E-Commerce Website Quality Evaluation

Adriano Bessa Albuquerque
adrianoba@banconordeste.gov.br

Arnaldo Dias Belchior
belchior@unifor.br

Mestrado de Informática Aplicada, Universidade de Fortaleza (UNIFOR)
Av. Washington Soares, 1321 CEP 60.811-341 Fortaleza – CE – Brazil

ABSTRACT

E-commerce is considered an excellent alternative for companies to reach new customers. Sometimes, many e-commerce websites have a short life. The success of these virtual stores depends on many issues, especially their quality, as it is such a complex solution. This paper defines a relevant set of e-commerce website quality attributes based on the literature. Research was undertaken to validate and establish the relative importance of these attributes. The results were obtained from a software quality evaluation model.

1. Introduction

Today's world, becoming more competitive every day, is demanding new postures from companies, such as the flexibility to adjust themselves to the permanent situations of market change, readiness for constant innovation and warranty of the quality of products and services, seeking customer satisfaction and the maintenance of their market share.

The same thing is demanded of computer science, with the added difficulty that information technology is highly attached to the quality and speed of management decisions. To an increasing extent, software is determining the nature of experiences that customers, employees, partners and investors have with the company, its products and services and its operations [15].

As the demand for complex systems increases, quality proves to be an essential factor in software development. It thus becomes clear that there is an increasing need to invest in quality. Our industry faces three harsh realities: developing complex software of quality is extremely hard, it's not getting any easier and there is a very real shortage of skilled men and women to do the work [4].

At the same time as the above, there is a great growth in the number of business-to-business and business-to-consumer transactions performed on the internet, through websites (or simply sites) involving ecommerce. According to Coppel [6], in 1991, the Internet had less than three million users all over the world and there were no e-commerce applications. In 1999, it is estimated that 250 million users accessed Internet and approximately a quarter of the users shopped on-line through e-commerce sites, spending approximately $110 billion. [6].

Furthermore, according to Jupiter Research, e-commerce transactions: business-to-business and business-to-consumer, could exceed US$7 trillion per annum by 2005 [8]. However, these sites do not completely satisfy their customers in several aspects and those deficiencies can eventually threaten the very existence of many of those companies in the market.

This paper is intended to contribute towards the improvement of the scenario in question, collaborating in the effort to produce e-commerce sites of quality, through the identification and ranking of their main quality characteristics, as well as a survey of the different developers' and users' points of view. After analyzing those points of view, it is possible to evaluate the different expectations from this software product.

The results of this research will help developers define the subjects into which they are supposed to put more or less effort during e-commerce projects, allowing them to implement a more productive work strategy whilst serving the user.

This paper is organized as follows: Section 2 describes presents aspects related to e-commerce website quality. Section 3 presents and analyzes the results obtained in field research. Section 4 presents the main conclusions from this research.

2. Electronic Commerce Website Quality

Quality is an intrinsic and multifaceted characteristic of a product [18]. The relevance of each facet can vary with the context and over time, because people can change their points of view and update their references related to an object or a subject.

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Quality is not, therefore, absolute, but depends on the appraiser's perspective. So, any quality measure must be subjective, summarizing the impressions of a given class of individuals that interact with the product [7].

To attain the desired quality of software products, it is necessary to produce models that enable evaluation of those products' quality. According to ISO [9], the main purpose of software quality evaluation is to supply referential quantitative results to the software products that are reliable, understandable and acceptable to anyone interested. User satisfaction and economic return are also important considerations.

The first step for this approach was the identification of the e-commerce sites' quality characteristics, through research in specific bibliography, as well as through the analysis of important national and international sites. Identifying the requirements of what you should build is the hardest part of the design process. It is also what separates excellent Web shops from average ones [17].

The quality characteristics were organized using the *Fuzzy Model to Software Quality Evaluation.* The model ranks a set of software quality attributes, organizing them into three objectives, these being the general properties that the product should have. Each objective is composed of quality factors. Those factors can be subdivided into sub-factors.

Usability is a quality objective that refers to the characteristics that allow use of the e-commerce site in the most diverse situations, not only during its development process, but also during its operation and maintenance. Conceptual Reliability concerns the ecommerce site's capacity to implement, satisfactorily, what was specfied and designed. The Reliability of the Representation refers to the e-commerce site's representation characteristics that affect its understanding and manipulation along its life cycle.

