Science and Technology
16 Sachtouri Str, Patras, GR 26223, Greece
xenos@eap.gr

SUMMARY

This paper presents a model used for assessing the quality of e-commerce systems. The proposed model is used for the analysis of user-centered quality characteristics of e-commerce systems and has formed the basis for the creation of expert evaluation checklists and surveys on user perceived quality of e-commerce systems. The paper discusses quality assessment of e-commerce systems, following the ISO 9126 quality factors and emphasising on the user-centered factors of functionality, usability, reliability and efficiency. The paper presents the decomposition of each of the aforementioned factors in specific characteristics of e-commerce systems, which leads to a hierarchical quality model comprising of three levels. The application of the model is also discussed in brief.

KEYWORDS: E-Commerce, Quality, ISO 9126, Functionality, Usability, Reliability, Efficiency.

INTRODUCTION

Electronic commerce (e-commerce) involves sharing business information, maintaining business relationships and conducting business transactions by means of telecommunication networks [1]. The medium of e-commerce is the World Wide Web, which growth has been unprecedented, with millions of users world-wide [2]. Consumers can use the web [3] to purchase all kinds of goods and services, like: books, cars, flowers, food, banking, entertainment, etc. It is easy to understand that e-commerce has brought a whole new range of services to all these users. For this reason, its growth has been impressively rapid. By the year 2003, the number of people purchasing goods and services on-line will have trebled, compared to nowadays, while it is expected that 80% of European companies will be connected to the web [4], meaning that they will be enabled to conduct electronic transactions. E-commerce consists of two distinct categories [5]: Business-to-Consumer (B2C) commerce and Business-to-Business (B2B) commerce. It should be noted that this work focuses on B2C e-commerce systems, since the proposed model assesses

the quality of e-commerce systems, as perceived by end users.

As stated by Zwass [6], the principal technologies, which are enabling e-commerce, are computer networking and telecommunications, client-server computing, multimedia and hypermedia. It can be said that e-commerce is a system which final scope is the satisfaction of the end user. The latter communicates with the virtual seller of the e-commerce shop, using a human-computer interface (HCI). Such interface is user-centred and should be effective for the user [7]. Since the e-commerce user interacts with a computer, the quality of the interface should follow the same principles as software quality. In brief, the quality of e-commerce systems is related to system quality, quality of the HCI and quality of the services offered. Given the fact that all interaction with the end user is accomplished through the human-computer interface, the quality of e-commerce systems can be addressed in similar terms as software quality.

According to the ISO 9126 standard [8], software quality consists of six quality factors, which are functionality, reliability, usability, efficiency, maintainability and portability. These factors can be further analysed in specific characteristics. Similar works concerning e-commerce systems, quite often, consider the quality factor of usability as the most significant factor of software quality [9]. However, usability is not the only factor involved in e-commerce quality; the quality factors of functionality, reliability and efficiency also contribute to user satisfaction.

The following section presents the relation of the aforementioned quality factors (functionality, reliability, usability and efficiency) to the characteristics of e-commerce systems. Emphasis is given on the effort to provide good justification why the specific quality factors play such an important role in user satisfaction. Moreover, the correlation among each of the four quality factors and the e-commerce system characteristics is discussed. The third section presents a model for assessing the quality of e-commerce systems. The model consists

of three levels; each level classifies the characteristics of e-commerce systems, according to their importance and relates them to the four quality factors. Finally, the last section summarises the basic conclusions of the paper and discusses suggestions for future work.

QUALITY IN E-COMMERCE SYSTEMS

Since the user interacts through a web interface, it is evident that e-commerce quality is related to the quality of the web pages and the services that are provided to the end user. It is argued that the quality of e-commerce systems is related to four quality factors, which are *functionality*, *reliability*, *usability*, and *efficiency*. It is worth mentioning that some of the characteristics of e-commerce systems are related to more than one of the above quality factors. A brief discussion on the quality factors follows.

Functionality

Functionality [10] refers to a set of functions and specified properties that satisfy stated or implied needs. Its sub-characteristics are suitability, accuracy, interoperability and security. Based on the definition, it is obvious that the quality factor of functionality can be related to the basic characteristics of e-commerce systems. Some of these characteristics follow. The name of the e-commerce web site and the time needed to interact with the site's web pages create the first impression to the user, given the fact that the user expects direct access to the web site and navigability through the web pages. Navigability, pleasant interface, compatibility with all kinds of browsers, multilinguality and provision of accurate information also play an important role.

