

WebQual: An Exploration of Web-site Quality

Stuart Barnes & Richard Vidgen

*School of Management, University of Bath, Bath BA2 7AY, United Kingdom
mnsj@management.bath.ac.uk, mnsrv@management.bath.ac.uk*

Abstract - The issue of web-site quality is tackled from the perspective of the ‘voice of the customer’. Quality function deployment (QFD) is adopted as a framework for identifying web-site qualities demanded by users, which are gathered through a quality workshop. From the workshop an instrument for assessing web-site quality is developed (WebQual) and tested in the domain of UK business schools. The results of the WebQual survey are presented and analyzed, leading to the generation of a WebQual Index of web-site quality. Work under way to extend and refine the WebQual instrument includes electronic commerce evaluation, where web-site service quality is proposed as a key issue.

I. INTRODUCTION

In the relatively short time since the Internet entered mainstream commercial activity the worldwide web (WWW) has become a major area of business focus. Companies of all shapes and sizes in a broad range of industries are exploring ways to initiate Internet commerce. By the millennium (2000) it is estimated that electronic commerce will be worth \$160 billion (<http://www.forrester.com>). Moreover, besides the predicted growth the WWW will allow businesses to reach out to new markets that could not otherwise be explored [29].

In the Internet environment users are both providers and consumers of information and services. The ease with which web pages can be published has created numerous problems, such as incorrect or out of date information, disorientating navigation, and broken links. Information and service quality are now significant factors impacting the effectiveness of web-sites and it is an issue which will determine the ability of businesses to reap the benefits of ecommerce. However, although Web technologies might be relatively new, the issues of information system quality are a longstanding topic of IS research.

In this paper we report on empirical research exploring some of the dimensions of web-site quality. In section 2 we place this research in a broader context by considering the literature relating to information quality. This is followed by an explanation of the research methodology used in the study - quality function deployment (QFD), which uses a questionnaire to reflect the ‘voice of the web-site user’. The fourth section reports on the data collection process and in the fifth section the results of the data analysis are reported, including preliminary exploration of validity and reliability. Finally, some conclusions are provided along with plans for

future developments of the research.

II. INFORMATION QUALITY

There is a longstanding body of IS literature examining aspects of information and information quality. Most of this literature predates the explosion in Web Commerce (e.g. see [10]). The originators of much of this research effort were Shannon and Weaver [26], who pioneered seminal work on communications. Critically, they examined “information” as the message in a communication system, from sender (S), via a communication channel, to receiver (R). This can be measured at a number of levels: technical, referring to the accuracy and efficiency of the system producing information; semantic, referring to the success of the system in conveying intended meaning; and, effectiveness, referring to the effect or influence [19] of the information on the receiver. Such a conception is most poignant, even to Web Commerce, where organisations aim to transmit data efficiently and accurately over the Internet, e.g. product offerings, which convey the desired meaning, e.g. characteristics of products, and have the desired effect, e.g. sales.

Consequently, communication theory demonstrates the serial nature of information (as a form of communication); the system, such as the Web, creates information which is communicated to the recipient, who is then influenced (or not) by the information. Latterly, in addition to first party access of information, where the user directly seeks or “pulls” information from the Web, technology is also available which allows information to be “pushed” or “broadcast”, i.e. provided by a third party according to a profile of requirements. A fundamental aspect of this process is the quality of the information produced and transmitted to the recipient. As we shall see, this is also, to a certain extent, controllable. However, strongly associated with this, one of the most difficult aspects of this process is determining the influence of such information on end-users, particularly with regard to the complexity and diversity of recipients on the WWW. Within this paper, the discussion is confined to the former: examining the quality of information produced and transmitted by the sender. The latter is not within the domain of this paper, although effort is currently being employed in this area.

Following on from the work on communications theory, a number of authors have attempted to define and measure characteristics contributing to the quality of information produced and transmitted within IS. Such work has emerged

from field, laboratory, theoretic and taxonomic research (e.g. [2], [3], [10], [16], [18], [20], [21], [28]).

One of the best known pieces of work in this area is that of Bailey and Pearson [2], who develop a tool for measuring IS user satisfaction from fieldwork with 32 managers in 8 organisations. From this, DeLone and McLean [10] in their taxonomy of IS success variables identify 9 items pertaining to information quality: accuracy, precision, currency, timeliness, reliability, completeness, volume, format and relevance. However, and perhaps related to their loose application of the concepts of “system” and “information” quality, such a classification is not entirely appropriate. Indeed, as others have suggested, some inherent qualities of the system contribute directly to the quality of information [22]. Subsequently, taking a holistic stance, we may tentatively include the items referring to confidence/security of data, convenience of access, language, understanding, utility and integration. In support, some other studies examining quality also identify these additional measures (e.g. [8], [18], [22]).