The fuzzy theory is inspired by the way the human brain acquires and processes information at low cost and high efficiency [20], that is, the manner in which the human mind deals with subjective concepts such as *high*, *low*, *old*, and *new* (linguistic terms), and its natural inclination toward organizing, classifying and grouping into sets objects that share common characteristics or properties [21].

A fuzzy set is characterized by a membership function, which maps the elements of a domain, space or discourse universe X for a real number in [0, 1]. Formally, $\tilde{A} : X$? [0, 1]. Thus, a fuzzy set is presented as a set of ordered pairs in which the first element is x ? X, and the second, $?_{\tilde{A}}(x)$, is the degree of membership or the membership function of x in $\tilde{A}$, which maps x in the interval [0, 1], or, $\tilde{A} = \{(x, ?_{\tilde{A}}(x)) \mid x ? X\}$ [20]. The membership of an element within a certain set becomes a question of degree, substituting the actual dichotomic process imposed by set theory, when this treatment is not suitable. In extreme cases, the degree of membership is 0, in which case the element is not a member of the set, or the degree of membership is 1, if the element is a 100% member of the set [20].

The fuzzy model stages used for the evaluation of e-commerce website quality are described below [3]:

First Stage: *establishment of the evaluation object and the set of items to be evaluated.*

The identification of the characteristics of e-commerce website quality to be appraised was done through research in specific bibliography, as well as through the analysis of important national and international sites.

For the three quality objectives, 116 (hundred and sixteen) sub-factors for e-commerce website developers (specialists) were found and appraised, contained in 18 quality factors. For commerce website users, 78 (seventy eight) sub-factors were found, constituting a subset of the specialists' sub-factors, contained in 9 (nine) quality factors.

The evaluators gave grades from 0 to 4 to each sub-factor, which underwent fuzzification, that is, the transformation of those grades into normal triangular fuzzy numbers according to *Table 1*. Its pertinence functions graph is presented in *Figure 1* below.

A normal triangular fuzzy number can be represented by $\tilde{N}$ (a, m, b), where the values a and b identify, respectively, the inferior and superior limits of the triangle base, where $?_{\tilde{A}}(x) = 0$. The value of m corresponds to the triangle height, where $?_{\tilde{A}}(x) = 1$ [21].

Scale	Fuzzy Number	Linguistic Term
0	$\tilde{N} = (0.0; 0.0; 1.0)$	Not important (**NI**)
1	$\tilde{N} = (0.0; 1.0; 2.0)$	Little importance (**LI**)
2	$\tilde{N} = (1.0; 2.0; 3.0)$	Desirable (**D**)
3	$\tilde{N} = (2.0; 3.0; 4.0)$	Very Important (**VI**)
4	$\tilde{N} = (3.0; 4.0; 4.0)$	Indispensable (**I**)

Table 1: Normal triangular fuzzy numbers for the e-commerce website quality evaluation [3]

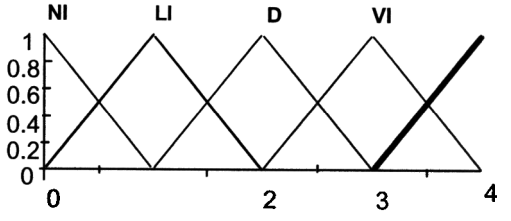

Figure 1: Pertinence functions of fuzzy numbers [3]

The set of items to be appraised, that is, the quality attributes found in this paper, were based upon [1], [2], [5], [8], [10], [11], [12], [13], [14], [16], [19].

Table 2 displays the complete set of those quality attributes. The sub-factors are organized, inside of the factors, in decreasing order of importance, according to the consolidated evaluation, that is, the joint result of the specialists' evaluation and ecommerce site users.

