

2001

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Xue Li

*The University of Queensland, Xueli@csee.UQ.edu.au*

Wayne Huang

*Ohio University, huangw@ohio.edu*

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## Recommended Citation

Li, Xue and Huang, Wayne, "On the Assessment of Commercial Website - An Expert System Approach" (2001). *ACIS 2001 Proceedings*. 50.

<http://aisel.aisnet.org/acis2001/50>

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## On the Assessment of Commercial Website - An Expert System Approach

Xue Li<sup>a</sup> and Wayne Huang<sup>b</sup>

<sup>a</sup>School of Computer Science and Electrical Engineering  
The University of Queensland, Brisbane, Australia  
Xueli@csee.UQ.edu.au

<sup>b</sup>Dept. of Management Information Systems  
College of Business, Ohio University, USA  
huangw@ohio.edu

### Abstract

*The assessment of commercial website is about the evaluation of websites on the Internet for commercial usage. From an information system perspective, they can be assessed objectively or subjectively. From a business point of view, they can be assessed quantitatively or qualitatively. In this paper we propose an expert system approach to evaluate commercial website in both of these two aspects in order to gain a clear picture of their values.*

### Keywords

Expert Systems HA04, Software Evaluation ED02, Interactive Information Systems GE04

### INTRODUCTION

Currently, every 24 hours, about 1.9 million new web pages are posted and 12,981 domain names registered. The number of unique websites reached 3.65 million and some 4400 sites were launched each day (Hollands 2000). A huge amount dot.com companies are registered daily now. An imposing question is that:

How can a decision-maker know the newly proposed e-business model is going to be competitive and viable on the Internet?

The issue here is to gain the information in order to estimate the value of the website that is built based on an e-business model. It is easy to analyse the websites that are already successful but it is not easy for a “copy-cat” e-business to survive (Liu 1997, Viehland 2000). For the emerging e-businesses, they have to analyse the risks and to compare and contrast the proposed model with all e-business models on-line. A few studies have been reported for both subjective and objective assessment of commercial usage of the WWW (Cheung and Huang 2000, Elliot *et al* 2000, Liu *et al* 1997). In those studies, traditional survey methodology is used to sample the websites for e-business model analysis. We consider improving the decision-making process by applying an expert system (Turban 1992) approach to deal with the analysis of the implementation of an e-business model. In general, an on-line expert system should be constructed to reflect the decision making process of assessing an e-business model for its usefulness, competitiveness, and the viability. The usefulness is about the functionality of the e-business model (Huang and Li 2001). The competitiveness is about the strength of the e-business model that provides customers with cost-effective products and services (Li and Low 2000). The viability is about the ability of coping with changes and dynamics in the WWW environment (Li 2000a, 2000b). These three properties will also affect each other. The overall representation of these three aspects can be simplified as a value of the website (Ho, 1996).

We regard e-business models are externally viewed as commercial websites. So from a user’s view point, a commercial website can be classified in terms of its:

- **functions** (advertising, On-line ordering, searching, etc),
- **appearance** (frames, cascading style sheets, forms, etc),
- **application areas** (Finance, Manufacturing, etc),
- **technologies** (Static or dynamic HTML pages, server-side, client-side scripting, cookies, etc), and
- **performance** (responding speed, security control, etc.).

Furthermore, a commercial website can be assessed based on its **architecture**: the front-end (animations, multimedia, stylish pictures, personalised services,) and back-end system supports (Database connectivity, Decision Support, Analytical tools, Data Warehousing, etc). The overall assessment of a commercial website requires the knowledge-based assessment to all the aspects of a website. In other words, it needs expertise to qualify a website for its commercial usage.