Overall, we can identify 15 items from Bailey and Pearson’s 39-item instrument which relate to information quality. These items provide a rounded and comprehensive assessment of information quality; herein lies the strength of the measures, and this is one of the reasons why Bailey and Pearson’s work has proved enduring over the last two decades. We could look at numerous other peer-related works to try and develop and extend this selection, but the overarching story would be very similar: the literature lends strong support to these measures (e.g. [3], [12], [20], [21], [28]).

Having explored information quality in IS in general terms, this begs the question of how the issues relate specifically to the WWW. There are few academic studies and measures of Web information quality, although doubtless many are in the process of development. Recent research (in progress) examining the quality of Web-sites (e.g., [1], [4], [24], [25]) tend to raise a number of important issues in measuring the quality of information. In particular, some of these tend to focus on “hard” characteristics or functionality of Web-sites, at the expense of softer issues surrounding quality as espoused by users [4]. Such soft issues are very important if Web-sites are to be demand-driven (by user requirements) rather than supply-driven (by technological capability). Indeed, there is evidence to suggest that it is the simple accessibility and usefulness of sites that is taking precedence over “technical wizardry” [11]; technological capability should be used appropriately to support the development of sites focused on the user. Going one step further, research in the general area of product quality advocates disentangling the concepts of demand-driven, soft characteristics, from hard characteristics and functionality [17]; the approach makes these entities explicit and maps the relations between them. However, in some Web assessment research these areas are combined, which tends to confuse the issue, making it more difficult to assess the added value of sites for the user [24].

The corollary of this is an emphasis on the importance of the techniques used in assessing the quality of Web-sites. Taking onboard the importance of providing user-oriented offerings for the customer, how should we go about defining their requirements? Only then can we realistically go about creating relevant functionality and technological content. At first, this is not an easy question to answer. However, we believe that there is a particular technique that can prove enlightening in this important area – quality function deployment (QFD). The next section describes the technique and its use in the context of this study.

III. THE RESEARCH APPROACH

The research approach adopted is to use quality function deployment (QFD) as a framework for exploring web-site quality. QFD is a “structured and disciplined process that provides a means to identify and carry the voice of the customer through each stage of product and or service development and implementation” [27]. This approach is also reflected in the work of Strong et al., who underline the importance of going beyond intrinsic data quality: “the quality of data cannot be assessed independent of the people who use data – data consumers” [28]. Based upon a distinction of ‘what’ and ‘how’, a series of matrices are used to deploy customer-demanded qualities through design requirements, product functions, part characteristics, and manufacturing operations into production requirements ([15], [17]). QFD has roots in manufacturing industries but there have been applications to software development (e.g., most notably by [5], [9], [14], [31], [32]).

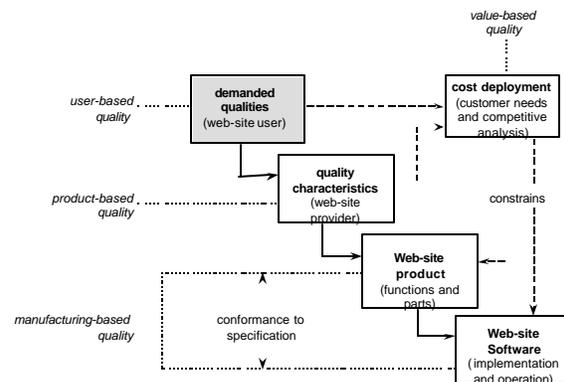


Fig. 1. QFD and Web-site Development

We have adapted QFD for web-site development and incorporated Garvin’s [13] different views of quality into our conceptual framework (Fig. 1). This view of quality recognises that although customers might drive quality there is also a place for product-based quality (the supplier perspective), conformance to specification, and a general recognition of cost constraints and competitive pressures as real-world

factors to be taken account of. For example, in the context of web-sites, one of the user web-site qualities identified in our research was “is easy to find”. A quality characteristic relevant to this user need might be “percent of correct guesses at URL of web-site by users in a panel test” together with some target, such as 90% recognition. Another characteristic related to this quality might be ranking in search engines, where a web-site function associated with the characteristic might be the capacity for automated submission of the site to search engines.