QUALITY SUB-FACTORS	DEVELOPERS ($\tilde{N}$)	USERS ($\tilde{N}$)	CONSOLIDATED($\tilde{N}$)
1. USABILITY	**(2.00, 3.01, 3.74)**		**(2.00, 2.98, 3.75)**
	(2.26, 3.26, 3.85)		**(2.18, 3.18, 3.85)**
1.1.1 Time behavior	(2.80, 3.80, 3.99)	(2.44, 3.44, 3.96)	(2.62, 3.62, 3.98)
1.1.2 Purchase process performance	(2.60, 3.60, 3.99)	(2.30, 3.30, 3.97)	(2.45, 3.45, 3.98)
1.1.3 Page generation speed	(2.30, 3.30, 3.96)	(2.07, 3.07, 3.97)	(2.19, 3.19, 3.96)
1.1.4 Resource behavior	(1.91, 2.91, 3.68)	(2.07, 3.06, 3.86)	(1.99, 2.99, 3.77)
1.1.5 Graphics generation speed	(1.69, 2.69, 3.63)	(1.63, 2.62, 3.50)	(1.66, 2.66, 3.57)
1.2 User friendliness	**(1.77, 2.76, 3.53)**	**(1.95, 2.94, 3.68)**	**(1.86, 2.85, 3.61)**
1.2.1 Understandability	(2.64, 3.64, 3.97)	(2.70, 3.70, 3.97)	(2.67, 3.67, 3.97)
1.2.2 Undo facilities	(2.51, 3.51, 3.96)	(2.74, 3.74, 3.96)	(2.63, 3.63, 3.96)
1.2.3 Business rules availability	(2.44, 3.44, 3.87)	(2.82, 3.76, 4.00)	(2.63, 3.60, 3.93)
1.2.4 Products information availability	(2.41, 3.41, 3.88)	(2.64, 3.63, 3.97)	(2.52, 3.52, 3.92)
1.2.5 Accessibility	(2.30, 3.30, 3.88)	(2.21, 3.20, 3.97)	(2.25, 3.25, 3.93)
1.2.6 Interactivity	(2.21, 3.17, 3.88)	(2.25, 3.25, 3.93)	(2.23, 3.21, 3.88)
1.2.7 Learnability	(2.33, 3.17, 3.88)	(1.95, 2.95, 3.82)	(2.13, 3.06, 3.85)
1.2.8 Information localizability	(1.81, 2.81, 3.66)	(2.08, 3.07, 3.82)	(1.94, 2.94, 3.74)
1.2.9 Response time uniformity	(1.83, 2.83, 3.73)	(1.99, 2.99, 3.78)	(1.91, 2.91, 3.75)
1.2.10 Communication facilities	(1.73, 2.73, 3.66)	(2.06, 3.06, 3.88)	(1.90, 2.90, 3.77)
1.2.11 Conventional forms of payment availability	(1.69, 2.69, 3.54)		(1.82, 2.82, 3.58)
1.2.12 Storage of purchase list	(1.24, 2.24, 3.20)	(1.71, 2.70, 3.66)	(1.47, 2.47, 3.43)
1.2.13 Help availability	(2.30, 2.30, 3.29)	(1.50, 2.49, 3.58)	(1.40, 2.40, 3.43)
1.2.14 Products comparison	(1.09, 2.09, 3.06)	(1.61, 2.60, 3.57)	(1.35, 2.35, 3.31)
1.2.15 Multilingual communication	(1.20, 2.20, 3.15)	(1.44, 2.44, 3.40)	(1.32, 2.32, 3.28)