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There are two ways to assess a website within two aspects: objective or subjective, qualitative or quantitative. Figure 1 shows these perspectives. From a perspective of the information systems, the objective assessment is a process that the external properties of the system (e.g., functions and performances) are studied by human being. While the subjective assessment is a process that human knowledge is applied to benchmark the systems. From a business point of view, the qualitative assessment is about the evaluation of the system functions or the behaviours that are usually not quantifiable. While the quantitative approach is about the measurement of the factors that reflect the system properties in terms of frequencies, patterns, and any other quantifiable attributes. More details regarding these four different options in Figure 1 will be given in the section of related work.

|              | Objective | Subjective |
|--------------|-----------|------------|
| Qualitative  |           |            |
| Quantitative |           |            |

Figure 1: The Assessment of Commercial Web Site

In the following discussions, we will discuss our on-going project namely, Commercial Website Assessment (CWA) expert system that aims to gain the expert experiences in assessing the commercial websites. In a way it is subjective because the individual expertise is used. However we consider the further integration of the online analytical tools to be used for improving its objectiveness (Li and Low 2000). We will firstly introduce our expert system framework. Then we give some sample inference rules for the website assessment. The relevant works will be described before the final conclusions.

## FRAMEWORK OF CWA

We view the website assessment as a specific problem of website pricing since the price of a website is a simplified mechanism to reflect the overall website value. Our Commercial Website Advisor (CWA) expert system represents the acquisition website assessor's decision making process when reviewing a commercial website for its pricing. A problem domain is the area with which a domain expert is familiar. In CWA, the expert could be a **Web Analyst** who has some years of experience in internetworking and information technology. The analyst's experience should be widely recognised among colleagues and have made a number of successful web assessment decisions (such as the sales of the *hotmail.com* to Microsoft or *ozmail.com* to Telstra Australia).

The problem domain is narrow and well defined. It can be solved through the use of an expert system shell. The domain is relatively stable, so it is not amenable to major changes in its knowledge base when completed. In addition, the problem domain requires only moderate solution time at an affordable cost of building the expert system for the website assessment.

### Justification

Several reasons led to the development of an expert system to capture the web analyst's knowledge in this particular case:

- The improved productivity of the website will offset the cost of developing CWA, which is expected to improve the long-term profitability of the Consultant Company who offers the assessments for the stock markets.
- This proposed system could not only assist the web analyst in making the final decision, it can also assist with the training of junior web analysts.
- Web Intelligence Consultant is a stable business, because web developers are not likely to stop adopting best websites for their e-business development.
- The decision to offer prices of purchase or to reject commercial website is not a hardened quantifiable rule. Indeed, this area bases itself on heuristics and lends itself extremely well to an expert system.
- The CWA offers a higher level of consistency for decision making than the human analyst does. Since the rules will be clearly defined, the ultimate decision is more consistent when compared to similar cases over time.
- The benefits of CWA include increased competitive advantage, strategic planning of commercial web development, higher productivity, and job enrichment.

### Multiple Web Analysts for the Objective Assessment

In deciding on the expert system to assess commercial websites, the knowledge engineer has to decide on a single versus multiple analysts for the job. The initial prototype is built with a single expert on the basis of the analyst's availability, willingness to spend time on the project, and low-cost. The limitation of this approach is that the resulting system represents just one analyst's opinion (ie, a subjective assessment). A single expert is

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bound by certain constraints that are unique to commercial website. Thus the CWA would need greater standardisation of the advice it would provide across multiple analysts. On the other hand integrating CWA with knowledge discovery tools could also enhance the CWA performance.

### **Goal of CWA**

For simplicity, we could decide the outcomes that CWA can provide:

- (1) **Recommend** the Website (e.g., mark a price or buy its shares),
- (2) **Try** do some initial business with the website to test its functions,
- (3) **Reject** the website.

In advising on the final decision, the expert system considers following identified factors (see Alsop 1999, Cockburn and Wilson 1996, Elliot 2000, Ho 1996):

- Accessibility of the website for its services (speed, friendliness, easy to find, etc)
- Functionality (powerful to perform a variety of on-line activities),
- Security (authentication, encryption, transaction integrity),
- Availability (7 days a week, 24 hours a day, mobile delivery, no crashes),
- Connectivity (fully supported by the search engines),
- Viability (Competitive to the same kind of website, coping with changes),
- Customisation (website is tailored to individual needs), and
- Analytical (dynamically maintained for up-to-date user profiles).