IV. DATA COLLECTION

To build an initial list of qualities we ran a quality workshop. Bossert [6] recommends a three-stage process for the workshop: establish a single issue for discussion; collect quality requirements and functions using post-it notes; and, use affinity grouping to gather requirements into categories that make sense to the customer. The delegates at the workshop were six Masters students studying for a degree in Management and Strategic Information Systems. The single issue for discussion was: “What are the qualities of an excellent web-site?” Delegates worked individually writing out their ideas onto post-it notes and were encouraged to put down a brief phrase together with a longer sentence to explain the rationale for the proposed quality. The delegates were then allocated to two teams and asked to combine their qualities into affinity groups (a tree-structured list), initially working in silence to move the post-its around and creating headings as felt appropriate. Finally, the two teams were brought back together to produce a single consolidated list of demanded qualities. By the end of the session we had collected fifty-four raw qualities which were structured hierarchically into affinity groupings.

A. Refining the Voice of the Customer

From the raw qualities a pilot questionnaire with thirty-five questions was developed. This was completed by the six attendees of the workshop and used to refine the questions. One outcome of the pilot was a recognition that the questionnaire was too long – to answer thirty-five questions for each of four web-sites leads to 140 assessments, plus a further 35 assessments of the importance of each quality. Using the literature on information quality and looking carefully for overlap of qualities the questionnaire was reduced to a more manageable 24 questions. Wherever possible, we removed questions that referred too directly to characteristics, functions, or parts of the web-site, since these represent the supplier perspective and are addressed in subsequent QFD matrices. In conjunction with defining the qualities a dictionary was developed to provide a short textual description of each quality to provide the user with further contextual detail when completing the questionnaire. This is similar to the textual backup provided with the society for information management (SIM) surveys of key issues in

information systems [7]. For example, the quality “Has an appropriate style of design for site type” has in the quality dictionary: “The layout and appearance of the site are in character with the site type. For example, an entertainment site might have a radical and innovative design that would not be appropriate for a government agency.”

B. The WebQual Instrument

The revised list of qualities was developed into an Internet-based questionnaire to evaluate the quality of four UK business school web-sites: Bath, London (LBS), Manchester (MBS), and Warwick (WBS). The design settled on was to have an opening instruction page that would then open a separate Web browser window containing the qualities to be assessed (Fig. 2). The control panel allowed the user to switch the contents of the target window between the instruction page, the target web-site to be evaluated, and the quality dictionary. This allowed the user to decide on the sequence of site evaluation. For example, the user could decide to answer all 24 questions for one site and then move on to the next site, answer the same question for all four sites, or adopt a mixture of the two approaches. Having the quality dictionary online and linked to the question number made it easy to get more details of a particular quality. Using an Internet questionnaire with two windows was vastly preferable to using a paper-based questionnaire – it also allowed for the automatic collection of results.

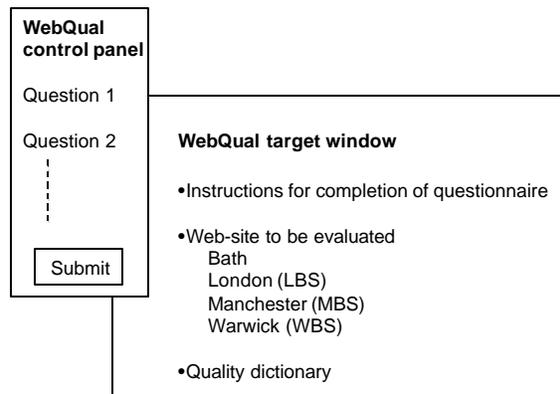


Fig. 2. Internet-based Online Questionnaire

V. ANALYSIS AND DISCUSSION OF RESULTS

The data collected is summarised in Table 1. Note that at this stage, we have not presented any groupings of the questions to provide pertinent categories (this is discussed below). There were 46 questionnaires used for the main part of the analysis, collected from two independent samples of respondents. There were 32 responses from 40 final year