1.2.16 Coherence of "shopping cart" metaphor	(1.55, 2.55, 3.38)	(1.06, 2.05, 3.01)	(1.30, 2.30, 3.20)
1.2.17 Printing facilities	(0.82, 1.82, 2.82)	(1.33, 2.32, 3.32)	(1.07, 2.07, 3.07)
1.2.18 Download facilities	(0.79, 1.79, 2.78)	(1.10, 2.09, 3.09)	(0.94, 1.94, 2.94)
1.3 Navigability	**(1.69, 2.69, 3.48)**	**(1.81, 2.81, 3.61)**	**(1.75, 2.75, 3.55)**
1.3.1 Absence of navigation errors	(2.81, 3.81, 3.97)	(2.50, 3.50, 3.97)	(2.66, 3.66, 3.97)
1.3.2 Browsers independence	(2.60, 3.60, 3.92)	(2.50, 3.50, 3.86)	(2.55, 3.55, 3.89)
1.3.3 Browsers version independence	(2.34, 3.34, 3.81)	(2.44, 3.44, 3.90)	(2.39, 3.39, 3.85)
1.3.4 Products taxonomy suitability	(2.12, 3.12, 3.87)	(2.28, 3.27, 3.97)	(2.20, 3.20, 3.92)
1.3.5 Site security information availability	(1.89, 2.89, 3.58)	(2.40, 3.39, 3.87)	(2.14, 3.14, 3.73)
1.3.6 Hardware independence	(2.20, 3.20, 3.77)	(2.07, 3.06, 3.66)	(2.13, 3.13, 3.71)
1.3.7 Minimal path	(1.98, 2.98, 3.80)	(2.06, 3.05, 3.90)	(2.02, 3.02, 3.85)
1.3.8 Drawback	(1.83, 2.83, 3.71)	(2.15, 3.15, 3.89)	(1.99, 2.99, 3.80)
1.3.9 Navigation structure taxonomy suitability	(1.94, 2.94, 3.78)	(1.98, 2.98, 3.83)	(1.96, 2.96, 3.81)
1.3.10 Links visibility	(1.90, 2.90, 3.77)	(1.77, 2.76, 3.64)	(1.83, 2.83, 3.70)
1.3.11 Information and order links visualization consistence		(1.72, 2.72, 3.62)	(1.79, 2.79, 3.65)
1.3.12 Shortcuts availability	(1.40, 2.40, 3.36)	(1.88, 2.88, 3.78)	(1.64, 2.64, 3.57)
1.3.13 Alternative paths	(1.38, 2.38, 3.32)	(1.79, 2.82, 3.78)	
1.3.14 Access device adaptability	(1.47, 2.44, 3.26)	(1.67, 2.66, 3.56)	
1.3.15 Contextualization	(1.32, 2.32, 3.32)	(1.51, 2.51, 3.38)	
1.3.16 Disabilities users interface availability	(1.08, 2.08, 3.02)	(1.49, 2.48, 3.48)	
1.3.17 Navigational prediction	(1.16, 2.16, 3.13)	(1.33, 2.33, 3.30)	
1.3.18 User class adaptability	(1.14, 2.14, 3.10)	(1.11, 2.11, 3.11)	(1.13, 2.13, 3.11)
1.3.19 User level adaptability	(1.08, 2.08, 3.01)	(1.16, 2.15, 3.15)	(1.12, 2.12, 3.08)
1.3.20 Interaction storage capacity	(0.81, 1.81, 2.81)	(1.32, 2.31, 3.31)	(1.06, 2.06, 3.06)