### **The Domain Expert**

The goal of the first session with the domain expert (ie, a web analyst) is to develop a master list of all the variables that the expert considered important in deciding on the website assessment. These variables are condensed into possibilities and then ranked in order of importance. A proposed framework can be found in (Elliot 2000). The ranking is presented to the expert for verification. The variables are reduced to the most important ones.

- Accessibility
- Functionality,
- Security Level,
- Availability,
- Connectivity,
- Viability,

In preparation for the first interview, the knowledge engineer reviews published articles about assessing commercial websites (Cheung 1998, Fairley 2000, Gillespie 2000, Huizingh, 2000), what website get recommended, the criteria used in making favourable decisions, and the website assessment process. This background provides a number of prefatory questions that are mentioned above.

### **Knowledge Acquisition**

During our CWA development, several knowledge acquisition tools are used. Knowledge is acquired from a number of interviews with the expert (the web analyst). The early interviews encompass fairly broad questions about the expert's decision making process. The later interviews extract more detailed information about the expert's decision process by discussing the outcome of specific sample decisions to which uncertain factors are concerned.

An induction table (similar to a decision table) is developed which include possible combinations of a few variables and their outcomes—Recommend, Try, or Rejection of a commercial website. This induction table is the basis for some of the more detailed case scenarios presented to the expert. It forces the expert to give concrete examples of decisions based on specific variables, which allowed the expert to focus on actual decision processes and enabled the knowledge engineer to realise the complexity of the problem. In addition, the induction table served as the initial input into a C4.5 rules induction for the expert system rule generation (see Quinlan 1987). The table is later used for verification of the prototype and testing the final system.

During a series of interviews, the knowledge engineer may have opportunity to do on-site observation of the expert's mannerisms and decisions related to the problem domain. It provides a clearer picture of the expert's biases, and the subjective nature of the comments received from the website assessors.

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## Knowledge Representation

In this project, a procedure unique to knowledge representation is followed. Before creating CWA knowledge base using EXSYS Developer & CORVID (<http://www.exsys.com>), six questions are brought up that an end user using CWA would answer. Each question, based on the variables identified in the knowledge acquisition phase, has three possible answers. The questions are presented to the expert to ensure proper wording. Some sample questions and alternative answers are shown in Figure 2.

|     |  |                              |                    |                           |
|-----|--|------------------------------|--------------------|---------------------------|
| (a) | What is the responding time of the website? (Assess accessibility, few mouse clicks, is this easy-to-use?) | Fast                         | Average            | Slow                      |
| (b) | What is the Website Security Control? (Assess the Security Level)  | SSL/SHTML                    | Password Control   | None                      |
| (c) | What kind of business activities can be performed? (Assess the Functionality)                              | On-line Ordering             | On-line Payment    | Product Browse Only       |
| (d) | What kind of Service Channel available? (Assess Availability)  | Call Centre                  | Mobile Phone       | Web Browser Only          |
| (e) | What kind of search capability of the Website? (Assess Connectivity)                                       | Universal Resource Discovery | Database Search    | Local Search only         |
| (f) | Is the website update the information instantly with the real world? (Analytical capability)               | Dynamic Updates              | Periodical Updates | Web Master Manual Updates |

Figure 2: Sample Interactive Questions in CWA.

The induction table includes possible combinations of the six variables and their outcomes (Recommend, Try, or Reject the website). The table is the basis for some of the more detailed case scenarios presented to the expert. It also serves as the initial input into the expert system shell for the initial decision tree generation.

After the initial rules are generated from the induction table (using C4.5 algorithm), they are combined where possible (using AND and OR statements). After the basic rules are formulated, the knowledge base is customised. First, it is set to execute in "runtime" mode. Then it is changed to include custom colours, some user instructions, and better-phrased questions for the user to answer. Next, explanation for the user for WHY the information asked for in the system is needed. The whole system is web accessible by using the CORVID web-enabled inference engine (<http://www.exsys.com/>).