TABLE 1
SUMMARY AVERAGES FOR WEIGHTED AND UNWEIGHTED DATA SETS

No.	Description	Import.	Bath Data		LBS Data		MBS Data		WBS Data	
			Score	Wgt. Score	Score	Wgt. Score	Score	Wgt. Score	Score	Wgt. Score
1	is easy to use	4.35	3.76	16.43	3.37	14.65	3.15	13.85	3.50	15.24
2	has things where you expect to find them	4.11	3.67	15.43	3.50	14.59	3.28	13.70	3.63	14.96
3	is easy to find your way around	4.35	3.67	16.35	3.33	14.46	3.30	14.57	3.70	16.04
4	has fast navigation to pages	4.11	4.30	17.63	3.87	15.93	4.02	16.57	3.83	15.67
5	has useful links to other sites	3.02	2.72	8.78	3.04	9.65	2.67	8.41	2.76	8.61
6	is easy to find	4.11	3.72	15.41	3.74	15.57	3.76	15.63	3.37	13.96
7	facilitates return visits	3.39	3.39	12.07	3.50	12.57	3.30	11.61	3.20	11.46
8	has an attractive appearance	3.76	3.59	13.63	4.02	15.46	2.35	8.67	3.17	11.78
9	has an appropriate style of design for site type	3.56	3.72	13.36	3.49	12.69	2.78	9.71	3.52	12.41
10	provides quick and easy access to finding information	4.54	3.72	17.17	3.43	15.61	3.35	15.17	3.76	17.09
11	provides relevant information	4.41	3.72	16.57	3.46	15.30	3.50	15.50	3.63	16.11
12	provides information at an appropriate level of detail	3.96	3.67	14.67	3.33	13.07	3.20	12.61	3.50	13.96
13	provides information content that is easy to read	4.11	3.98	16.72	3.52	14.65	3.22	13.37	3.59	15.02
14	communicates information in an appropriate format	3.83	3.74	14.48	3.26	12.59	3.07	11.83	3.43	13.24
15	provides information content that is easy to understand	4.04	4.02	16.52	3.57	14.46	3.54	14.50	3.80	15.57
16	has information that is updated regularly	4.11	3.24	13.52	3.78	15.72	3.37	13.89	3.30	13.76
17	has reliable information	4.43	3.72	16.70	3.67	16.50	3.63	16.30	3.59	16.09
18	has a reasonable loading time	4.33	4.26	18.59	3.87	16.85	4.00	17.37	3.91	17.13
19	creates an experience	3.07	2.98	9.13	3.48	11.09	2.52	7.67	3.00	9.30
20	conveys a sense of community	2.72	3.17	8.76	3.24	9.04	2.93	8.22	3.02	8.22
21	keeps the user's attention	3.96	3.22	13.07	3.57	14.39	2.43	9.80	2.98	11.96
22	is a site that feels secure	3.43	3.52	12.80	3.37	12.02	3.28	11.87	3.33	12.04
23	makes it easy to give feedback	3.43	3.22	11.37	3.09	10.89	3.20	11.26	3.22	11.13
24	makes it easy to contact the organisation	4.11	3.96	16.74	3.78	15.98	3.91	16.48	3.74	15.65
TOTALS:			86.67	345.90	84.27	333.71	77.78	308.56	82.48	326.39

business administration undergraduates, on a four year 'sandwich' course, and 14 responses from a total of 33 M.Sc. students studying Management and Strategic IS, a one-year taught conversion course for graduates. The questionnaire responses were received via e-mail and converted into a form usable in SPSS, the statistical package.

A. Comparing Questionnaire Samples

In order to conduct analysis with a higher level of significance, it was desirable to combine the two questionnaire sets into just one set of data. This makes intuitive sense, since both were sets of students studying similar topics at the same University. The demographics were also quite similar in terms of proportions of international students and age. However, there were some differences, such as the length of tuition at the University and familiarity with the Internet. Thus, in order to confirm that the two questionnaire sets can be soundly combined, it was important to compare the distributions of the two samples to establish similarity.

To compare the questionnaire sets, two main tests were conducted. A t-test was used to test for differences in means. Levene's test was used to compare for equality of variances. These tests were conducted on the weighted responses for each of the assessed web-sites: Bath, LBS, MBS and WBS.

Levene's test confirmed that, for 23 questions, the variances were the same for the samples collected from both groups of students, with 95% confidence. The exception was question 18, which failed the test for three of the four business

school data sets; this question was later removed from the analysis. The reason for this result may be due to the bias of network architecture for the local site, in which case it should be removed.

The t-test for comparison of means showed that with a few notable exceptions, the means were also the same, again with 95% confidence. The exceptions were some close calls for three questions in single data sets, which, in the overall context of the complete sets of data, were not considered important.

