Art, Science/Technology and History Museums on the Web

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Abstract:

During the last years, museums have used the Internet to make their presence known, to exhibit their artifacts virtually, and to communicate with people. As a result, virtual visits to museums' websites have increased and continue to increase at a constant and rather impressive rate. In order to increasingly improve their presence and the offered services, they need to continually evaluate various aspects of their websites. This paper presents a quality evaluation framework called MuseumQual. It consists of 35 criteria classified into the following six categories: Content, Presentation, Usability, Interactivity & Feedback, E-Services, and Technical. Furthermore, MuseumQual is applied to evaluate 210 museums' websites (70 art, 70 science/technology, and 70 history museums) worldwide. The evaluation results show that all three museums' categories present sites that stay at a satisfying, yet not exceptional, level. Science museums' sites lead the way, with art museums' sites following closely and history museums' sites showing next. Almost all sites outperformed with respect to Technical characteristics. However, many sites present inefficiencies regarding Interactivity & Feedback. Finally, suggestions for improvements are made.

Keywords: Art; Criteria; Evaluation; History; Museum; Technology; Quality.

1. Introduction

In a rapidly evolving and changing society, in which Internet is being used by a growing number of people, museums could not avoid to take part in this revolution. Like other sectors, museums are discovering the Internet. Museums have been learning to use the World Wide Web technology at a rapid rate since it has become widely available from the mid 1990s onwards (Jones-Garmil, 1997). Due to the continuous technological advantages, fast and clever adoption of new technology could be a boost of being a step ahead of others. During the last years, various web site style guides and design philosophies tried to help web site designers and developers (Nielsen, 2006; Rosenfeld and Morville, 2002).

However, museums comprise a peculiar sector because they combine both educational and commercial features. They are very successfully labelled as content providers for the web, since they are very rich in high quality content. Schweibenz (1998) identified virtual museums as part of a move towards a focus on information rather than on objects. The Internet offers to the museums the possibility to disseminate information about their collections to a world wide public (Harms and Schweibenz, 2001). Therefore, one can state that "museums are in the communi-

cation business" (Silverstone, 1988). Museums contain rich sources of material in their collections, and there is particular interest in making this material available to a wide audience (Fahy and Sudbury, 1995). The combination of information and entertainment is important because museums are in competition for visitors with other leisure pursuits and mass media (MacDonald, 1996). So, their content should be accessible and usable by many people (Donovan, 1997).

The Internet can help museums to have a more stable, prevalent and leading position in the future. The fact that back in 1998, 38% of 290 UK museums had a website and 20% were planning to have one in the future (Dawson and Mckenna, 1998) is a good example of the situation. But do their websites achieve the results museums expect to? Do they attract people to visit the museum after their online visit or museums' websites just provide us with really boring information that seems useless? The effects of poor design can be dramatic. Forrester Research (Nielsen, 1998) estimated a loss of 40% of potential repeat visits following an initial negative experience. The British Columbia Museums Association (BCMA, 1996) found that many museums were unable to measure in an objective way any benefits which might have been gained from being on the Internet. There is also an increased recognition that simply having a web site is no longer sufficient, a web site should be achieving specific business objectives (Day, 1997). Hertzum (1998) suggested that museum web sites tend to suffer from three characteristic problems:

1. The majority of museum sites have been developed without a clear notion of what the site should achieve;
2. The sites have not been evaluated to find out whether they match the users' needs and wishes; and
3. The material on the sites tends to duplicate material in the physical museums rather than to rethink it, given the possibilities provided by the new medium.

Through their websites, museums would create an environment that visitors are not only able to explore the exhibited objects and art works, but also deal with new original experiences and ideas. Therefore, visitors can have a more essential and important experience. The Museum of the History of Science, Oxford, reported a conservative estimate of three virtual visitors for every one physical visitor (Sphaera, 1999). That, obviously, is the best way to understand the huge significance and the role that a web site plays today. In order to take advantage of web sites at a highest pitch, the information that they provide should be presented in a location that will make visitors feel much comfortable as if they were at the physical museum's location.

2. Statement of the problem

A museum's web site has to be a dynamic entity in order to keep up with the technology's evolution and to attract a continuously growing number of visitors. By understanding the link between motivation and meaning-making, museum professionals will be able to provide more effective and more enriching on-line experiences for their visitors (Goldman and Schaller, 2004).

Authors in the museum web development field are calling for a more professional and visitor-centred approach to Web development (Cunliffe et al., 2001). The basic problem lies on the deficiency of a satisfying and adequate website design. The designers of museums' websites must understand that they have to satisfy the needs and expectations of both museums' administrators and visitors. Futers (1997)

found that 52% of virtual visitors expect to be able to download images from online exhibitions. On the other hand, the museum wishes both to encourage paying visitors to view the physical exhibits and to gain financially from the Intellectual Property Rights it controls. Also, it is very often that we see large museums finding the sources and being able to attract sponsorships and partnerships, in order to invest in perfect designed and functional websites (Bowen, 2000). On the other hand, small museums usually depend on the interest of an individual sponsor.

Although most of the museums have developed websites, little work exists on evaluating these websites. By evaluating the museums' websites, the web designers and developers would identify the shortages and inefficiencies of their design. They would also persuade the museums' administrators to finance the web sites' upgrade in order to keep up with technological advances and visitors' expectations.

In order to perform an evaluation, it is needed a comprehensive evaluation framework containing quality criteria. These quality criteria should satisfy the visitors' needs. For example, is it easy to explore the web site? Does the web site present the artefacts in a pleasant way? Can a visitor make a reservation for a museum's event or buy tickets, souvenirs, art copies, etc?