## Inference Rules

The following sample rules (see Figure 3) are used in the prototyping of the CWA project.

|  |
|--|
| RULE 1: IF Accessibility is VG AND Functionality is OK<br>AND Connectivity is VG<br>THEN Try the website   |
| RULE 2: IF Security Level is LOW OR Accessibility is BAD OR Functionality is BAD<br>OR Availability is BAD OR Connectivity is BAD<br>OR Analytical Capability is POOR<br>THEN Reject the website         |
| RULE 3: IF Security Level is HIGH OR Functionality is GOOD<br>THEN Try the website   |
| RULE 4: IF Accessibility is BAD AND Functionality is POOR<br>THEN Reject the website   |
| RULE 5: IF Security Level is VH AND Accessibility is VG AND Functionality is VG<br>AND Availability is VH AND Connectivity is VG<br>AND Analytical Capability is VG<br>THEN Recommend to buy the website |
| RULE 6: IF Responding time of website is Fast<br>THEN Accessibility is VG  |
| RULE 7: IF Responding time of website is Average AND Functionality is GOOD<br>THEN Accessibility is GOOD   |
| RULE 8: IF Responding time of website is Slow  |

|          |  |
|----------|--|
|          | THEN Accessibility is BAD  |
| RULE 9:  | IF Security Control is SSL/SHTML<br>THEN Security Level is VH                                    |
| RULE 10: | IF Security Control is Password Control<br>THEN Security Level is HIGH                           |
| RULE 11: | IF Security Control is None<br>THEN Security Level is LOW  |
| RULE 12: | IF Business Activity is On-line Payment AND Security Level is VH<br>THEN Functionality is VG     |
| RULE 13: | IF Business Activity is On-line Payment AND Security Level is HIGH<br>THEN Functionality is GOOD |
| RULE 14: | IF Business Activity is On-line Payment AND Security Level is LOW<br>THEN Functionality is BAD   |
| RULE 15: | IF Business Activity is On-line Ordering<br>THEN Functionality is GOOD                           |
| RULE 16: | IF Business Activity is Product Browse Only<br>THEN Functionality is BAD                         |
| RULE 17: | IF Service Channel is Call Centre<br>THEN Availability is VH                                     |
| RULE 18: | IF Service Channel is Mobile Phone<br>THEN Availability is HIGH                                  |
| RULE 19: | IF Service Channel is Web Browser Only<br>THEN Availability is LOW                               |
| RULE 20: | IF Search Capability is Universal Resource Discovery<br>THEN Connectivity is VG                  |
| RULE 21: | IF Search Capability is Database Search<br>THEN Connectivity is GOOD                             |
| RULE 22: | IF Search Capability is Local Search Only<br>THEN Connectivity is BAD                            |
| RULE 23: | IF Website Updates is Dynamic Updates<br>THEN Analytical Capability is VG                        |
| RULE 24: | IF Website Updates is Periodical Updates<br>THEN Analytical Capability is GOOD                   |
| RULE 25: | IF Website Updates is Web Master Manual Updates<br>THEN Analytical Capability is POOR            |

Figure 3: Sample Inference Rules in CWA

Although this set of rules represents only a proportion of the knowledge base, it is a consistent set of rules.

## **SYSTEM IMPLEMENTATION**

The implementation of CWA is considered to use a web-enabled expert system shell, namely CORVID (<http://www.exsys.com>). The system is Java deliverable and can be deployed as an interactive expert system on Websites.