B. Discussion of the Summary Data

Table 1 shows a number of items for discussion. Firstly, the Import. score gives the average importance ranking for each question, based on the 46 responses. Secondly, the per question average scores for each of the business school data sets is given. This is displayed in two modes: Score is the average for raw, unweighted ratings (with a theoretical range of 1 to 5), and Wgt. Score is the average for weighted ratings (theoretically ranging from 1 to 25). The latter refers to multiplying the unweighted score by the importance for each respondent, and then calculating the average.

Referring to Table 1, we see some interesting patterns in the data. In terms of the importance ratings of particular questions, there are some useful grouping to note. Those questions considered most important, e.g. above upper quartile of 4.16, are all about getting fast and easy access to relevant and reliable information. Here we find, in order of

importance, questions 10, 17, 11, 3 and 1 (question 18 was removed from the analysis - see above). At the other end of the spectrum, those questions considered least important, e.g. below the 3.53 lower quartile, are based around the experience, security, links, feedback and return visits. Specifically, questions 20, 5, 19, 7, 22 and 23 are in ascending order of importance. Other questions are in between, and the median is 4.08.

The results suggest that there are specific priorities in the qualities demanded from business school web-sites by users. Getting easy access to 'good' information appears paramount, whilst certain other aspects which may be important for some commercial sites, such as security and building a networked community experience for users to return to, is not so important. Intuitively, such trends make sense, particularly when we consider that the primary focus seems to be on information-orientation rather than business transactions, achieving critical mass or brand loyalty.

Of course, the importance ratings filter through to the weighted results of the business school data sets. Unweighted results for individual questions show some varying results for individual questions, with each institution achieving a top score for one or more questions. Weighted results serve to accentuate these differences in the direction of user priorities.

One key aim of this approach is to achieve some overall quality rating for each assessed web-site. To this end, total scores are provided for weighted and unweighted data sets. In this case, the rankings of total scores for the sites are the same, although the relative sizes are different via the weighting scheme.

Unfortunately, the total scores make it difficult to give a benchmark for the sites. One way to achieve this is to index the total weighted score for each site against the total possible score (i.e. the total importance for all questions multiplied by 5, the maximum rating for a site). A summary of these calculations and totals are given in Table 2 (adjusted for the removal of question 18). Overall, it appears that the quality rankings are, in descending order: Bath, LBS, WBS and MBS.

TABLE 2
COMPARATIVE TOTAL SCORES FOR THE SITES

Site	Wgt. Score	Max.	WQ Index
Bath	327.31	444.52	0.74
LBS	316.86	444.52	0.71
WBS	309.26	444.52	0.70
MBS	291.19	444.52	0.66

However, perhaps more interesting is some assessment of how the web-sites differ in quality. A discussion of scores for each and every question would be cumbersome at this point. Rather, it would be useful to assess the ratings of the sites in a number of meaningful, reliable question sub-groupings. To this end, the next section derives a number of sub-groupings

and applies them to the analysis.

C. Scale Reliability and Question Groupings

In order to verify the reliability of the WebQual instrument, a statistical reliability analysis was conducted using Cronbach's α . This was used on each of the business school data sets. The test resulted in α scores between 0.91 and 0.93 for all 23 questions (excluding question 18), suggesting that the scale is in fact quite reliable.

TABLE 3
SUMMARY OF RELIABILITY ANALYSIS FOR QUESTIONNAIRE CATEGORIES

Original Groups	Qn.s	Avg α	Final Groups	Qn.s	Avg α
<i>Navigation</i>	1-7	0.73	<i>Ease of Use</i>	1-3	0.83
- navigation	1-5		- navigation	2-3	
- finding the site	6-7		- general ease of use	1	
<i>Presentation</i>	8-9	0.79	<i>Experience</i>	8-9,19-21	0.87
- aesthetics	8-9		- visual impact	8-9	
<i>Information</i>	10-17	0.86	- individual impact	19-21	
- finding information	10		<i>Information</i>	10-17	0.86
- information content	11-17		- finding information	10	
<i>Experience</i>	19-22	0.76	- information content	11-17	
- site experience	19-21		<i>Comm. & Integration</i>	4-7,22-24	0.71
- security	22		- external integration	5-7	
<i>Interaction</i>	22-23	0.57	- communication	4,22-24	
- communication	22-23				

Furthermore, to better analyse the differences in user-derived qualities of the sites, reliability analysis was extended to a number of question sub-groupings. The beginning and end results of this analysis are summarised in Table 3, which displays groupings and average Alpha values achieved for the four business school data sets. Originally, a number of tentative, intuitive sub-groupings were proposed, and these were used for the first phase of reliability analysis. As we can see, some of these groupings are supported by the Cronbach's α average values, particularly the Information category ($\alpha=0.86$). However, some of the Alpha average values are relatively low (e.g. for Interaction where $\alpha=0.57$), indicating that the scales are less reliable, and that the question groupings are less than optimal.