After presenting such an evaluation framework called MuseumQual, we apply it to test the web sites of 210 museums worldwide. This evaluation framework examines the museums' web sites from various points of view. A visitor is interested in not only finding useful information and services but also in doing it easily and pleasantly. The evaluation would fuel the web site's continuous development and improvement. The web site's designers and developers would take into consideration the large variety of visitors and try to satisfy their increasing expectations.

3. Previous studies on evaluation of web sites

There are several previous studies on museums' web sites evaluation and on web sites evaluation in general. However, there is not a comprehensive evaluation framework for evaluating the quality of museums' sites. Initially, this paper presents such a framework consisting of many qualitative and quantitative criteria.

In order to make the study of the previous evaluation frameworks easier for the readers, we classified them in two separate groups according to their methodology (Table 1). Previous studies used either qualitative or quantitative methodologies. Based on "qualitative" methodologies, previous studies used a number of criteria (such as usability, content, navigation) in order to evaluate the web site's quality. These criteria were used by users, undergraduate students, expert evaluators, researchers or even the authors themselves to evaluate the web site. The evaluators assigned scores to the web site for each criterion. On the other hand, based on "quantitative methodology", other studies used automated tools like Bobby Validator or JAWS Screen Reader to evaluate the web site. These tools test and measure a site using computer programs.

Insert Table 1

Most previous studies used qualitative methodologies. Olsina Santos (1999) presented the QEM (Quality Evaluation Method), a methodology for the quantitative evaluation and comparison of web site quality. The core models and procedures for

evaluation were supported by the Logic Scoring of Preference (LSP) model and continuous preference logic as mathematical background. Dyson and Moran (2000) evaluated a number of museum web sites. The evaluation described the facilities offered by the sites and analysed their usability and presentation. A two-tier evaluation tool was created, consisting of a formal and informal level. Loiacono et al. (2000) developed WebQual in order to measure the quality of a web site. It is based on twelve core dimensions. Sutcliffe (2001) proposed a three phase model for web site evaluation, based on initial attractiveness, exploration-navigation and transaction. He proposed heuristics that are based on various factors in order to assess the attractiveness of web user interfaces. Smith (2001) performed a survey in which he applied criteria for the evaluation of government web sites to a sample of five web sites of New Zealand government entities. The criteria are divided into two groups: Information content criteria and Ease-of-use criteria. Albuquerque and Belchior (2002) defined a set of e-commerce web site quality attributes. Di Blas et al. (2002) used an evaluation method called MILE (Milano-Lugano Evaluation Method) in order to examine the quality and usability of museums' web sites. MILE is based on a mixture of Inspection and Empirical Testing. Ranganathan and Ganapathy (2002) examined the key characteristics of a business-to-customer web site. The attributes were based on the answers to an online questionnaire survey. Avouris et al. (2003) proposed techniques for usability evaluation of an academic web site. They used tree different evaluation techniques: Questionnaire-Based Evaluation Studies, Heuristic Evaluation and User Observation. Huang (2003) presented an empirical study in which he evaluated the usability of 50 corporate web sites. Rian van der Merwe and James Bekker (2003) introduced a web site evaluation framework methodology that was used in order to evaluate e-commerce web sites. Rinalducci (2004) studied the usefulness of online resources of museum libraries and research centres in meeting the scholars' needs. The case study examined the helpfulness of these online resources to provide relevant information that could help researchers at their online studies. Signore (2005) defined a quality evaluation model based on six main criteria categories. Finally, Gledec (2005) introduced a quality evaluation methodology from users' perspective.

As far as studies that used quantitative methodologies, Brajnik (2000) evaluated tools that analyze web sites. He depictured the type of automatic tests that they performed and the usability aspects that each test was more closely related to. The tests were grouped into different categories according to usability-related properties. Cunliffe et al. (2001) presented evaluation methods that could easily be used by non-professional individuals in order to evaluate the usability of museums' web sites. Micheloni and Bowen (2002) analysed and tested for accessibility and usability of 25 UK and International art gallery and museum web sites. Cast Bobby Validator and the Jaws Screen Reader were used in order to establish the sites' usability and accessibility. Bobby Validator helped them to identify changes to their pages so that users with disabilities can more easily use the web pages. Bobby evaluates HTML and checks for HTML errors. Jaws Screen Reader examines various parameters such as frames, tables, pull down menus. Bowen (2003) also used Bobby Validator. He performed an accessibility survey on some museum web sites in order to depicture the lack of proper interest for disabled persons. Glenn (2004) examined the presence and quality of web sites of one hundred randomly selected local history repositories in the United States. Using content analysis methodology, he examined business-related content, archival space-specific content, and structure and construction elements. Davoli et al. (2005) presented FQT4Web (Fuzzy Quality Tree

for Web Inspection), a quantitative inspector-based methodology for web site evaluation with a hierarchical structure. It is based on fuzzy operators. It helps the detection of quality deficiency. Eschenfelder and Miller (2005) presented a toolkit for evaluating the openness of government web sites containing information about public policies. Kelly and Vidgen (2005) proposed a framework which is based on combination of two quality evaluation methods: E-Qual, a web site quality evaluation method, and QA Focus, a quality assurance method. Hassan and Li (2005) introduced a framework that uses the benchmarking technique in order to evaluate the usability and content usefulness of web sites.

4. Aim of this paper

This paper presents MuseumQual, a comprehensive quality framework for evaluating museums' web sites. In contrast to previous studies, it takes into consideration a large number (35) of quality criteria to holistically evaluate a museum's web site. It is based on both qualitative and quantitative criteria. It also covers many different dimensions of a web site. For example, it is not enough to present a lot of information on the web site. It is also important that a visitor easily explores and utilizes it.