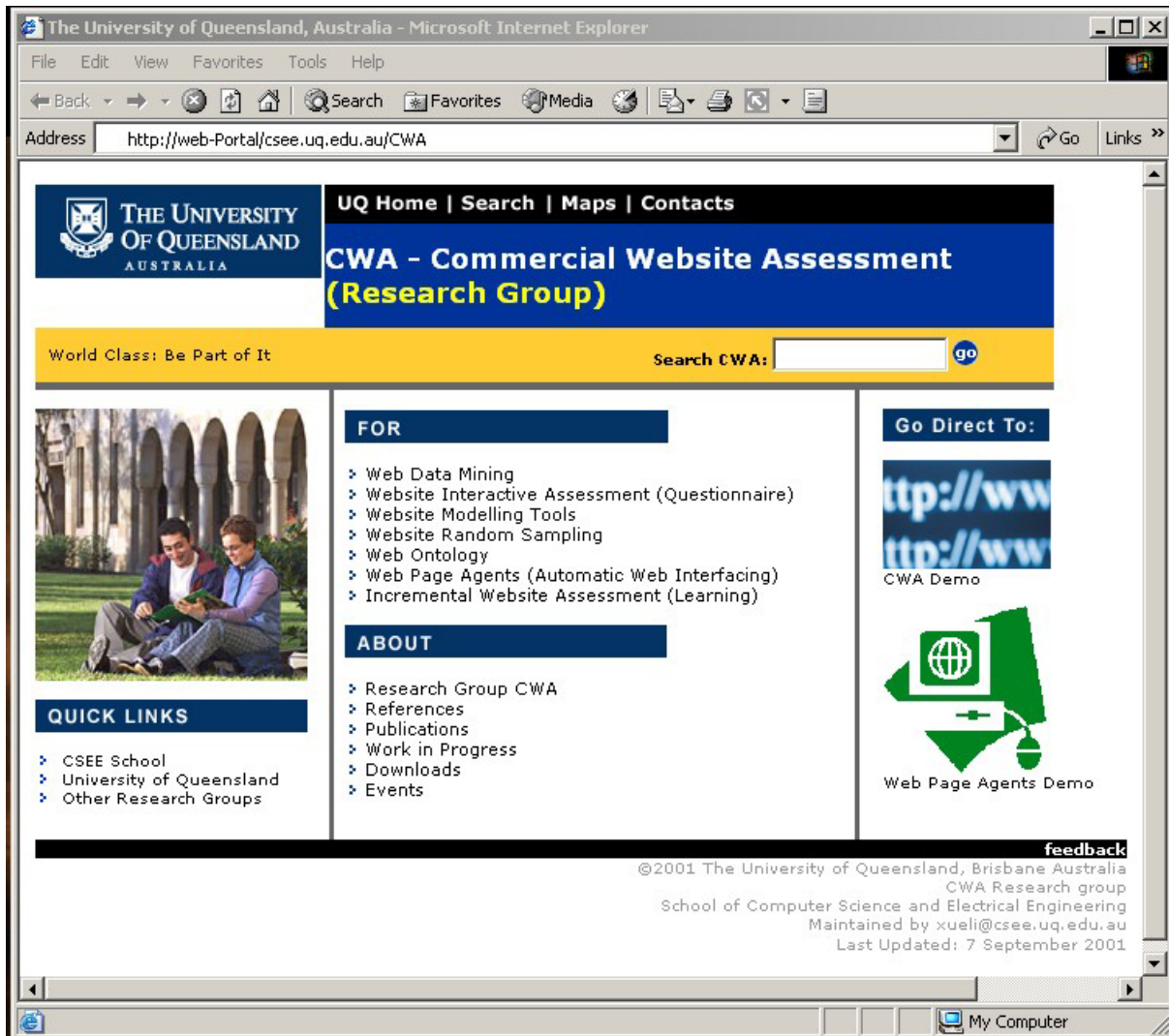


Figure 5: The Face Page of CWA Website

Figure 5 shows the system home page. It is currently under the development and CWA system is to be integrated into a broader area of web data mining, web ontology, and website modelling, etc. (Li 2001). A scenario of system execution is that a user firstly choose “Web Page Agents (Automatic Web Interfacing)” to invoke the CWA system (or a use clicks on the “CWA Demo” button to see an tutorial-like execution). Then Figure 6 as the main system page is shown on the screen. This is a multi-Tab web page, which will lead user to assess a single known website or search on the WWW for statistical assessments.

Web Interface Agents are used to automatically interact with websites to provide information such as user name and password. When web interface agents are authorised, they may access the website log files or other server-side files to provide more sensible assessment for a website (e.g., user behaviours, access patterns, etc). More details on web interface agents discussed in (Li 2001).