Iterative removal and replacement of questions in different groupings showed that, in terms of statistical reliability, they could be improved. Thus, we move from the five main categories on the left of Table 3, to the four on the right. The values of α for the new categories are high, indicating these groupings are quite reliable. Intuitively, these groups appear valid and meaningful. Briefly, they can be explained as follows:

- *Ease of Use*. Being able to get around a site and find things. Important aspects include simple, intuitive and consistent navigation.
- *Experience*. The visual and personal experience of visiting the site. Issues include design, use of colours and style, as well as building interest and a sense of community.

- *Information.* Access to good quality information content. Such information is appropriate for consumption by the user. Typically, the information should be easy to read and understand, relevant, current, reliable and provided via an appropriate level of detail and format.
- *Communication and Integration.* The way the site is integrated with the external environment and communication with the user. This includes being able to find and return to a site, integration or links with other sites, the speed and security of communication, and provision for feedback and other contact.

The above categories provide some useful criteria by which to assess the web-sites of the four business schools. This is discussed in the next subsection.

D. Site Analysis Using Question Subcategories

Using the question groupings, we can build a profile of an individual web-site that is easily compared to its contemporaries. We are now in a position to examine why some sites fared better than others on the WebQual Index, as given in Table 2. Fig. 3 gives an example of how this can be achieved.

As a starting point, the data was summarised around the questionnaire subcategories. Then, and similarly to the WebQual Index in Table 2, the total score for each category was indexed against the maximum score (based on the importance ratings for questions multiplied by 5). Fig. 3 is the result, which rates each of the four web-sites using these criteria. Note that the scale has been adjusted to between 0.4 to 0.8 to allow for clearer comparison.

Fig. 3 demonstrates that each site has its own strengths and weaknesses, as measured through the voice of the user or customer. For example, the LBS web-site creates the greatest

aesthetic impact and impact on the individual, and is soundly integrated externally, being easily found by the user, and with extensive links to other sites. In contrast, the Bath site is easier to use and navigate, placing emphasis on the quality of information and communication links. The WBS site is not far behind on these scores. However, the MBS site is clearly lacking in a number of areas, most noticeably in terms of aesthetic appeal, individual impact, navigation and ease of use, with information subcategories also given a low ranking.

E. Extending the Model

As well as providing information, web-sites can be thought of as providing a service, especially sites geared toward electronic commerce. This is the active aspect of a web-site that goes beyond delivering information, moving into interactivity such as placing orders, making payment, and tracking the status of online transactions. We therefore suggest that the literature on service quality is relevant to web-sites since information quality will be accompanied by a perception of service quality. The SERVQUAL instrument [30] is a well-established model of service quality and has been applied in many domains, including information system effectiveness [23]. Our aim is to adapt the SERVQUAL instrument to assess web-site service quality rather than IS department service quality. The SERVQUAL instrument incorporates 5 service quality dimensions: tangibles, reliability, responsiveness, assurance, and empathy. Tangibles, for example, are concerned with the appearance of facilities, employees, materials, while reliability is the ability to perform the promised service dependably and accurately, and assurance is achieved when employees instil confidence and customers feel safe in the hands of the company. A first comparison of WebQual and SERVQUAL shows that many of