Furthermore, the provision of electronic shopping cart, where the user can drop and store the merchandise while he continues to navigate, is also a functional mechanism. Additionally, electronic shopping lists enable the user to create a list for future shopping, thus saving time and effort. Another important facility, for the user, is the ability to find the right information at the right time; the availability of a search engine service and the creation of shopping categories can aid in reducing search time, but in order to search with efficiency, one needs an operable search engine and a functional site map.

Another basic functional characteristic of e-commerce is the procedure of payment. There are various methods of payment [11], such as digital currency, electronic credit card and electronic check payment. In all the above methods of payment, a very important parameter is security. The reversibility of user's actions, the existence -in every stage of the transaction- of a clear exit and the confirmation, by e-mail, that the transaction has been completed are important e-commerce characteristics related to functionality.

Navigation in an e-commerce shop is similar to a walk in a real shop, where the shopper (user) interacts with the seller (e-commerce system interface) and requires answers to questions. The provision of frequently asked questions (FAQs), or means of direct access to the e-commerce shop (telephone number, fax, e-mail) should be included in a functional e-commerce system. Moreover, a functional help service provides all kinds of information and instructions for a helpful navigation. Furthermore, the identification of the user (shopper) every time he visits the web site, as well as the provision of a district server for frequent users are functions that ensure user satisfaction.

Reliability

The quality factor of reliability [12] refers to a set of attributes that bear on the capability of software to maintain its performance level, under stated conditions, for a stated period of time. Sub-characteristics of reliability are maturity, fault tolerance and recoverability. The reliability, as far as e-commerce systems are concerned, is related to the accuracy of the information (text, images, multimedia) provided about products and services, as well as the consistency of the services (shopping list, shopping cart, searching). The e-commerce system is reliable when it restores user transactions, even in the case of a system failure.

The basic characteristic of e-commerce systems related to reliability is security of electronic financial transactions. Five blocks of security have been identified [12], as far as Internet transactions are concerned. These are confidentiality, authentication, access control, data integrity and user's accountability. For this purpose, means like digital certificates and the Secure Socket Layer (SSL) have been created and their role is to guarantee the security of transactions. The aforementioned means, using cryptographic methods, ensure the reliability of e-commerce systems and are meant to guarantee security of transactions, even in the case of system failure. Another important characteristic of e-commerce systems, which should be provided to the user, is privacy of personal information. Certain users may want to limit the number of detailed personal information (such as buying habits, or financial resources) that they are required to provide to an e-commerce system, in order to complete a transaction. Others may allow the disclosure of personal information, only if they have access to the collected information, or may want to maintain a personal record and analysis of what personal information has been collected [13]. A reliable e-commerce system should provide the possibility of such actions.

Usability

Usability is defined as a set of attributes that bear on the effort needed for the use and on the individual assessment of such use by a stated or implied set of users. Ac-

According to ISO 9126, usability's sub-characteristics are understandability, learnability and operability. Based on the definition, it is obvious that the quality factor of usability is related to characteristics of e-commerce systems, such as provision of accurate informative texts about products and services offered, as well as provision of thumbnails, photographs and videos presenting the services and products available. Additionally, a well-designed interface that attracts user's attention and facilitates navigation, contributes to the usability of e-commerce systems. Another important characteristic, related to usability, is easy and simple access to the web site of the virtual shop. A web site can either be accessed directly (by means of its name), or indirectly (through a web search engine like Yahoo [14], Altavista [15], Lycos [16], etc.

Furthermore, the effective provision of services like electronic shopping cart, electronic shopping list, site map, search engine and payment methods is of great importance to an easy to use e-commerce system. Additionally, even an inexperienced user should be able to access and use the aforementioned services easily, while experienced users demand fast and easy access to the web pages that interest them, through clear paths (e.g. not having to pass through informative pages, such as the company's history, or the company's profile). Finally, a usable e-commerce system should enable the end user to adapt the web pages to his own personal profile and needs. Consequently, applications that process user profile and adjust the interaction based on one's specific needs and preferences are desirable characteristics of e-commerce systems.

The user of the e-commerce system, just as every buyer, wishes to receive the best products and services possible, with all the advantages that a simple shop provides, like offers and special prices. Moreover, an e-commerce system should be updated regularly; new products should be presented, while those that are not for sale any more should be removed from catalogues. It is important that an e-commerce system provides the facility of cross selling complementary or similar products. Additionally, special forms enabling the user to accurately describe the ideal product for him are very usable for searching the appropriate product. Finally, it is self-evident that the provision of a detailed help service (avoiding, however, unnecessarily long texts) affects greatly the usability of the system. The operability, attractiveness and understandability of all the aforementioned characteristics of e-commerce systems are important to the usability.