Then, MuseumQual is used to evaluate 210 museums' web sites. No previous study performed such a massive evaluation of museums' web sites. The web sites of 70 art, 70 science/technology and 70 history museums are evaluated to identify the current situation of museums' web sites worldwide. Guideline and suggestions to museums' administrators and web sites' designers and developers are also provided.

5. Methodology

Based on previous studies on evaluation of museums' web sites, discussions with colleagues, as well as our own previous research and experience in other e-services sectors, we developed MuseumQual. It consists of six (6) main criteria categories: Content, Presentation, Usability, Interactivity & Feedback, E-Services and Technical. Each main category contains many criteria (Table 2). MuseumQual may be useful not only to designers, developers of museums' web sites, but also to museums' administrators. They would identify which dimensions of their web site need improvement and work on them. We further analyze all these 35 criteria in the next section along with the discussion of the evaluation results.

Insert Table 2

During Fall 2006, we tried to gather lists of museums' web sites. We looked at ICOM (International Council of Museums), National Museums' Associations and Cultural Organizations. We also used search engines to find museums' lists all over the world. Finally, we visited the Ministry of Culture web sites of many countries. After exhaustive search, we compiled 3 lists with museums' web sites: 1) art, 2) science/technology and 3) history museums. Then, we randomly selected 70 museums from each list without looking at their web sites. So, we selected 70 art museums, 70 technology and science museums, and 70 history museums. We tried

to include museums all over the world (e.g. Argentina, Australia, Austria, Belgium, Brazil, Bulgaria, Canada, China, Croatia, Czech Republic, Denmark, Egypt, Finland, France, Germany, Greece, Indonesia, Iraq, Ireland, Israel, Italy, Japan, Korea, Malaysia, Mexico, Netherlands, Norway, Russia, Spain, Sweden, Switzerland, Thailand, UK, USA). The only restriction was that a version of the web site should use the English language.

Finally, we (the authors) evaluated each one of these web sites using MuseumQual. We sat together and examined the web sites. We were discussing and arguing about each criterion category. Then we agreed about the quality of the site and assigned a single score for the specific criterion category. We gave a score from 0 to 5 (0 = non existence, 1 = very poor, 2 = poor, 3 = fair, 4 = good, and 5 = very good) for every criterion category taking into consideration all of its criteria. We also used webxact.watchfire.com and www.netmechanic.com to test technical criteria. Saying it again, we assigned a single score for every criterion category of every web site. In the sequence, we calculated the percentages, average and variance of every criterion category for each museum category (art, science/technology, history).

6. Evaluation of museums' web sites worldwide

In this section, we explain more thoroughly each one of the six (6) main criteria categories of MuseumQual and describe the evaluation results. The following Figures 1 to 6 present the distribution of the scores for every criterion category. So, it is shown the percentages of web sites achieving scores in the ranges [0,1), [1, 2), [2, 3), [3, 4) and [4,5] for every criterion category.

6.1 Content

The content is the core of a site. Usually, someone visits a museum's site to check information related to the museum. So, the content would be complete and useful. If a virtual visitor does not find what he is looking for, then he will be disappointed. On the other hand, if a site provides accurate and comprehensive content that includes information about the artefacts, plenty of references, the museum's operation times and location, more than one language, links to relevant and interesting sites, then the visitor would be satisfied. Existence of content that is appropriate for kids or special categories of people is also a big advantage for a site.

Insert Figure 1

Regarding content, more than one third of art and history museums achieved very high scores (score between 4 and 5) (Figure 1). However, science/technology museums fell behind. About one third of them provided small number of online exhibitions and collections, limited information regarding the artists and very few references. Most sites (either art or science/technology or history museums') achieved good scores (scores between 3 and 4). The best site was that of the Museum of Fine Arts of Boston (www.mfa.org) (average score: 5.00). It provided a huge amount of accurate and unique information. Also, it supported an impressive application (My MFA) which allowed someone to become member of the site and set

his preferences about his favourite arts, programs and others. Every time he logged in the site, he had access to his Personal Page.

6.2 Presentation

The first impression about a site strongly depends on the site's presentation. If the content is not presented nicely, it will not attract the visitor. Multimedia would help to enhance the presentation. Also, the appropriate and consistent use of styles, formats, colours and fonts in combination with right spelling and grammar are important. Also, the appropriate type and quantity of multimedia (e.g. visual, verbal) is a plus.

Insert Figure 2

Regarding presentation, about two third of science/technology museums' sites achieved good scores (score between 3 and 4) (Figure 2). They were aesthetically pleasant using high fidelity multimedia and elegant styles. Art museums' sites closely followed. Most history museums' sites achieved mediocre scores (score between 2 to 3). They lacked quantity and some times quality of multimedia. Even the use of colours and fonts were inadequate. The best site was that of Scitech Science Museum (www.scitech.org.au) (average score: 4.60). It provided simple and appropriate format and styles, right quantity and high quality of multimedia.

6.3 Usability

Usability is essential in order a virtual visitor to easily and efficiently use a site. Many factors can facilitate a visitor to explore the site. In other words, the deficiency of some factors could lead many visitors to abandon the site and never visit it again. The appropriate design of the home page, background, frames, menus and toolbars are important points. The simple and intuitive structure and organization of the site, the easiness of navigation, and the ability to easily and accurately find what someone is looking for are all very important criteria. A visitor would easily explore the site and not become confused. Existence of alternative paths to a page would also help an experienced user. If a user is lost in the site, path orientation information as well as a return to home page button in every page would help him. Also, a site map is useful. There should not exist under construction pages or broken links. Finally, everyone, regardless of age, education, web experience and other factors should be able to use the site.