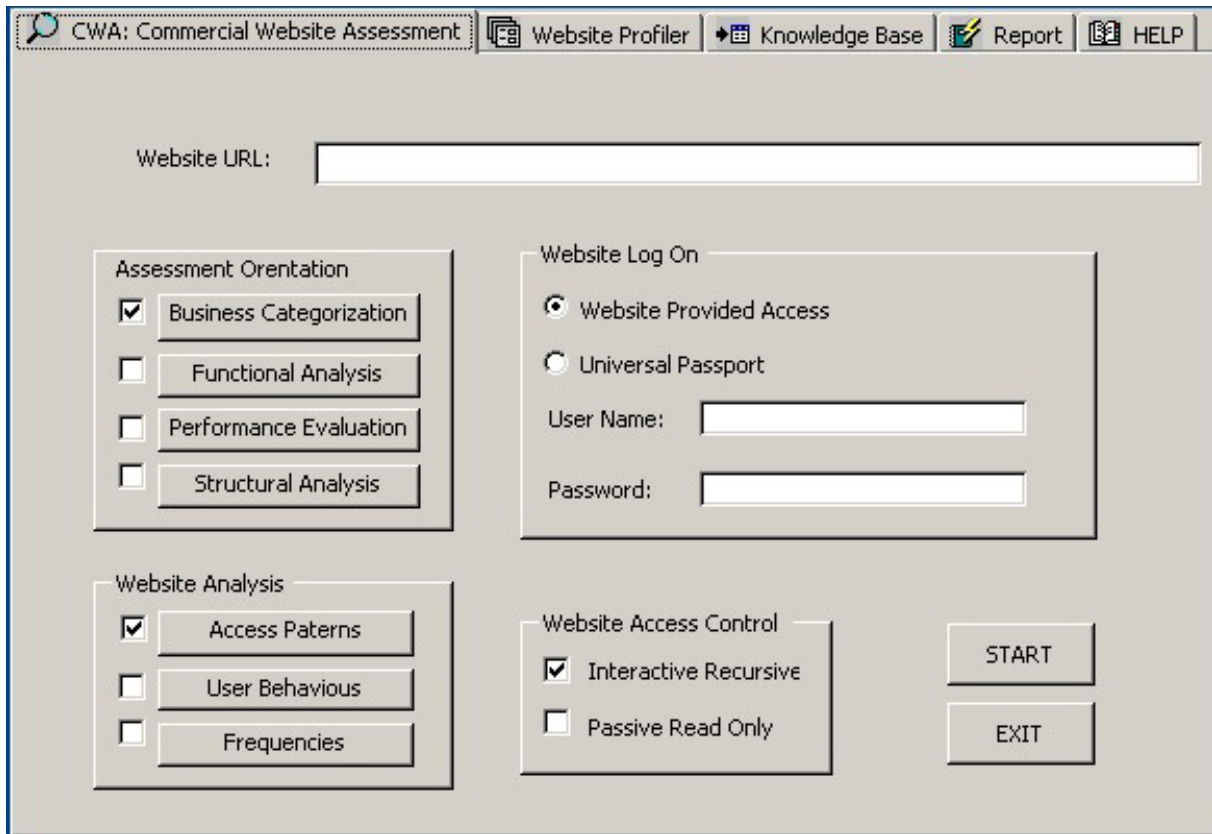


Figure 6: The Multi-Tab CWA Interface

## RELATED WORK

Website assessment involves the identification of the properties of websites in many different perspectives. In an objective assessment, the websites are studied by an ontological categorisation or classification method. Every website studied is cross-referenced in a certain paradigm. A qualitative and objective assessment means the research is interested in their intentions and meant-to-be functions. While a quantitative objective method focuses on what the websites can do in their measurable activities. On the other hand, in a subjective assessment, the assessor will design a list of identifiable attributes and then incorporate it into a survey questionnaire as a framework to benchmark the website that they would select. In a subjective and qualitative assessment, the survey is interested in finding the rationales or conclusive opinions about the websites. While in a subjective and quantitative approach, the assessment is a survey that uses the statistics to check the threshold values of those measurable properties of the website in order to justify an assessment framework. In this case the statistics services as a proof of the ideas.