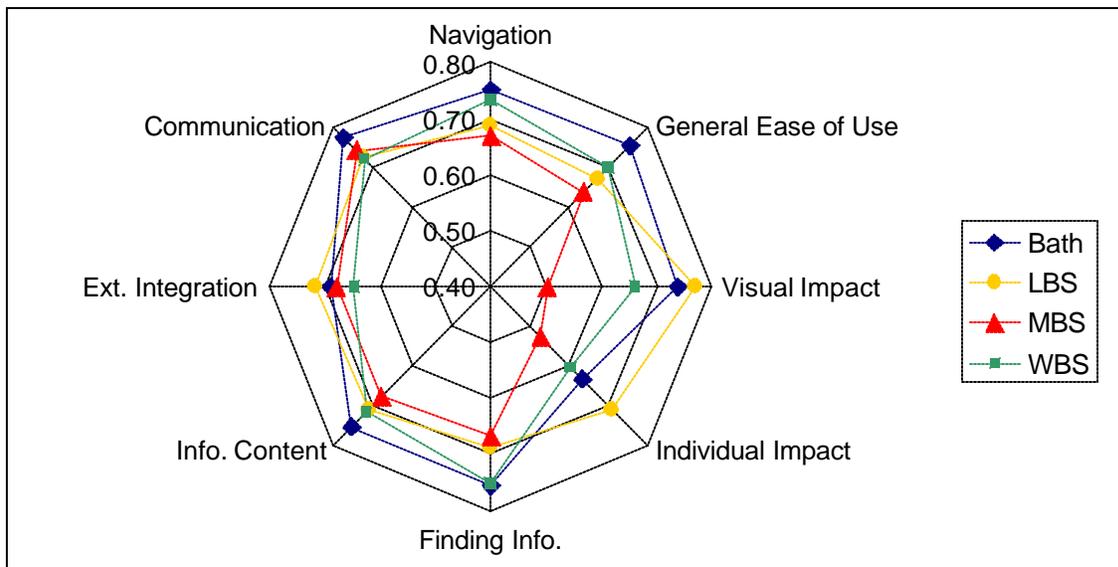


Fig. 3: Radar Chart of WebQual Subcategories for the Four Data Sets

the SERVQUAL characteristics are encompassed in WebQual (e.g., web-site tangibles) but some dimensions are addressed less well (e.g., empathy). We believe that these dimensions will be particularly relevant to e-commerce sites where web-site information quality will need to be balanced by web-site service quality. To this end a detailed comparison of WebQual with SERVQUAL is being undertaken.

VI. SUMMARY AND FUTURE WORK

The WebQual instrument was developed from a quality workshop and tested in the domain of business school web-sites. Analysis of the results suggests that the WebQual instrument has validity, although clearly further testing with larger and varied samples is needed. Although the primary aim of this research was to develop the WebQual instrument, a necessary output of the research is a ranking of business school web-sites. To check for bias it would be desirable to conduct the same WebQual survey using students from each of the business schools to see to what extent the use of Bath students may have biased the results.

Future development of the instrument falls into three main areas. Firstly, we will develop the instrument through application to different domains and populations and conduct further statistical tests to ascertain validity and generalizability across domains (e.g., travel bookings). Secondly, we will enhance the questionnaire through comparison with existing instruments - notably Bailey and Pearson for information quality and SERVQUAL for web-site service quality - to improve internal validity and to check for external validity. Thirdly, we aim to deploy the WebQual qualities into web-site characteristics and web-site functions to give the instrument predictive ability. Aligned with this will be tests where WebQual is administered before and after web-site redesign to assess by how much user perceptions of quality have improved. More generally, we will also include benchmarking against exemplary or well-known sites, such as Amazon books, so that organizations can gauge how their WebQual Index compares with industry leaders and the industry average.

