A FUZZY EVALUATION PROCESS FOR GENERAL PURPOSE WEB SITES

L. Martínez, L.G. Pérez
Department of Computer Sciences, University of Jaén
Campus Las Lagunillas s/n. 23071. Jaén. Spain.
martin,lgonzaga@ujaen.es

J.Liu
School of Computing and Mathematics,University of Ulster
Jordanstown, Belfast, Nothern Ireland, UK
j.liu@ulster.ac.uk

ABSTRACT

Nowadays, the evaluation of web sites plays an important role in order to know the critical factors for their success. Different evaluation approaches have been developed and most of them force the evaluators to provide their information using fixed numerical scales. However, the use of precise information is not always suitable because of some aspects of the quality are related to human perceptions and to factors that are unknown or unpredictable. In this contribution, we propose an adaptive fuzzy hierarchical model to evaluate the services of a general purpose web site that offers a flexible framework in which the evaluators can express their scores in different expression domains according to their knowledge.

KEYWORDS

Quality, web site, fuzzy modeling, decision-making, hierarchical process

1. INTRODUCTION

An Internet user can find many web sites that offer similar services. In the past, the quality of these web sites was not a critical factor because there was not a big competence. But currently, due to the fact of Internet development and the existence of many web sites related to the same topics, the quality of their services has become a critical factor to be successful. In such a context, evaluation tools are applied to the web sites in order to improve the quality of their services and identify their lacks.

The *Quality* of a web site measures how well it meets the consumer necessities and so, it is associated with consumer *satisfaction* (Nagel, P.J.A. and Cilliers, W.W., 1990). *Quality* can be described as conformance to requirements and *satisfaction* as conformance to expectation. The ideal situation is when there are no differences between consumer judgments of quality and experienced satisfaction. However, it is very difficult to meet all the consumers' requirements.

In the literature we can find different evaluation models applied to specific types of web sites (Banârte, M. et al, 1997; Bharati, P. and Chaudhury, A., 2004; Kurnia, S. and Schubert P., 2004; Negash S. et al, 2003; Torres, A.I. and Vitorino F., 2004). However, the quality evaluation is not an easy task because quality is a complex concept that depends on many factors, where some of them are related to human perceptions or depend on factors that are unknown or unpredictable.

In this contribution we shall propose an adaptive fuzzy evaluation process for general purpose web sites that can be easily adapted for different specific types of web sites. This model will offer a flexible hierarchical evaluation framework, where the quality will be described by a set of dimensions, and where each dimension is formed by a group of criteria. These criteria could be assessed according to its nature and the experts' knowledge with different types of information. Moreover, this model could be adapted to different kinds of web sites or situations changing the aggregation mechanisms, in such a way, the model could measure the importance of an expert, criterion, or dimension, or even ignore those that are not relevant to the kind of the evaluated web site.

To accomplish these aims, on the one hand, the aspects need to be described or evaluated in a domain according to their nature. While quantitative aspects can be described by numbers, qualitative aspects are better described by linguistic sentences than by numbers because it is closest manner to how the evaluators express this kind of knowledge. The Fuzzy Linguistic Approach (Zadeh, L.A., 1975) represents qualitative aspects as linguistic values by means of linguistic variables and has proved to be successful managing this kind of information. On the other hand, because of we are dealing with information that belongs to different domains, linguistic or numerical, and there is no direct way to aggregate it, we propose the use of the 2-tuple Linguistic Approach (Herrera, F. and Martínez, L., 2000 (2)). This approach has showed to be successful in other topics managing heterogeneous information, such as decision making (Herrera, F. and Martínez, L., 2001), engineering system evaluation models (Martínez, L. et al, 2005) or educational quality evaluation (Martínez, L. et al, 2004).

This contribution is structured as follows: In section 2 we review some evaluation models, in section 3 we present our proposal, in section 4 we show how to adapt the evaluation process and eventually, some concluding remarks are pointed out.

2. OVERVIEW OF QUALITY EVALUATION MODELS FOR WEB SITE

In the Table 1 we can find a review of several evaluation methods for web sites with different purposes.