Insert Figure 3

Most museums' sites performed well with respect to usability (Figure 3). Once more, science/technology museums' sites excel. More than half of them scored very high (score between 4 and 5). Art and history museums' sites followed. Best sites were those of the New York Hall of Science (www.nyhallsci.org), Museum of Science & Industry of Manchester (www.msim.org.uk) and Science Museum in London (sciencemuseum.org.uk) (average score: 4.78). These sites supported all necessary usability facilities.

6.4 Interactivity & Feedback

Recently, the web users demand more than comprehensive and useful content, nicely presented and easy to explore and use it. They want two-way communication and active participation. So, the sites should provide enhanced interactivity & feedback. They would provide both asynchronous (e.g. sms, newsletter, e-mail, alerts, suggestions) and synchronous (e.g. chat, videoconference) communication. It would be also preferable to support e-communities (e.g. member, volunteer), forums, chat and interactive multimedia applications. Members, friends and volunteers are really valuable for every museum. So, the site would support various types of participation, communication, and contribution.

Insert Figure 4

Unfortunately, all three museums' types were weak with respect to interactivity & feedback (Figure 4). Science/technology museums' sites were the best. However, their average score was only 2.66. They offered interactive online exhibitions and interactive multimedia applications for kids regarding technological and scientific subjects. They also offered to the visitor a variety of ways to interact and communicate with the site and the administrators. Moreover, they developed their e-communities section more than art and history museums did. History museums' sites were the worst. More than half of them failed to present adequate interactivity & feedback. The best site was that of the Museum of Science and Industry in Chicago (www.msichicago.org) (average score: 4.00). A visitor would sign up, by giving his e-mail address, in order to receive a regular e-newsletter. Also, he would interact with the museum's site exhibitions by playing games and puzzles tailored to the exhibition's theme.

6.5 E-Services

Nowadays, it is not enough to only provide information. In conjunction with interactivity & feedback, web users demand advanced e-services and applications. So, the museums' sites would offer various online services and applications to satisfy their visitors' expectations. Online ticket reservation, purchase and payment, shopping, donation, virtual tours and other online transactions are useful e-services. Notification about upcoming events, recent acquisitions, opening hours, location and maps are welcomed. One of a museum's primary objectives is to educate people and raise culture. So, online learning is important. A museum's site would offer e-classes, educational games, e-books, e-quizzes and other educational objects about artists, exhibits, art, science/technology, history, etc. In addition, a museum's site would offer online amusement such as virtual tours, online games, music, e-postcards, ring tones, wallpapers, etc.

Insert Figure 5

Regarding e-services, science/technology museums came first (average score: 3.21), art museums followed (average score: 2.74) and history museums came cellar (average score: 2.71) (Figure 5). More than half of science/technology museums' sites offered a satisfying quantity and quality of e-services (score between 3 and 4). By filling out an online application, a visitor would become museums' member, volunteer or even donator, and buy tickets or souvenirs. Also, several sites

presented a cheerful view offering e-cards, e-music and e-games. The best site was that of the National Science and Technology Center in Australia (www.questacon.edu.au) (average score: 5.00). It offered many pioneer e-services, such as Mini Q, an exhibition especially aimed for little kids. It also offered an e-shop to buy various items online and a virtual tour to the museum's spaces and exhibitions.

6.6 Technical

In order a site to effectively function, it should continuously (24*7) operate at fast downloading speeds and be securely accessed from various devices using different software. So, a visitor should be able to access the site using any operating system (e.g. MS Windows, Linux, Mac OS), web browser (e.g. Internet Explorer, Firefox, Opera, Netscape Navigator), and multimedia tools (e.g. Shockwave, QuickTime, RealPlayer). Also, the site should not use unusual types of files or it should give the ability to the visitor to download such software. It can also offer the same files and applications using a variety of options (e.g. .doc, .pdf, .ps). The site's processing power should be high enough to not be affected by the operation of heavy applications. It can also offer the possibility to skip such processing intensive applications (e.g. Flash). The "obligatory" use of specific software does not facilitate the visitor. Moreover, the site should provide security guarantees and filters in order to offer a safe environment for the visitor. The visitor's privacy should be also protected. In order to evaluate the technical criteria, we inspected the sites and we also used special software (webxact.watchfire.com and www.netmechanic.com).

Insert Figure 6

Almost all sites achieved very high scores (between 4 and 5) with respect to the technical criteria (Figure 6). The average scores were 4.57 for history, 4.54 for science, and 4.45 for art museums' sites. The best site was that of Hong Kong Museum Of History (www.lcsd.gov.hk/CE/Museum/History/en/aboutus.php) with an average score of 4.83.

7. Discussion of the results

Our evaluation results showed that the museums' sites in all three museum types (art, science/technology and history) stood at a very satisfactory, but not outstanding, level. Science/technology museums' sites achieved the highest average score in total (Table 3). Art museums followed and history museums ranked third. However, the differences between the three museum types are not that high. Science/technology museums are engaged in technological issues and they would provide the most advanced sites. They ranked first in four out of the six criteria categories. Most of them provided sufficient, original and qualitative content. Some characteristic examples were the sites of the Miami Science Museum (www.miamisci.org), Fort Lauderdale Museum of Discovery and Science (www.mods.org), and Science Museum of Minnesota (www.smm.org). They offered a huge amount of practical and valuable information. The majority of the sites that belong to the science/technology museums' type supported easy navigation and an aesthetically nice environment. Impressive sites with respect to presentation and