1.3.21 Mobile devices accessibility	(1.12, 2.12, 3.09)	(0.95, 1.95, 2.95)	(1.04, 2.04, 3.02)
1.4 Maintainability	**(2.00, 3.00, 3.82)**		**(2.00, 3.00, 3.82)**
1.4.1 Extensibility	(2.24, 3.24, 3.93)		
1.4.2 Stability	(2.09, 3.09, 3.85)		
1.4.3 Testability	(1.96, 2.96, 3.84)		(1.96, 2.96, 3.84)
1.4.4 Analyzability	(1.90, 2.90, 3.70)	–	(1.90, 2.90, 3.70)
1.4.5 Changeability	(1.83, 2.83, 3.78)	–	(1.83, 2.83, 3.78)
1.5 Technology suitability	**(2.14, 3.14, 3.88)**	–	**(2.14, 3.14, 3.88)**
1.5.1 Appropriateness of development environment	(2.36, 3.36, 3.96)	–	(2.36, 3.36, 3.96)
1.5.2 Technological infrastructure suitability	(1.92, 2.92, 3.80)	–	(1.92, 2.92, 3.80)
1.6 Reusability	**(2.07, 3.10, 3.81)**	–	**(2.07, 3.10, 3.81)**
1.6.1 Component based development	(2.10, 3.19, 3.79)	–	(2.10, 3.19, 3.79)
1.6.2 Modularity	(2.13, 3.13, 3.80)	–	(2.13,
1.6.3 Applicability	(1.97, 2.97, 3.85)	–	(1.97,
1.7 Implementation feasibility	**(2.12, 3.12, 3.76)**	–	**(2.12, 3.12, 3.76)**
1.7.1 Legal feasibility	(2.64, 3.64, 3.90)	–	(2.64, 3.64, 3.90)
1.7.2 Market feasibility	(2.21, 3.21, 3.89)	–	(2.21, 3.21, 3.89)
1.7.3 Economic feasibility	(2.18, 3.18, 3.80)	–	(2.18, 3.18, 3.80)
1.7.4 Human resources feasibility	(2.13, 3.13, 3.78)	–	(2.13, 3.13, 3.78)
1.7.5 Financial feasibility	(2.12, 3.12, 3.77)	–	(2.12, 3.12, 3.77)
1.7.6 Technology feasibility	(1.97, 2.93, 3.65)	–	(1.97, 2.93, 3.65)
1.7.7 Social feasibility	(1.63, 2.63, 3.51)		
1.8 Profitability	**(2.07, 3.07, 3.89)**	–	
1.8.1 Lucrative	(2.25,	–	
1.8.2 Market harmony	(	–	
1.8.3 Competitiveness		–	3.06, 3.99)
1.8.4 Marketing value	(2.05, 3.05, 3.93)	–	
1.8.5 Trust	(1.90, 2.90, 3.77)	–	
1.9 Involvement Capacity	**(1.92, 2.92, 3.69)**	**(1.75, 2.75, 3.58)**	**(1.83, 2.84, 3.63)**
1.9.1 Attractiveness	(2.40, 3.40, 3.99)	(2.29, 3.29, 3.95)	(2.35, 3.35, 3.97)
1.9.2 Aesthetic attributes	(2.31, 3.31, 3.94)	(2.09, 3.08, 3.95)	(2.20, 3.20, 3.95)
1.9.3 Client profile identification	(2.04, 3.04, 3.77)	(1.63, 2.63, 3.45)	(1.84, 2.84, 3.61)
1.9.4 Simulation	(1.38, 2.38, 3.37)	(1.75, 2.75, 3.54)	(1.57, 2.57, 3.46)
1.9.5 Additional services availability	(1.45, 2.45, 3.37)	(1.01, 2.01, 3.00)	(1.23, 2.23, 3.19)
2. CONCEPTUAL RELIABILITY	**(2.25, 3.26, 3.75)**	**(2.39, 3.38, 3.86)**	**(2.31, 3.31, 3.84)**
2.1 Functionality	**(2.16, 3.16, 3.81)**	**(2.12, 3.12, 3.77)**	**(2.14, 3.14, 3.79)**
2.1.1 Accuracy	(2.48, 3.48, 3.97)	(2.69, 3.68, 3.99)	(2.58, 3.58,3.98)
2.1.2 Client support	(2.52, 3.52, 3.99)	(2.61, 3.60, 3.92)	(2.56, 3.56, 3.96)
2.1.3 Availability of information on product delivery	(2.28, 3.28, 3.84)	(2.59, 3.59, 3.99)	(2.44, 3.44, 3.92)
2.1.4 Suitability	(2.03, 3.03, 3.80)	(1.95, 2.95, 3.85)	(1.99, 2.99, 3.82)
2.1.5 Flexibility	(2.12, 3.12, 3.88)	(1.51, 2.51, 3.51)	(1.82, 2.82, 3.69)
2.1.6 Interoperability	(1.50, 2.50, 3.40)	(1.41, 2.40, 3.37)	(1.45, 2.45, 3.39)
2.2 Security	(2.70, 3.70, 3.95)	**(2.85, 3.85, 3.97)**	**(2.77, 3.78, 3.96)**
2.2.1 Payment systems security	(2.95, 3.95, 4.00)	(3.00, 3.99, 4.00)	(2.96, 3.96, 4.00)
2.2.2 Vulnerability	(2.93, 3.93, 4.00)	(2.97, 3.97, 4.00)	(2.96, 3.96, 4.00)
2.2.3 Site authentication	(2.95, 3.95, 4.00)	(2.89, 3.89, 3.98)	(2.92, 3.92, 3.99)
2.2.4 Access control	(2.91, 3.91, 3.99)	(2.82, 3.82, 3.97)	(2.87, 3.87, 3.98)
2.2.5 Confidentiality		(2.97, 3.96, 4.00)	(2.78, 3.78, 3.97)