Efficiency

The quality factor of efficiency [10] refers to a set of attributes that bear on the relationship between the software's performance and the amount of resources used under stated conditions. Sub-characteristics of efficiency

are time behaviour and resource behaviour. Based on the definition above it is argued that efficiency is also important to the quality of e-commerce systems. A system is efficient, if the user can access the relevant web pages promptly and easily. Additionally, navigation through the web pages should be completed at the minimum time possible, and access to the categories of products and relevant descriptive information (text and thumbnails) should be easy. Therefore, an efficient e-commerce system should rely on user personal profile, user preferences and other user information available.

THE QUALITY MODEL

The model for software quality assessment of e-commerce systems is presented in this section. The model consists of three distinct levels, in which the different characteristics of e-commerce systems are related to the quality factors. High level comprises of those characteristics of e-commerce systems that are most important for their quality. Middle level consists of the characteristics of systems that are related to the services provided, but are not as important as those of the high level. Finally, low level includes the least important characteristics. All three levels are presented in table 1, 2 and 3, correspondingly. A brief analysis of the 3 levels of the model follows.

Characteristics of e-commerce systems	Related quality factors
Easy access to the web pages of the e-commerce system.	Functionality Usability Efficiency
Easy navigation.	Functionality Usability
Adaptation to user profile.	Functionality Usability Efficiency
Search engine service.	Functionality Usability Reliability
Easy exit – undo functions.	Functionality
Useful help service.	Functionality Usability Efficiency
Electronic shopping cart.	Functionality Usability
Electronic shopping list.	Functionality Usability
Secure and reliable transactions.	Functionality Reliability
Security protocols SET, SSL.	Reliability
Correct and accurate information about the products.	Reliability
Direct delivery of the products.	Usability Efficiency
Indisputable financial transactions.	Reliability
Recoverability of products and services.	Usability Functionality
Legitimate web site.	Reliability

Table 1: High level characteristics of e-commerce systems.**High level**

This level comprises of basic services of e-commerce systems. For example, it is evident that easy access to the e-commerce web pages and navigability create the first positive impression to users. Moreover, services like electronic shopping cart, electronic shopping list and search engine are related to the functionality, efficiency and usability of e-commerce systems. Another significant factor, for earning user's trust, is the reliability of the system and the security that it provides. Therefore, the user expects a legitimate web site with indisputable transactions and services.

Middle level

This level includes services, such as multilinguality, company profile, site map, smart agents and FAQs. In order to increase user satisfaction and e-commerce systems usability, various services are provided to the user. Such services contribute to building strong relationships with customers, based on trust inspired by the system's reliability.

Characteristics of e-commerce systems	Related quality factors
Multilinguality.	Functionality Usability Reliability
Provision of company profile.	Functionality Reliability
Better and direct service for the frequent user.	Functionality Usability
Alternative searching services.	Functionality Usability
Site map service.	Usability
Alternative presentation of the products, using images, multimedia etc.	Functionality Usability
Attractive interface.	Usability
Categorisation of products.	Usability Efficiency
Direct contact with the company's personnel.	Functionality
Smart agents – FAQ.	Functionality
Sales and discounts in selected cases.	Usability Functionality

Table 2: Middle level characteristics of e-commerce systems.**Low level**

This level includes additional services and facilities aiming at the improvement of user perceived usability and efficiency. Such services and facilities are cross selling, enabling the user to select and view the product using various attributes (such as colours, sizes, etc), presentation of the product using colourful backgrounds (multimedia, graphics, special sounds, etc). The aforementioned low level characteristics are mostly related to the aesthetic of the e-commerce interface.

The use of the model

The model presented in this section aims at the assessment of the quality of e-commerce systems. The assessment method is based on a set of characteristics of e-commerce systems, as these are perceived by the users of such systems, and follows the ISO 9126 standard analysis of these characteristics. The proposed user-centered characteristics of e-commerce systems do not just form a set of properties that an e-commerce system may have or not. More than this, they form a set of hierarchically-ordered characteristics, which constitute specific quality factors according to defined weights, and eventually contribute to the overall quality of the e-commerce system which is under assessment.