multimedia included those of the Scitech Science Museum (www.scitech.org.au), Pusat Sains Negara Museum (www.psn.gov.my/en/) and Science Museum in London (www.sciencemuseum.org.uk). Although science/technology museums' sites were not strong regarding content, they put special emphasis on interactivity and e-services factors. Science Museum of Minnesota (www.smm.org) and Infoage science center (www.infoage.org) represented best cases of how an interactive site would be. They provided to the visitor the opportunity to interact with the site in various ways, from e-mails and e-newsletters to forums and chat rooms (e.g. Pusat Sains Negara Science Museum: www.psn.gov.my/en/). The best sites regarding e-services were those of Marian Koshland Science Museum (www.koshland-science-museum.org), National Science and Technology Museum of Australia (www.questacon.edu.au), and Science Museum in London (www.sciencemuseum.org.uk). Also, many sites included games, puzzles and many other impressive interactive applications (e.g. Infoage Science Center: www.infoage.org; Canada Science and Technology Museums: www.sciencetech.technomuses.ca; Milton J. Rubenstein Museum of Science and Technology: www.most.org). Finally, many science/technology museums' sites encouraged the visitors to register in the site in order every time they logged in as members to offer them many extra features and possibilities (e.g. Museon Museum: www.museon.nl and Scitech Science Museum: www.scitech.org.au).

Insert Table 3

Examining the variances of the scores, we remark that there were large differences among the sites with respect to Content, Interactivity & Feedback, and E-Services (Table 3). On the other hand, there were very small differences among the sites with respect to Technical criteria. Almost all sites achieved high scores in the Technical category.

The majority of the sites provided a satisfying personalized content for kids, teachers, and persons with special needs. Regrettably, only a small number of sites satisfied even at a minimum percentage the presentation personalization. Two museums that show special interest for their disabled visitors were Centre Pompidou (www.centrepompidou.fr) and Swedish Museum of National Antiquites (www.historiska.se). The first one offered a totally different site, included in the original site, adjusted to the needs of disabled persons (e.g. larger images, titles and texts). The second one offered an 'adjust' button that allowed a visitor to adjust the text size, fonts, row space and contrast and to save the settings. So, every time the user visited the museum's pages he would have his own personal settings.

A section that needs to be enhanced is the synchronous interactivity. Videoconference, chat rooms and online forums are necessary ingredients for a modern site. Sadly, there were not any sites that offered videoconference or even an online community for people to post their opinions, suggestions and ideas. Interactivity between a site and its visitor will be perhaps the key for success in the future, since users' demands and expectations constantly increase.

According to our evaluation, the top three museums' sites were: 1) Museum of Fine Arts of Boston (www.mfa.org) (total average score: 4.55), 2) Centre Pompidou (www.centrepompidou.fr) (total average score: 4.53), and 3) The Science Museum in London (www.sciencemuseum.org.uk) (total average score: 4.48).

Museum of Fine Arts of Boston (www.mfa.org): This was the best site. A visitor could take a virtual tour on many of the museum's exhibitions and collections.

Personalization was taken into serious consideration ('My MFA' application). In its online shop, a visitor could buy souvenirs, kids' toys, clothes and jewelry, as well as renew his membership. It also offered a useful RSS/XML (Really Simple Syndication/ Extensible Markup Language) feed. An RSS message contains either a summary of frequently updated content from a site or the full new text. So, a member is automatically informed of any new content on the site.

Centre Pompidou (centrepompidou.fr): This site offered complete and qualitative content with really original information. The user had full access to online resources such as libraries, catalogues and archives documents. The virtual tours, polls, interactive maps, advanced search engines, FAQs and perfect mixture of colors, fonts and multimedia applications were just a few of its advantages. Its strongest point was that it provided a completely tailored made site (inside the main site) for disabled people. Furthermore, it offered free WiFi access at the physical museum's place. So, a user with a laptop computer or a PDA (Personal Digital Assistant) was able to browse the web for free.

Science museum in London (sciencemuseum.org.uk): This site was characterized by its high level of interactivity and the huge number of interactive multimedia applications. A user could search and sort interesting happenings on a comprehensive and updated calendar about various events. The interactive map, the carefully personalized complete content, the perfect navigation and usability were just a few of its advantages. Its most attractive section was that of the 'online stuff'. A visitor could interact (and learn many things online) with a large variety of online multimedia applications, e-games, and museum's exhibits.

8. Conclusions and future research

Over the past years, museum's environment has radically changed due to the use of the Internet. The number and size of museums' web sites are continually increasing. The importance of the Web for museums and especially for museums as online content and service providers is also increasing. Evaluation is really important, even necessary in order to discover sections where museums' sites present inefficiencies. Evaluation criteria must be continually adapted to accommodate changes at all levels. As the environment around us changes, users change their needs and expectations.

This paper presented an innovative evaluation framework called MuseumQual. It consists of six main criteria categories containing 35 specific criteria. Based on this evaluation framework, 210 museums' sites were evaluated. They belong to art, science/technology and history museums. Despite the fact that history museums' sites were slightly inferior, all three museum categories need to improve their sites. This will enable them to increase their benefits and profits and simultaneously satisfy visitors' growing needs and expectations.

Before referring to the omissions and weaknesses that we noticed, we mention some factors in which most of the sites did quite a good job. So, the evaluation results showed:
- ❖ 67% of the sites provided a site map,
- ❖ 73% of the sites provided a search engine,
- ❖ 90% of the sites could be thoroughly explored without the need of specialized software,

- ❖ 93% of the sites were compatible with many different web browsers (internet explorer, firefox, opera, netscape navigator)
- ❖ 97% of the sites provided a "return to Home" button.