2.2.6 Privacy	(2.71, 3.71, 3.99)	(2.83, 3.83, 3.95)	(2.77, 3.77, 3.97)
2.2.7 Clients authentication	(2.63, 3.63, 3.92)	(2.71, 3.71, 3.94)	(2.67, 3.67, 3.93)
2.2.8 Imputability	(1.93, 2.93, 3.72)	(2.60, 3.59, 3.94)	(2.26, 3.26, 3.83)
2.3 Reliability	**(2.12, 3.12, 3.81)**	**(2.24, 3.24, 3.94)**	**(2.18, 3.18, 3.87)**
2.3.1 Recoverability	(2.22, 3.22, 3.92)	(2.19, 3.18, 3.97)	(2.20, 3.20, 3.95)
2.3.2 Maturity	(2.04, 3.04, 3.74)	(2.34, 3.34, 3.92)	(2.19, 3.19, 3.83)
2.3.3 Fault tolerance	(2.11, 3.11, 3.76)	(2.20, 3.20, 3.94)	(2.16, 3.16, 3.85)
2.4 Integrity	**(2.35, 3.35, 3.81)**	**(2.37, 3.37, 3.82)**	**(2.36, 3.36, 3.82)**
2.4.1 Data Integrity	(2.96, 3.96, 4.00)	(2.88, 3.88, 3.97)	(2.92, 3.92, 3.98)
2.4.2 Data entry signalizing	(2.21, 3.21, 3.75)	(2.32, 3.32, 3.84)	(2.27, 3.27, 3.79)
2.4.3 Robustness	(2.34, 3.34, 3.80)	(2.12, 3.12, 3.83)	(2.23, 3.23, 3.82)
2.4.4 Audit trail	(1.88, 2.88, 3.69)	(2.16, 3.15, 3.66)	(2.02, 3.02, 3.67)
2.5 Trustworthiness	**(2.25, 3.25, 3.83)**	–	**(2.25, 3.25, 3.83)**
2.5.1 Correctness	(2.61, 3.61, 3.92)	–	(2.61, 3.61, 3.92)
2.5.2 Completeness	(2.39, 3.39, 3.88)	–	(2.39, 3.39, 3.88)
2.5.3 Necessity	(1.74, 2.74, 3.68)	–	(1.74, 2.74, 3.68)
2.6 Content adequacy	**(1.97, 2.97, 3.30)**	**(2.40, 3.33, 3.81)**	**(2.18, 3.15, 3.81)**
2.6.1 Updated content	(2.68, 3.68, 3.95)	(2.81, 3.80, 3.99)	(2.74, 3.74, 3.97)
2.6.2 Correctness	(2.52, 3.52, 3.99)	(2.70, 3.69, 3.97)	(2.61, 3.61, 3.98)
2.6.3 Intelligibility	(2.24, 3.24, 3.82)	(3.05, 3.54, 3.97)	(2.64, 3.39, 3.90)
2.6.4 User oriented	(1.91, 2.91, 3.77)	(2.16, 3.15, 3.86)	(2.03, 3.03, 3.81)
2.6.5 Respectability	(1.65, 2.65, 3.59)	(2.32, 3.32, 3.91)	(1.99, 2.99, 3.75)
2.6.6 Concise content	(1.83, 2.83, 3.75)	(2.10, 3.10, 3.81)	(1.97, 2.97, 3.78)
2.6.7 Completeness	(1.64, 2.64, 3.56)	(2.11, 3.10, 3.92)	(1.87, 2.87, 3.74)
2.6.8 Compatibility with real store	(1.28, 2.28, 3.24)	(1.92, 2.97, 3.83)	(1.63, 2.63, 3.54)
3. REPRESENTATION RELIABILITY	**(1.96, 2.96, 3.63)**	–	**(1.96, 2.96, 3.63)**
3.1 Readability	**(2.12, 3.12, 3.82)**	–	**(2.12, 3.12, 3.82)**
3.1.1 Language correctness	(2.75, 3.75, 3.94)	–	(2.75, 3.75, 3.94)
3.1.2 Style uniformity	(2.22, 3.22, 3.95)	–	(2.22, 3.22, 3.95)
3.1.3 Clarity	(2.17, 3.17, 3.96)	–	(2.17, 3.17, 3.96)
3.1.4 Conciseness	(2.01, 3.01, 3.73)	–	(2.01, 3.01, 3.73)
3.1.5 Terminology uniformity	(1.82, 2.82, 3.70)	–	(1.82, 2.82, 3.70)
3.1.6 Abstraction uniformity	(1.74, 2.74, 3.65)	–	(1.74, 2.74, 3.65)
3.2 Standards conformance	**(2.04, 3.04, 3.54)**	–	**(2.04, 3.04, 3.54)**
3.2.1 Interface standards	(2.29, 3.29,3.83)	–	(2.29, 3.29,3.83)
3.2.2 Programming standards	(1.91, 2.91, 3.79)	–	(1.91, 2.91, 3.79)
3.2.3 Navigation standards	(1.91, 2.91, 3.76)	–	(1.91, 2.91, 3.76)
3.3 Easy of manipulation	**(1.73, 2.73, 3.53)**	–	**(1.73, 2.73, 3.53)**
3.3.1 up-to-date	(1.89, 2.89, 3.57)	–	(1.89, 2.89, 3.57)
3.3.2 Ability to trace	(1.70, 2.70, 3.55)	–	(1.70, 2.70, 3.55)
3.3.3 Documentation availability	(1.67, 2.67, 3.46)	–	(1.67, 2.67, 3.46)
3.3.4 Structure	(1.65, 2.65, 3.52)	–	(1.65, 2.65, 3.52)