REFERENCES

- [1] E. Abels, M. White, and K. Hahn, "Identifying user-based criteria for Web pages", *Internet Research: Electronic Networking Applications and Policy*, 7(4), 1997, pp. 252-262.
- [2] J.E. Bailey, and S.W. Pearson, "Development of a Tool for Measuring and Analyzing User Satisfaction", *Management Science*, 29(5), 1983, pp. 530-545.
- [3] L. Berry, and A. Parasuraman, "Listening to the Customer - The Concept of a Service-Quality Information System", *Sloan Management Review*, Vol. 38(3), 1997, pp. 65-76.
- [4] C. Bauer, and A. Scharl, "A Classification Framework and Assessment Model for Automated Web-site Evaluation", *Proceedings of the Seventh European Conference on Information Systems*, 1999, pp. 758-65
- [5] M. Betts, "QFD Integrated with Software Engineering", *Transactions from the Second Symposium on Quality Function Deployment*, Novi, Michigan, June 18-19, 1990.
- [6] J. L. Bossert, *Quality Function Deployment, a practitioner's approach*, ASQC Quality Press, Wisconsin, 1991.
- [7] J. Brancheau, B. Janz, and C. Wetherbe, "Key issues in information systems management: 1994-95 SIM Delphi Results", *MIS Quarterly*, 20(2), 1996, pp. 225-242.
- [8] R.B. Clements, *Creating and Assuring Quality*, ASQC Quality Press, Wisconsin, 1990.
- [9] L. Cohen, *Quality Function Deployment*, Addison-Wesley, Reading, MA, 1995.
- [10] W.H. DeLone, and E.R. McLean, "Information Systems Success: the Quest for the Dependent Variable", *Information Systems Research*, 3(1), 1992, pp. 60-95.
- [11] S. Dutta, and A. Segev, "Business Transformation on the Internet", *European Management Journal*, 17 (5), 1999, pp. 466-76.
- [12] C. Firth, *When Do Data Quality Problems Occur?*, available [Online] at: <http://sunflower.singnet.com.sg/~cfirth/dq1.htm>, 1997.
- [13] D. Garvin, "What does Product Quality Mean?", *Sloan Management Review*, No. 4, 1984, pp. 25-43.
- [14] S. Haag, M. Raja, and L. Schkade, "Quality Function Deployment Usage in Software Development", *Communications of the ACM*, 39(1), 1996, pp. 39-49.
- [15] J.R. Hauser, and D. Clausing, "The House of Quality", *Harvard Business Review*, 3 (May-June), 1988, pp. 63-73.
- [16] B. Ives, M.H. Olson, and J. Barouldi, "The Measurement of User Satisfaction", *Communication of the ACM*, 26(10), 1983, pp. 785-793.
- [17] R. King, *Better Designs in Half the Time: implementing QFD*, GOAL/QPC, Methuen, Massachusetts, 1989.
- [18] W.R. King, and B.J. Epstein, "Assessing Information System Value", *Decision Sciences*, 14 (1), 1983, pp. 34-45.
- [19] R.O. Mason, "Measuring Information Output: A Communication Systems Approach", *Information Processing and Management*, 1(5), 1978, pp. 219-234.
- [20] H. Miller, "The Multiple Dimensions of Information Quality", *Information Systems Management*, 13(2), 1996, pp. 79-82.
- [21] J. Miller, and B.A. Doyle, "Measuring the Effectiveness of Computer Based Information Systems in the Financial Services Sector", *MIS Quarterly*, 11(1), 1987, pp. 107-117.
- [22] V. Ribièrè, A.J. LaSalle, R. Khorramshahgol and Y. Gousty, "Hospital Information Systems Quality: A Customer Satisfaction Assessment Tool", *Proceedings of the 32nd Hawaii International Conference on System Sciences*, 1999.
- [23] L. Pitt, R. Watson, and C. Kavan, "Service Quality: a Measure of information systems effectiveness", *MIS Quarterly* June, 1995, pp. 173-187.
- [24] P. Schubert, and D. Selz, "Web Assessment -Measuring the Effectiveness of Electronic Commerce Sites Going Beyond Traditional Marketing Paradigms", *Proceedings of the 32nd Hawaii International Conference on System Sciences*, 1999.
- [25] P. Schubert, and D. Selz, "Web Assessment - A Model for the Evaluation and the Assessment of Successful Electronic Commerce Applications", *International Journal of Electronic Markets*, 7(3), 1997, pp. 46-48.
- [26] C. Shannon, and W. Weaver, *Mathematical Theory of Communication*, University of Illinois Press, Urbana, 1949.
- [27] R. Slabey, "QFD: A Basic Primer. Excerpts from the implementation manual for the three day QFD workshop", *Transactions from the Second Symposium on Quality Function Deployment*, Novi, Michigan, June 18-19, 1990.
- [28] D.M. Strong, Y.W. Lee, and R.Y. Wang, "Data quality in context", *Communications of the ACM*, 40(5), 1997, pp. 103-110.

- [29] G. Yan, and J.C. Paradi, "Success Criteria for Financial Institutions in Electronic Commerce", *Proceedings of the 32nd Hawaii International Conference on System Sciences*, 1999.
- [30] V. Zeithaml, A. Parasuram an, and L. Berry, *Delivering Quality Service: balancing customer perceptions and expectations*, The Free Press, New York, 1990.
- [31] R. Zultner, "Software Quality [Function] Deployment: applying QFD to software", *Transactions from the Second Symposium on Quality Function Deployment*, Novi, Michigan June 18-19, 1990.
- [32] R. Zultner, "TQM for Technical Teams", *Communications of the ACM*, 36(10), 1993, pp. 79-91.