Table1. Evaluation models

Purpose	Evaluation model	Dimensions and criteria
Evaluation of e-commerce web sites	WAI (Web Assessment Index) (Miranda, F.J. and Bañegil, T.M., 2004.)	4 dimensions: accessibility, speed, navigability, content quality. 21 criteria
	A framework and methodology for evaluating e-commerce web sites (Merwe, R. van der and Bekker, J., 2003.)	5 criteria categories: interface, navigation, content, reliability, technical; and 4 criteria group within each of the criteria categories. 5 criteria for each criteria group
	EWAM (Extended Web Evaluation Model) (Schubert, P., 2003)	6 dimensions: information phase, agreement phase, settlement phase, after-sale phase, community component, final section. 26 criteria
	The Servqual scale adapted to electronic services (Torres, A.I. and Vitorino F., 2004.)	9 dimensions, 6 for the evaluation search satisfaction (information reliability, convenience, entertainment, assurance, site design, virtual environment) and 3 for Internet purchase experience satisfaction (security, product offer, convenience). 34 criteria
	Sitequal (Webb, H.W. and Webb, L.A., 2004)	Service quality has 5 dimensions: reliability, responsiveness, assurance, empathy, tangibility; and information quality 4 dimensions: accessibility quality, contextual quality, representational quality, intrinsic quality. 43 criteria (21 service quality and 22 information quality)
	Developing and validating an instrument for measuring user-perceived web quality (Aladwani, A.M. and Palvia, P.C., 2002.)	4 dimensions: technical adequacy, specific content, content quality, web appearance. 25 criteria.
	Web site design benchmarking within industry groups (Kim, S.-E. et al, 2003)	6 dimensions: business function, corporation credibility, contents reliability, web site attractiveness, systematic structure, navigation. 46 criteria
Evaluation of Decision Support System web sites	Evaluation of web-based decision support systems (Bharati, P. and Chaudhury, A., 2004)	3 dimensions: system quality, information quality, information presentation. 13 criteria
Evaluation of academic library web sites	Assessing the quality of academic libraries on the Web: the development and testing of criteria (Chao, H., 2002)	No dimension. 16 criteria
Evaluation of general purpose web sites	Perceptions about the quality of web sites: a survey amongst students at Northeastern University and Erasmus University (Iwaarden, J. van et al, 2004.)	12 dimensions: clarity of purpose, design, communication, reliability, service and faq, accessibility and speed, product or service choice, order confirmation, product purchase, user recognitions, extra service, frequent buyer incentives. 50 criteria
Evaluation of e-government web sites	Measuring Web site quality improvements: a case study of the forum on strategic management knowledge exchange (Barnes, S.J., 2003)	4 dimensions: usability, design, information quality, service quality. 20 criteria
Evaluation of educational web sites	EWSE (Educational Web Site Evaluator) (Hwang, G.-J. et al, 2004)	3 dimensions: the design of the student interface, the quality of instructional content, the assessments functions. 25 criteria

We must realize that because quality is a complex concept and there is not any formal definition of quality, no method evaluates it directly, but they use their own evaluation framework. Therefore, depending on the evaluated web site, it must be analyzed which factors will describe better the quality and how they will be evaluated and aggregated. Moreover, the aim of some of these models is not only to obtain a global assessment of the web site, but to obtain where the lacks of quality are. In these cases, intermediate results are offered in order to identify which parts of the web site should be improved. Last but not least, different scales must be chosen in order to make easier the evaluation for the evaluators but enough accurate to gather the assessments without losing information.

These decisions are not easy to make and some methodologies and solutions have been proposed. In the next section, we shall review them.

2.1 Choosing criteria and scales

To resolve the problem of choosing the best criteria that defines the quality of the web site, some authors (Chao, H., 2002; Hwang, G.-J. et al, 2004.) propose to do tests, analyze data obtained from the evaluation or use the opinions of a group of experts with the aim of being able to choose the most suitable criteria that describe the quality of the web sites that they want to evaluate. Another solution (Miranda, F.J. and Bañegil, T.M., 2004) is to be flexible enough to develop a model that is adaptable to the type of web sites.