As far as museums' sites disadvantages are concerned, sites' designers would take into serious consideration persons with special needs. Most of the sites neglected disabled people. Everyone has the right to access culture, art and knowledge, let alone when this can be done easily via the Internet. Only 58% of the sites provided content personalization and information about access and compatibility capability that could help persons with special needs. Sadly, only five sites provided presentation personalisation. Some improvements that would be done include the following:

- ❖ Virtual people (agents, avatars) that talk and inform the visitors about the current exhibitions of the museum and upcoming events,
- ❖ Zoom in and zoom out choice,
- ❖ Choice of changing fonts, backgrounds and format,
- ❖ Choice of changing text size and colour,
- ❖ Choice of selecting alternative file types.

Personalisation would be improved drastically for the benefit of not only people with special needs but also the general public. People's demands and expectations are continuously growing and museum sites' designers and developers would follow this high speed tempo. Only 4% of the sites provided a "register / login" possibility. However, some users would like to register, become members and set up the options that the site offers to them according to their preferences. Various versions of the web site would be offered according to the identity of the user profile (pupil, student, researcher, visitor, etc.). Keeping on information about the registered users, the administrators would plan their strategies in order to provide better services. It would also help the museum satisfy its visitors in a better way by suggesting artists or collections that would be of interest to the particular visitor profile.

The sites would also increase their interactivity and communication with the visitors. So, they would enhance the following sections:

- ❖ Polls
- ❖ Forums
- ❖ Sms alerts
- ❖ Online forms for communication
- ❖ Chat rooms
- ❖ Videoconference
- ❖ Surveys
- ❖ Online "tests" and knowledge competitions in order to stimulate visitors
- ❖ Interactive applications for kids based on the museum's collections.

Although RSS/XML feed is a useful application, only a few sites provided this feature. Since podcast technology and portable media players have burst dynamically into our lives, museums' sites would adopt these advances. Moreover, museum's sites would offer virtual tours that present the museum's spaces, exhibitions and collections. Virtual tours enhance the contact between the visitor and the museum. It is also a nice way to promote its exhibits to people who do not have the opportunity to visit the museum imminently.

Existence of correct, substantial and useful headlines is of great importance. A visitor would be able to understand within a few seconds what he would find in every page, just from reading each page's headline. The titles have to be written in simple language and must state clearly the page's content. Furthermore, the key

information (e.g. new events or new temporary collections) would be placed at the top of every page in order to be visible by the visitor.

The links also affect the smooth navigation. Not only broken links are a disadvantage, but also irrelevant links deteriorate the site's usefulness. Links would be followed by a short explanation about the page or the site they lead to. There would be links to other sites with similar or relevant content. Another point is related to the quality of the images. Many visitors want to download some photos or look at the museum's exhibitions. Therefore, the pictures' quality plays a significant role on whether a user is going to revisit the web site or not.

This study would be replicated in specific countries to reveal the current situation of the museums' sites at that country. Finally, the museums would collaborate in order to develop a unified huge multimedia database that will contain all of their artefacts (either exhibited or in repository), information about art, culture, science, history, artists, exhibits, related events, etc. A visitor would search this database to find anything he is interested in. He would also participate in discussions with other visitors on common interest issues. Furthermore, the relationship among these objects would help the visitor to find interrelated information, to compare objects, to trace objects, to express his opinion about objects, etc. This would be useful not only to researchers, artists and museums' administrators but also to the general public.

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Table 1: Analysis of previous studies.

Previous Studies, Methodology used	Evaluation Criteria / Tools

Olsina Santos (1999)
 	
Qualitative evaluation by the author
	1. Usability
	    Global Site Understandability
	    Feedback and Help Features
	    Interface and Aesthetic Features
	    Miscellaneous Features
	2. Functionality
	    Searching Issues
	    Navigation (and browsing) Issues
	    Domain Specific and Miscellaneous Functions
	3. Site Reliability
	    Non-deficiency
	4. Efficiency
	    Information Accessibility
	    Performance Behaviour

Dyson & Moran (2000)
 	
Qualitative evaluation by the authors
	1. Formal Evaluation
	    General Aspects of Site (institutional information, finding aids, user information)
	    Features of the Catalogues or Collections (catalogues or collections, structural context, search mechanisms, search return)
	2. Informal Evaluation
	    Learnability (consistency, predictability)
	    Efficiency (accessibility, orientation)
	    Presentation (consistency, typography, images and text, overall)

Loiacono et al. (2000) Qualitative by web users, undergraduate students and expert evaluators	Informational Quality Fit-To-Task Interaction Trust Response Time Design Appeal Intuitiveness Visual Appeal innovativeness Flow-Emotional Appeal Integrated Communication Business Processes Viable Substitute
Brajnik (2000) Quantitative evaluation using 11 tools	A-Prompt Bobby Validator Doctor HTML LIFT LinkBot MacroBot MetaBot NetMechanic WebCriteria WebGarage WebSAT

Cunliffe et al. (2001)
 	
Quantitative evaluation using Direct Observation, Log Analysis, Online Questionnaire and Heuristic Evaluation
	1. Direct Observation
	    Artificial Context
	    Artificial Tasks
	    Artificial Motivation for the Subject
	    Observation Subjects
	    Think-aloud Protocol
	    Video
	    Observer's Note Book
	    Optimal Path
	    Time to Complete
	    Interviews
	2. Log Analysis
	    Difficulties in Identifying Visitors
	    Caching
	    Limited Range of Data Captured
	3. Online Questionnaire and Feedback
	    Self-selecting Nature of the Sample
	    Response Rate Required to Draw Reliable
	                    Conclusions
	4. Heuristic Evaluation
	    Consistency and Conformance to Standards
	    Recognition and Predictability
	    Web Pages Should Stand Alone
	    Flexibility and Efficiency of Use
	    Effectiveness
	    Readability
	    Every Page Should Express One Topic
	    Consider the Global Audience