Characteristics of e-commerce systems	Related quality factors
Notification about new products by e-mail.	Functionality Usability
Cross selling.	Functionality Usability
Form for the description of the ideal product.	Functionality Usability
Possibility to returning the product.	Usability
Thanking message after each purchase.	Usability
Variety of colour and graphics.	Usability

Table 3: Low level characteristics of e-commerce systems.

This model can be used both for assisting experts in evaluating the quality of e-commerce systems, as well as for providing guiding lines for the preparation of surveys focusing on users of e-commerce systems. At this point, it should be noted that the model presented forms part of an on-going research and its application, through the use of techniques for measuring quality [17,18], as perceived by users of e-commerce systems, is also in progress. The application of the proposed assessment model enabled us to use a standardised, for all involved parties, method for applying weights on the contribution of individual characteristics to the overall quality of e-commerce systems. Therefore, the analysis of results collected through the use of various methods (expert judgement and surveys on user perceived quality) was facilitated.

CONCLUSIONS AND FUTURE WORK

This paper presented a model for assessing the quality of e-commerce systems, based on a user-centered approach. The use of the model provides a standardised, for all involved parties, method for applying different techniques, such as expert judgement and surveys on user perceived quality. The on-going research on the quality of e-commerce systems, using such techniques, has offered us valuable feedback used to improve the model. Future work includes the collection –and publication– of the results gathered from the application of the proposed model, through the use of the aforementioned techniques. Moreover, it is our goal to make available, through the

internet (in a web site used for assessing the quality of e-commerce systems), the questionnaires and expert checklists, so that the collection and analysis of the results is accomplished automatically, as this would serve as a continuous assessment of e-commerce systems.

BIBLIOGRAPHY

1. Zwass, V. *Electronic commerce: structures and issues*. International Journal of Electronic Commerce, Vol. 1, No. 1, 1996, pp. 3-23.
2. FOCUS – White Paper. E-commerce. Available from <http://www.focusoft.com/ECwhitepaper.htm>
3. Bakos, J.Y. *Reducing buyer search costs: implications for electronic marketplaces*. Journal Management Science, Vol. 43, No. 12, 1997, pp. 1676-1692.
4. Ghosh S. *Making business sense of the Internet*. Harvard Business Review, March-April, 1998, pp. 127-135.
5. *Don't Panic Do E - Commerce. A Beginner's Guide to European Law Affecting E-commerce*. European Commission - Information Society Directorate-General. Available from <http://europa.eu.int/ISPO/ecommerce/legalguide.html>
6. Zwass V. *Structure and macro-level impacts of electronic commerce: from technological infrastructure to electronic marketplaces*. Published in *Emerging Information Technologies*, Thousand Oaks, CA: Sage Publications, 1999.
7. Avouris N. *Introduction to Human Computer Interaction*. Diavlos Publications, 2000.
8. ISO. *Information technology - Evaluation of software - Quality characteristics and guides for their use*. International Standard, ISO/IEC 9126: 1991.
9. Shneiderman B. *Designing information – abundant web sites: issues and recommendations*. Available from <http://www.hbuk.co.uk/ap/ijhcs/webusability/shneiderman/shneiderman.html>
10. Kitchenham B. and Pfleeger S. *Software Quality: The Elusive Target*. International Journal: IEEE Software, January, 1996, pp. 12-21
11. Perry T.S. *Electronic Money: Towards a Virtual Wallet*. Special Issue, IEEE Spectrum, Vol. 34, No. 2, 1997, pp. 18-28.
12. Fenton N. and Pfleeger S. *Software Metrics A Rigorous & Practical Approach*. Thomson Computer Press, 1997.
13. Hurwitz S.M. *Interoperable Infrastructures for Distributed Electronic Commerce*. Technical Report. National Institute of Standards. Technology Advanced Program, 1998.
14. Yahoo. Available at <http://www.yahoo.com>
15. Altavista. The search engine company. Available at <http://www.altavista.com>
16. Lycos. Available at <http://www.lycos.com>
17. Xenos M. and Christodoulakis D. *Software Quality: The user's point of view*. Published at "Software Quality and Productivity: Theory, practice, education and training", Edited by Mathew Lee et al. Chapman and Hall Publications, 1995, pp. 266-272.
18. Xenos M. and Christodoulakis D. *Measuring Perceived Software Quality*. International Journal: Information and Software Technology, Butterworth Publications, Vol. 39, June, 1997, pp. 417-424.