Table 2: Quality Attributes of e-commerce websites

Second Stage: *obtaining specialists' and users' profiles.*

The specialists' and users' profiles were obtained through the completion of the, *Specialist Identification Questionnaire* and the *User Identification Questionnaire* respectively, generating a weighting measured by each evaluator, which will influence in the final result of the evaluation.

The evaluator's selection, for the completion of this research was addressed at those who indicated greater experience in the development of e-commerce websites (specialists), or the highest frequency of use of those

websites (users), because the intention was to obtain a Quality Standard for e-commerce website construction.

Third Stage: *determining items identified in the first stage (degree of importance).*

Field research provided opinions from thirty specialists and thirty users in four Brazilian States (Ceará, São Paulo, Brasília and Pernambuco), a total of sixty evaluators, according to the questionnaire defined in the first stage. The evaluators were guided in the sense that they had to evaluate each of the quality sub-factors surveyed, according to its importance for the e-commerce website application domain.

Fourth Stage: *treatment of specialists' collected data, in the evaluation of each collected it em.*

In that stage, the fuzzy treatment of data collected was performed in the evaluation of the developers, users, and consolidated (developers plus users), using similar facilities, considering each specialist's and each user's weighting, obtained in the second Stage, as determined by the model.

Fifth Stage: *aggregation of software quality attributes, in each quality model hierarchical level.*

In this stage, the results obtained by the sub-factors were put together to calculate the factor results, according to the model. The results obtained by the factors were joined to calculate the objective results. The results obtained reveal the quality standard for e-commerce websites.

Below, this paper will present the evaluation of results, considering the consolidated data, that is, the concatenation of the specialists' and users' data obtained from e-commerce websites

3. Evaluation of Results

The analysis was accomplished for each quality factor and sub-factor for e-commerce websites, according to the fuzzy model to software quality evaluation used. *Figure 2* displays all the factors, in decreasing order of importance, according to the consolidated results.

The Security factor was considered the most important, not only by developers but also users. The result obtained indicates that, in e-commerce websites, security is fundamental, especially when it comes to electronic payments, which cannot be vulnerable to any kind of attack, and when it comes to the subject of site authentication itself. This factor obtained the defuzzification value of 3.78, that is 22% very important and 78% indispensable.

The Integrity factor was rated second in consolidated evaluation, reinforcing that an e-commerce website has to manage and control its stored data correctly and appropriately. The consolidated value obtained was 3.36, indicating 64% very important and 36% indispensable.