Finally, the most common scale that is used to evaluate the criteria and to show the results is the fixed numerical scale (Aladwani, A.M. and Palvia, P.C., 2002; Evans, J.R. and King V.E., 1999; Kim, S.-E. et al, 2003). The greatest disadvantage of using this scale is that it is not appropriate to assess qualitative aspects or quantitative aspects that are better described with words than with numbers. Furthermore, a unique scale is usually used to assess all criteria, although neither all criteria have the same nature nor the evaluators have the same knowledge about them.

2.2 Organizing criteria

The evaluation framework organizes the factors or criteria in order to obtain an evaluation of the quality of a web site. Most of the models use hierarchical structures with two layers structure (Hwang, G.-J. et al, 2004; Kim, S.-E. et al, 2003; Miranda, F.J. and Bañegil, T.M., 2004). In this structure (Figure 1), in the outer layer the quality dimensions are defined, and in the inner, their criteria are defined. In these cases, the evaluation process can be very simple, a group of evaluators must assess the criteria of the inner layer; these criteria are aggregated to obtain an evaluation of each dimension and finally these evaluations are aggregated to obtain the final evaluation of the quality of the web site. In this way, we have not only obtained the quality of a web site, but also we can identify and study where the lacks of quality are.

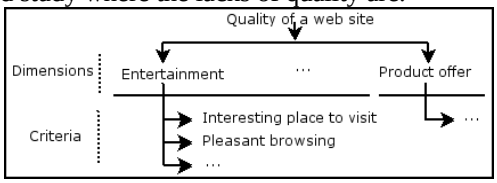

Figure 1. Two layers structure with dimensions and criteria

2.3 Evaluation models

A list of web sites evaluation models is showed in Table 1. We must remark that most of these models evaluate specific web sites or a type of web site such as EWSE that evaluates Educational Web Site (Hwang, G.-J. et al, 2004.), or WAI (Web Assessment Index) (Miranda, F.J. and Bañegil, T.M., 2004) that evaluates e-commerce web sites.

Most of these evaluations methods are based on the features showed in section 2.1 and 2.2. They have gathered their own set of criteria and dimensions to obtain the quality of a web site, organized them in a two

layers structure, and used fixed scale to evaluate them. This type of evaluation method is very common but presents some disadvantages that are showed in next subsection.

2.4 Problems

Although most of the evaluation models have obtained good results, there are still unresolved problems or new problems have arisen. Many of these models have been developed for a specific web site (Barnes, S.J., 2003; Bharati, P. and Chaudhury, A., 2004; Chao, H., 2002; Hwang, G.-J. et al , 2004) and can be hardly adapted to other similar situations.

Besides, most of the models force the evaluators (experts, users,...) to express their information for each criterion using the same numerical scale fixed in advance (Barnes, S.J., 2003; Torres, A.I. and Vitorino F., 2004; Iwaarden, J. van et al, 2004). However, there are some criteria that should not be evaluated with precise information because they are related to human perceptions or depend on factors that that are unknown or unpredictable. In these situations, the use of the fuzzy linguistic approach would be more suitable.

Eventually, the final results are usually expressed with numbers and reviewed by people that are untrained in statistical and/or numerical results. Therefore, their decisions about the improvement of the web sites cannot be taken easily and accurately, and the next quality evaluation of the web site could not be as good as it was expected, even, worse. We think these results should be expressed in a more natural way nearer to the human language (i.e. linguistic information).

3. A FUZZY QUALITY EVALUATION METHOD FOR GENERAL PURPOSE WEB SITES

As we have aforementioned in the previous sections, there are some aspects of the evaluation methods that could be improved. Our proposal has focused in those aspects that improve the use and the accuracy of the evaluation and the understanding of the results.

First of all, our method offers a flexible evaluation framework where the criterion can be assessed in different domains, numerical and linguistic, according to their nature and where evaluation process can be changed using different aggregation operators to adapt it to different types of web sites. Thus, this method permits to adapt the aspects evaluated for each web site and the domains utilized to asses them.

Secondly, this method expresses the results, *the web site quality* and *its quality dimensions*, by means of a linguistic evaluation scale that makes easier the understanding of the results than numerical values to make decisions about which aspect of the web site should be improved.