Sutcliffe (2001)
 	
Qualitative evaluation by a number of undergraduate students
	1. Attractiveness
	    Use of Colour
	    Symmetry / Aesthetic Style
	    Structured Layout
	    Depth of Field
	    Choice of Media
	    People and Personality
	    Unusual Images
	2. Exploration – Navigation
	    Visual Style
	    Brand Visibility
	    Mood and First Motivation
	    Secondary Motivation
	    Content and Requirements
	3. Transaction
	    Usability Criterion
	    Navigation Commands
	    Navigation Support
	    Transaction Prompts
	    Form Fill Layout
	    Transaction Controls

Smith (2001)
 	
Qualitative evaluation by the author
	1. Information Content
	    Orientation to Website
	    Content
	    Currency
	    Metadata
	    Services
	    Accuracy
	    Privacy
	    External Recognition
	2. Ease-of-Use
	    Links
	    Feedback Mechanisms
	    Accessibility
	    Design
	    Navigability

Albuquerque and Belchior (2002)
 	
Qualitative evaluation by users based on a Fuzzy Model
	1. Usability
	    Technical Features
	    User Friendliness
	    Navigability
	    Maintainability
	    Technology Suitability
	    Reusability
	    Implementation Feasibility
	    Profitability
	    Involvement Capacity
	2. Conceptual Reliability
	    Functionality
	    Security
	    Reliability
	    Integrity
	    Trustworthiness
	    Content Adequacy
	3. Representation Reliability
	    Readability
	    Standards Conformance
	    Ease Of Manipulation

Micheloni & Bowen (2002)
 	
Quantitative evaluation using Bobby Validator and JAWS Screen Reader
	1. Bobby Validator
	    HTML Errors
	2. JAWS Screen Reader
	    Frames
	    Flash
	    Tables
	    Pull Down Menus
	    JavaScript
	    Images / Link description
	    Passwords
	    Braille Compatibility

Di Blas et al. (2002)
 	
Qualitative evaluation by users and experts using the MILE method
	1. Inspection
	    Expert Evaluator
	    Systematically Exploring the Application
	2. Empirical Testing
	    Panel Of End Users Using the Application

Ranganathan and Ganapathy (2002)
 	
Qualitative evaluation by online users
	1. Information Content
	    Availability of Information
	    Availability of Decision Making
	    Completeness of Information
	    Availability of Option to Interact
	2. Design
	    Ease of Navigation
	    Time Taken for Navigation
	    Graphics, Audio, Video
	3. Security
	    Availability of Secure Modes
	    Non-Online Modes for Financial Transactions
	    Logon-Id and Passport
	    Overall Concern about Security
	4. Privacy
	    Gathering of Personal Information
	    Attitude Towards Sites that Demand Personal Information
	    Hesitation on Sharing Personal Information
	    Statement of How Personal Information will be Used

Avouris et al. (2003) Qualitative evaluation by students and experts	1. Questionnaire-Based Evaluation 2. Heuristic Evaluation 3. User Observation

Bowen (2003)
 	
Quantitative evaluation using Bobby Validator
	1. Accessibility
	2. Usability
	    Benchmarking
	    Graphical User Interfaces (GUI)
	    Input Devices and Strategies
	    Interaction Styles
	    Screen Design
	    Standardization
	    Style Guides
	    User-Centred Design
	    Voice I/O

Huang (2003)
 	
Qualitative evaluation by researchers
	1. Usability issues
	    Layout and Layout Consistency
	    Search Forms and Navigational Supports
	    Default Screen Resolution
	2. Multimedia usage
	    Video
	    Animation
	    Audio
	    Graphics

Van Der Merwe and Bekker (2003)
 	
Qualitative evaluation by online users
	1. Interface
	    Graphic Design Principles
	    Graphics and Multimedia
	    Style and Text
	    Flexibility and Compatibility
	2. Navigation
	    Logical Structure
	    Ease of Use
	    Search Engine
	    Navigational Necessities
	3. Content
	    Product Related Information
	    Company And Contact Information
	    Information Quality
	    Interactivity
	4. Reliability
	    Stored Customer Profile
	    Order Process
	    After-Order To Order Receipt
	    Customer Service
	5. Technical
	    Speed
	    Security
	    Software And Database
	    System Design

Rinalducci (2004)
 	
Qualitative evaluation by a number of librarians and art historians
	1. Relevance
	    Information Adds to and Supports Research
	    Site provides Cross-References To Print sources
	    Site Is A Reference Site
	2. Navigability
	    Information is Presented Clearly
	    Linking Between Sections is Easy
	    Site has a Usable Search Feature
	3. Coverage
	    There is an Introduction/Mission Statement and
	          it Matches the Coverage of the Site
	    Information Expands on Museum and Library
	                        Materials
	    Site Provides Reference
	4. Images
	    Images are Usable
	    Images are Easily Locatable and/or Searchable
	    Text Identifies and Describes Images

Glenn (2004)
 	
Quantitative evaluation using Content Analysis
	1. General Structure & Construction Elements
	   Accessible "alt" Tags for Images
	   Quick to Load
	   Succinct and Scannable
	   Appropriate Metadata in Source Code
	   User Friendly Navigation Scheme
	   Visually Appealing Colour Scheme
	2. Business-Related General Content
	   Hours of Operation
	   General Contact Info Easy to Find
	   Highly Selective Links
	   Important Information at Top of Page
	   Content Presented in a Logical Fashion
	   Last Updated Date
	   Mission, Vision or Statement of Purpose
	                         Present
	   Related Governing Entity
	3. Archives Specific Content
	   Unique Online Domain
	   User Archival Literacy Efforts
	   Statement Of Fees Charged to be Present
	   Photocopy Policy to be Stated
	   Format of Materials Available to be Stated
	   Access Restrictions to be Stated
	   Major Subjects of Collections are Stated
	   Reference Request From Present
	   Search Collections
	   Finding Aids Present