Figure 4 summarises the above four different cases identified in Figure 1. For case 1 (in Figure 4), Cheung and Huang (2000) used a random sampling method tested 250 websites in Singapore. In their assessment, 250 websites were randomly selected for being classified in 11 categories. In their findings they show that most corporations in Singapore do not reveal the information on product price and price discounts on their WWW home pages. This approach is useful in finding websites do's and don'ts.

|              | Objective                       | Subjective   |
|--------------|---------------------------------|--|
| Qualitative  | Case 1: Website random sampling | Case 2: Web surveying on identified attributes       |
| Quantitative | Case 3: Web data mining         | Case 4: Using statistics with a predefined framework |

Figure 4: Different Methodologies Used in Assessing Commercial Websites

Regarding case 2 (in Figure 4), Liu *et al* (1997) used a survey approach to ask 7 questions about Fortune 500 companies on their home page usage. A total 322 websites were found within those Fortune 500 companies. In its conclusions for example, the paper said: "Less than one-third (26.2%) of Fortune 500 companies provide for



online business. Only a small number of companies (46) specially mentioned pricing information on their home pages."

The differences between case 1 and case 2 are that (a) the random sampling is used in case 1 instead of a focused group of company websites (e.g., Fortune 500 in case 2). (b) The ontological categorisation is used in case 1 to group the websites in terms of its nature, while case 2 uses 7 pre-defined survey questions to investigate the specific questions that are interested to the assessor.

With regard to case 3 (in Figure 4), web data mining technology is used to understand the behaviours of the users and therefor reflect the publicity and the usefulness of the website (Chen et al 1998, Lin 1999, and Mobasher 1997). In this way the data of web server logs and the online mouse click-streams are analysed in order to find out the user access patterns as well as the topology of the URL links. In Li and Low (2000), we mapped data mining results into fuzzy logic rules in the reasoning of the website assessment. Web data mining (Li 2000) has shown a great potential in its capability of understanding the dynamics of commercial websites.

Concerning case 4 (in Figure 4), the methodology focuses on the analysis of the properties that are presented in website in contrasting with the business models for their justifications. Elliot et al (2000), proposed an evaluation framework consisting of six categories each with five elements. The framework is applied in an assessment of the websites of 100 companies. The approach is based on a wide range of the literature review from consumer adoption factors through technology interface to website evaluations. This approach is subjective in a sense that it is a predefined analytical framework. Then it is applied for the analysis of all (100) websites. So a scoring system is used to quantify the properties of 10 industrial sectors in terms of 6 identifiable attributes. For example after the testing of 100 websites, the paper said that:

"It shows substantial differences regarding the extent to which commercial web sites meet the '**best practice**' requirements as identified in the framework. One can identify that while companies across the board seem to have little problem in fulfilling almost 4 out of 5 requirements for 'company info', and in our assessment in a reasonable way are meeting '**ease of use**' requirements, they were by and large very poor on 'conducting transactions' and on what we have termed 'innovation'."

After an overview of those approaches, the ultimate goal of our approach is to integrate all of these four different methodologies to conduct the website assessment as a knowledge-driven process. To this end, the expert system should be able to interface with these four different approaches discussed in this section.

## CONCLUSIONS

It is reported that e-business over the Internet reached US\$518 million in USA in 1996, and in 1997, the e-business transactions reached US\$10 billion. The total e-business transactions will be in the range of US\$500 billion and US\$3 trillion in 2002 (see Forrester Research Institute: <http://www.forrester.com/Product/CoverageArea/0,4674,5,00.html>).

With more and more commercial websites emerging on the Internet, the assessment of those websites is becoming an important business for many consultant firms. Yet the consensus of the website commercial usage is still in its early stage of identifying the crucial characteristics and understanding the success factors. This paper has presented an expert system approach in achieving the goals that can maximise the human expertise in assessing the websites. One of the advantages is that it can accommodate the learning process of human expertise with the evolution of commercial websites.

In our Commercial Website Assessment (CWA) project, the expertise of web analysts can be captured and represented as inference rules to execute the evaluation frameworks that are the representation of the most important properties of the commercial websites. In combining with the web data mining (Li and Low, 2000), web interface agents (Li 2001), and other online analytical tools (Huang and Li 2001), we will improve our project with a better performance towards a unified knowledge-driven approach in website assessment.

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