Mathematically our model is an evaluation process in which a group of evaluators $E = \{e_1, \ldots, e_n\}$ will evaluate a web site WS where each expert, e_k will provide his/her opinions about a set of dimensions $D = \{d_1, \ldots d_q\}$ where each dimension, d_i, has a set of criteria $C_i = \{c_{1i}, \ldots, c_{ti}\}$ by means of a utility vector (see Figure 2).

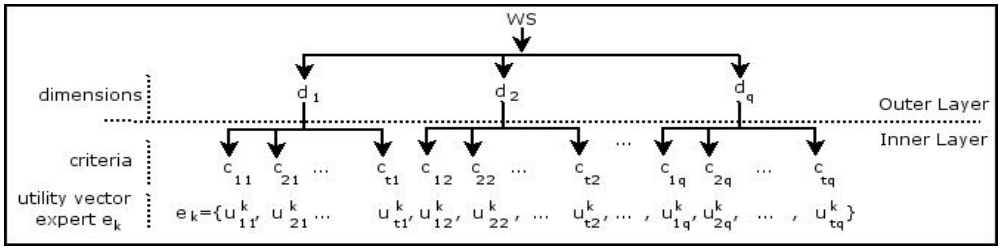

Figure 2. Hierarchical evaluation framework

Where u^k_{tq} is an assessment provided by the evaluator e_k that describes the criterion c_{tq} of the dimension d_q. It can be a numerical (N) or linguistic (L) value according to the nature of the criterion c_{tq} and the knowledge of the evaluators about the criterion.

In the following subsection is presented the evaluation framework we shall propose to evaluate the web site. Afterwards, we shall present the evaluation model.

3.1 Evaluation Framework

This section presents the set of dimensions and criteria that will be used to evaluate a general purpose web site and that will be organized into a hierarchical structure (see Figure 2). These criteria and dimensions have been chosen from the literature showed in Table 1.

The dimensions and their criteria are:

- **Entertainment:** *interesting place to visit*, *pleasant browsing*, *entertainment and leisure*, *easy browsing* and *information diversity.*
- **Convenience:** *economy of time spent*, *effort spent*, *easy access*, *fast information transmission*, *interaction capacity*, *fast delivery* and *easy way of buying.*
- **Information reliability**: *up-to-date information*, *information depth*, *search results*, *uncluttered web pages*, *easy search paths* and *easiness in comparing information.*
- **Security and assurance**: *payment security*, *trust in supplier*, *privacy of purchase*, *data transmission assurance* and *privacy.*
- **Site design**: *advertising contents* and *attractive presentation.*
- **Virtual environment**: *capacity of simulating reality*, *personal contact absence* and *personal-sales absence*.
- **Product offer:** easy to compare products' characteristics, diversity of products' brands, product guarantee, price reduced products and possibility to return.

3.2 Evaluation model

The evaluation model we propose consist of two phases. In the first one we obtain an evaluation value for each dimension and in the second one, we obtain the quality of a general purpose web site. These phases are (see Figure 3):

1. Quality of each dimension: the information provided by the evaluators is aggregated to obtain the quality of each dimension. We must notice that this information could have been assessed in different domains and must be treated before the aggregation process.
2. Global quality of a web site: the assessments obtained in the before step are aggregated in order to obtain the global quality of the web site.