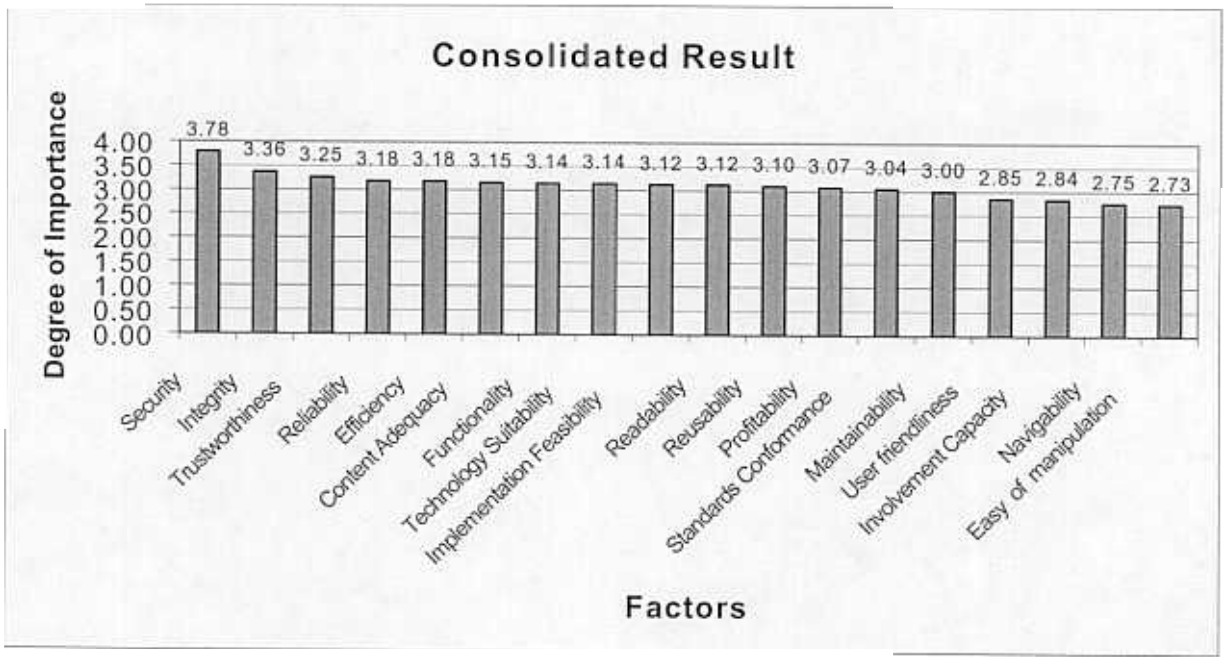

Figure 2: Consolidated result

According to *Figure 3*. it is possible to observe that the content adequacy, user friendliness and navigability factors had more sub-factors where the users' and developers' expectation difference was above 30%.

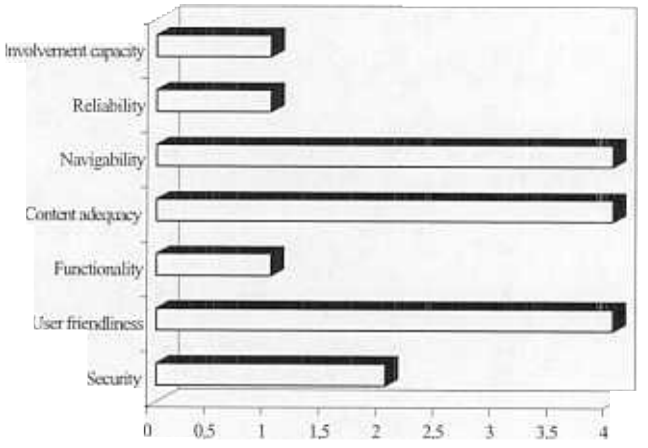

Figure 3: Factors (Difference of Expectation)

It may be seen that many developers have not sufficiently understood the importance of two fundamental attributes for e-commerce websites, the content administration (texts, graphs, video available for users) and .the usability.

4. Conclusion

All factors obtained a good final evaluation, however, the factors Security and Integrity obtained the best score of all in the consolidated evaluation (developers and users).

This result portrays the Web context, wherein electronic Commerce is inserted. Because these applications are public, accessed by a vast population of users and it is not hard to find cases of security systems defrauded by hackers who begin to gain access to unauthorized data, the community involved with the Internet (developers or users) is no longer tolerant towards e-commerce websites that do not safeguard customers' security.

Nevertheless, it was found that, in spite of the developers having evaluated the Content Adequacy, User friendliness and Navigability factors well, there are some user expectations, related with these factors, that are still not seen in the same light by them.

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