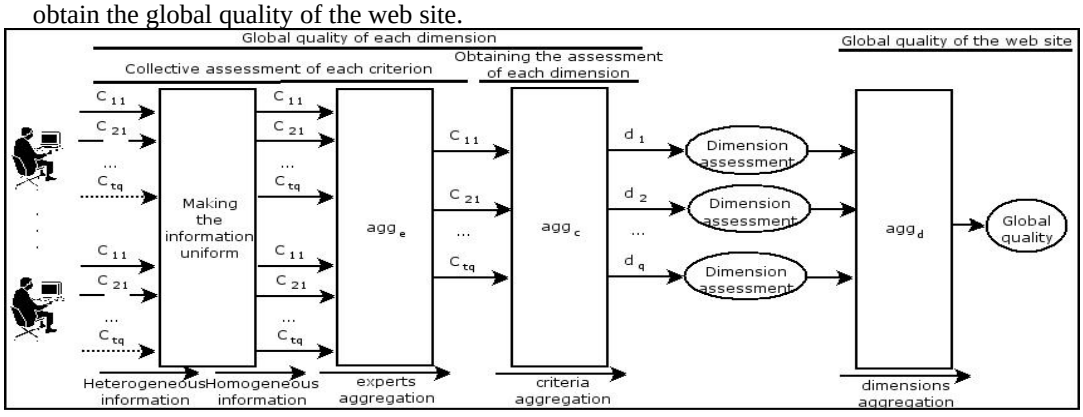

Figure 3. Evaluation model

3.2.1 Quality of each dimension

In this step we want to obtain a collective assessment for each dimension according to the opinions of a group of evaluators. These opinions may have been expressed in different domains (numerical or linguistic), and our aim is to obtain the collective assessments of each dimension in a specific linguistic domain that can be understood by the evaluators or by the people that are studying the web site.

To do so, we shall aggregate the information according to the following steps:

1. Making the information uniform.
2. Obtaining the collective assessments for each criterion.
3. Obtaining the quality of each dimension.

Now, we shall explain these steps in detail:

Making the information uniform

To manage this heterogeneous information, we shall transform it into a unified linguistic term set (BLTS), S_T. To accomplish this task, first of all, we need to choose a suitable S_T according to (Herrera, F. and Martínez, L., 2000), secondly, once S_T has been chosen, each numerical and linguistic value is expressed by means of a fuzzy set on the BLTS, $F(S_T)$, using the following functions (Herrera, F. et al, 2005):

- $\tau_{NS_T} : [0,1] \to F(S_T)$ that transforms numerical values ϑ in $[0,1]$ into $F(S_T)$:

$$\tau_{NS_T} : [0,1] \to F(S_T)$$

$$\tau_{NS_T}(\vartheta) = \{(s_0, \gamma_0), ..., (s_g, \gamma_g)\}, s_i \in S_T \text{ and } \gamma_i \in [0,1]$$

$$\gamma_i = \mu_{s_i}(\vartheta) = \begin{cases} 0, & \text{if } \vartheta \notin \text{Support } (\mu_{s_i}(x)) \\ \dfrac{\vartheta - a_i}{b_i - a_i} & \text{if } a_i \le \vartheta \le b_i \\ 1 & \text{if } b_i \le \vartheta \le d_i \\ \dfrac{c_i - \vartheta}{c_i - d_i} & \text{if } d_i \le \vartheta \le c_i \end{cases}$$

  Where the fuzzy sets are trapezoids and represented by a parametric function (a_i, b_i, d_i, c_i) *and* $g+1$ *is cardinality of* S_T. *A particular case is when we use linguistic assessments whose membership functions are triangular, i.e.,* $b_i = d_i$.

- $\tau_{SS_T} : S \to F(S_T)$ that transforms a linguistic term $l_i \in S$ into $F(S_T)$:

$$\tau_{SS_T} : S \to F(S_T)$$

$$T_{SS_T}(l_i) = \{(s_k, \gamma_k^i) / k \in \{0, ..., g\}\}, \forall l_i \in S$$

$$\gamma_k^i = \max_y \min\{\mu_{l_i}(y), \mu_{s_k}(y)\}$$

  Where $\mu_{l_i}(\cdot)$ *and* $\mu_{s_k}(\cdot)$ *are the membership functions of the fuzzy sets associated with the terms* l_i *and* s_k, *respectively.*

And finally, these fuzzy sets are transformed into 2-tuples by means of the function χ that transform a fuzzy set into a linguistic 2-tuple:

$$\chi : F(S_T) \to S_T \times [-0.5, 0.5)$$

$$\chi(F(S_T)) = \chi(\{(s_j, \gamma_j), j = 0, ..., g\}) = \Delta\left(\frac{\sum_{j=0}^{g} j\gamma_j}{\sum_{j=0}^{g} \gamma_j}\right) = (s, \alpha)$$

Where $\Delta : [0, g] \to S_T[-0.5, 0.5)$ *is* $\Delta(\beta) = \begin{cases} s_i & i = round(\beta) \\ \alpha = \beta - i & \alpha \in [-0.5, 0.5) \end{cases}$

Now, all the information is expressed as 2-tuples linguist terms and in the same domain. Therefore, this information can be easily aggregated and their results are easier to understand.

Obtaining the collective assessment of each criterion

Once we have unified the information, our objective is to obtain a collective evaluation for each criterion according to the opinions provided by the evaluators. To accomplish this point we shall aggregate the assessments provided by the experts using an aggregation operator:

$$CVC_{ti} = agg_e\left(u_{ti}^k, k = 1,\ldots n\right) = u_{ti}$$

Where agg_e is an aggregation operator. Its choice is presented in section 4.

Obtaining the assessment of each dimension

In this step we shall aggregate the collective assessments of the criteria that belong to a dimension ED_i in order to obtain a collective value for each dimension:

$$ED_i = agg_c\left(u_{ji}, j = 1,\ldots,t\right) = u_i$$

Where agg_c is an aggregation operator.

Global quality of the web site

Our final aim is to obtain a global evaluation assessment, EAW, for the web site we are evaluating. To obtain this value we shall aggregate the quality assessment of each dimension:

$$EAW = agg_d\left(u_i, i = 1\ldots q\right) = u$$

Where agg_d is an aggregation operator.

This final assessment stands for the quality of the web site and is expressed in the BLTS (our linguistic evaluation scale) that will be better understood than numerical values.

4. ADAPTING THE EVALUATION PROCESS

The evaluation process can be adapted to evaluate different types of web sites. This adaptation is based on the selection of the aggregation operators for agg_e, agg_c, agg_d. We shall use some of the 2-tuple aggregation operators presented in (Herrera, F. and Martínez, L., 2000 (2)) in order to adapt the evaluation process to different situations.

The purpose of agg_e is to obtain an overall assessments of the criterion aggregating the opinions of each expert. If within the group of experts we could find there are experts whose opinions are more important than the others, a weighted average operator would be more suitable because is able to capture the importance of the opinions of each expert. However, if everybody had an equal importance, this aggregation operation would be carried out by an arithmetic mean.

While agg_c and agg_d are used to aggregate the collective assessments of the criteria and dimensions, respectively. In most cases, we shall evaluate specific web sites that only need to evaluate some dimensions and criteria and where each criterion or dimension could have a different importance. To gather this importance and be able to remove useless dimensions and criteria we shall use a Weighted Average Operator. For instance, a hospital web site does not need to evaluate the dimensions and criteria related to selling product, such as product offer or payment security, could use a weighted vector that gives an importance of 0 to those dimensions and criteria that are not needed. In those cases where we use all the criteria and/or dimensions and they have an equal importance, an arithmetic mean will be used.

5. CONCLUDING REMARKS

Our proposal offers a very flexible model that can be adapted to different evaluation situations. First of all, the domain of each criterion is chosen according to the knowledge of the evaluators and the nature of the criterion. Secondly, the aggregations of these assessments are carried out using different aggregation operators depending of the situation and characteristic of our evaluation process. And finally, the results of the evaluations, both the factors of the quality and the quality, are expressed by means of linguistic assessments to make easier their understanding.

ACKNOWLEDGEMENT

This work has been partially supported by the Research Project MTM-2005-08982-C04-03.

REFERENCES

Aladwani, A.M. and Palvia, P.C., 2002. Developing and validating an instrument for measuring user-perceived web quality. *Information and Management*, Vol. 39 , No. 6, pp 467-476

Banârte, M. et al, 1997. Providing quality of service over the web: A newspaper-based approach. *Computer Networks and ISDN Systems*, Vol. 29 , No. 8-13, pp 1457-1465.

Barnes, S.J., 2003. Measuring web site quality improvements: a case study of the forum on strategic management knowledge exchange. *Industrial Management and Data System*, No. 103.

Bharati, P. and Chaudhury, A., 2004. An empirical investigation of decision-making satisfaction in web-based decision support systems. *Decision Support Systems*, Vol. 37, No. 2, pp 187-197.

Chao, H., 2002. Assessing the quality of academic libraries on the web: The development and testing criteria. *Library and Information Science Research*, Vol. 24, No. 2, pp 169-194.

Evans, J.R. and King V.E., 1999. Business-to-business marketing and the world wide web: Planning, managing, and assessing web sites. *Industrial Marketing Management*, No. 28, pp 343-358

Herrera, F. et al, 2005. Managing non-homogeneous information in group decision making. *European Journal of Operational Research*, 166:1, pp 115-132

Herrera, F. and Martínez, L., 2000. An approach for combining linguistic and numerical information based on 2-tuple fuzzy representation model in decision-making. *Int. J. of Uncertainty, Fuzziness and Knowledge-Based Systems*, Vol. 8 No. 5, pp 539-562

Herrera, F. and Martínez, L., 2000 (2). A 2-tuple fuzzy linguistic representation model for computing with words. *IEEE Transactions on Fuzzy Systems*, Vol. 8, No. 6, pp 746-752.

Herrera, F. and Martínez, L., 2001. The 2-tuple linguistic computational model. Advantages of its linguistic description, accuracy and consistency. *Int. J. of Uncertainty, Fuzziness and Knowledge-Based Systems*. Vol. 9(Suppl.), pp 33-49.

Hwang, G.-J. et al, 2004. A group-decision approach for evaluating educational web sites. *Computer & Education*, Vol. 42 No. 1, 2004, pp 65-86

Iwaarden, J. van et al, 2004. Perceptions about the quality of web sites: a survey amongst student at northeastern university and erasmus university. *Information and Management*, Vol. 41 , No. 8, pp. 947-959

Kim, S.-E. et al, 2003. Web site design benchmarking within industry groups. *Internet Research*, Vol 13 No.1 , pp.17-26

Kurnia, S. and Schubert P., 2004. An assessment of australian web sites in the grocery sector. *Proceedings of IADIS International Conference e-Commerce*. Lisbon, Portugal, pp 229-236.

Nagel, P.J.A. and Cilliers, W.W., 1990. Customer satisfaction: A comprehensive approach. *International Journal of Physical Distribution and Logistic Management*, Vol. 20, No. 6, pp 2-46.

Negash S. et al, 2003. Quality and effectiveness in web-based customer support systems. *Information and Management* Vol. 40, No 8., pp 757-768.

Martínez, L. et al, 2004. An automatic educational quality evaluation fuzzy system. *Proceedings of IADAT-e 2004 International Conference in Education*. Bilbao, Spain, pp, 28-32

Martínez, L. et al, 2005. A Multi-Granular Linguistic Evaluation model for Engineering Systems. *IFSA 2005 World Congress, Fuzzy Logic, Soft Computing and Computational Intelligence Theories and Applications*, Beijing, China.

Merwe, R. van der and Bekker, J., 2003. A framework and methodology for evaluating e-commerce web sites. *Internet Research*, Vol. 13, No.5, pp 330-341.

Miranda, F.J. and Bañegil, T.M., 2004. Quantitative evaluation of commercial web sites: an empirical study of spanish firms. *International Journal of Information Management*, Vol. 24, No. 4, pp 313-328.

Schubert, P., 2003. Extended web assessment method (EWAM) - evaluation of electronic commerce applications from the customer's viewpoint. *International Journal of Electronic Commerce*, Vol. 7, No. 2, pp 51-81

Torres, A.I. and Vitorino F., 2004. An e-satisfaction model - application to internet information search and purchase. *Proceedings of AIDIS International Conference e-Commerce.* Lisbon, Portugal, pp 313-319.

Webb, H.W. and Webb, L.A., 2004. Sitequal: an integrated measure of web site quality. *The Journal of Enterprise Information Management*, Vol. 17, No. 6, pp 430-440

Zadeh, L.A., 1975. The concept of a linguistic variable and its applications to approximate reasoning. *Information Sciences*, Part I, II, III, 8,8,9, pp 199-249, pp 301-357, pp 43-80.