Davoli et al. (2005)
 	
Quantitative evaluation using Fuzzy Quality Tree for Web Inspection
	1. Basic Functionality
	   Basic Information
	   Site Management
	2. Advanced Functionality
	   Services for Common Users
	   Scientific Services and Networks
	3. Usability
	   Usability Basics
	   Support and Multimedia
	4. Accessibility
	   Images, Maps, Multimedia Features
	   Client Side Programming Features
	   Sereen and Visual Behavior
	5. Efficiency
	   Connectivity
	   Visibility on Search Engines
	   Proper Use of TITLE and META Tags
	   URis Quality
	6. Maintainability & Compliance
	   Code Quality and Standard Suitability
	   Compliance
	   Reliability

Eschenfelder and Miller (2005)
 	
Quantitative evaluation using the Socio-Technical Website Evaluation Toolkit
	1. Website / Information Elements
	    Conduct a Benchmark Assessment with the following elements:
	      a. Number of Documents
	      b. Types of Documents
	      c. Subject Matter Covered in Documents
	      d. Amount of data Collected
	      e. Maps Available and the Scale of those Maps
	    Conduct an Assessment of the Usability of the Program Website
	    Check for Contact Information
	2. Socio-Political Context
	3. Assumptions about Citizen Roles in Policy Making
	    Private Citizen View
	    Attentive Citizen View
	    Deliberative Citizen View

Kelly and Vidgen (2005)
 	
Quantitative evaluation using a combination of E-Qual and QA Focus methods
	1. E-Qual
	    Usability (Easy to Navigate, Easy to Learn)
	    Information Quality (Believable Information, Accurate Information, Timely Information)
	    Service Interaction Quality (Trust)
	2. QA Focus
	    Digitisation
	    Web
	    Metadata
	    Software
	    Service Deployment

Signore (2005)
 	
Qualitative evaluation by expert evaluators and users
	1. Correctness
	2. Presentation
	    Layout
	    Text
	    Multimedia
	    Links
	    Forms
	3. Content
	    Readability
	    Information Architecture
	    Information Structure
	    Distinction between Author and Webmaster
	    Indication of Content's Currency
	4. Navigation
	    Navigation Bar
	    Site Structure
	    Horizontal, Vertical, Mixed Navigation
	5. Interaction
	    Transparency
	    Recovery
	    Help And Hints
	6. Additional considerations

Hassan and Li (2005)
 	
Quantitative evaluation using Benchmarking Technique
	1. Usability
	    Screen Appearance (space allocation, choice of colour, readability, scan-ability)
	    Content
	    Accessibility (loading speed, browser compatibility, search facility)
	    Navigation (list of key content in main page, list of key content in all sub-pages, links to main page, unbroken links, sitemap, no scrolling menus, text within text link)
	    Media Use (continues/time-based media, static media)
	    Interactivity (features for users' feedback, discussions, entertainment features)
	    Consistency (consistent page layout, font size and colour, consistent use of navigation aids)
	2. Content Usefulness
	    Scope
	    Accuracy
	    Reliability
	    Currency
	    Uniqueness
	    Linkages
	    Text Quality

Gledec (2005)
 	
Qualitative evaluation by the author
	1. Functionality
	    Suitability
	    Accuracy
	    Interoperability
	    Confidentiality
	2. Usability
	    Ease of Use
	    Comprehensibility
	    Level of Communication
	    Attractiveness
	3. Reliability
	    Availability
	    Fault Tolerance
	    Security
	4. Efficiency
	    Time Behaviour
	    Resource Utilization
	    Visibility
	    Flexibility
	5. Maintainability
	    Analysability
	    Changeability
	6. Portability
	    Adaptability
	    Install-ability
	    Coexistence

Table 2: MuseumQual criteria

Content	Presentation	Usability	Interactivity & Feedback
Quantity of Content Quality of Content Personalization	Multimedia Quantity Multimedia Quality Personalization Styles & Format Right Spelling, Grammar, Syntax, etc.	User Interface Site Structure & Organization Search Easy & simple Navigation Alternative Paths Return to Home No Under Construction Pages & Links Orientation Site Map	Asynchronous Communication Synchronous Communication E-Communities Interactive Multimedia Applications

E-Services	Technical
Quantity of E-Services Quality of E-Services Online Purchase & Payment Informational Services Virtual Tours Online Learning Online Amusement Technical Services	Compatibility (Browsers, etc.) No Need of Special Software Reliability & Availability Performance Security & Privacy No Cookies

Table 3: Average and Variance of the Ccore of Art, Science/Technology and History museums' websites in all six criteria categories.

Museums			Art	Science	History
			Average / Variance		
CRITERIA		Content	3.55 / 0.81	3.45 / 0.57	3.53 / 0.39
		Presentation	3.19 / 0.30	3.22 / 0.21	2.96 / 0.18
		Usability	3.88 / 0.38	3.93 / 0.28	3.51 / 0.39
		Interactivity & Feedback	2.11 / 0.73	2.66 / 0.50	2.01 / 0.63
		E-Services	2.74 / 0.68	3.21 / 0.57	2.71 / 0.48
		Technical	4.45 / 0.05	4.54 / 0.05	4.57 / 0.05
Total			3.32 / 0.49	3.50 / 0.36	3.22 / 0.35
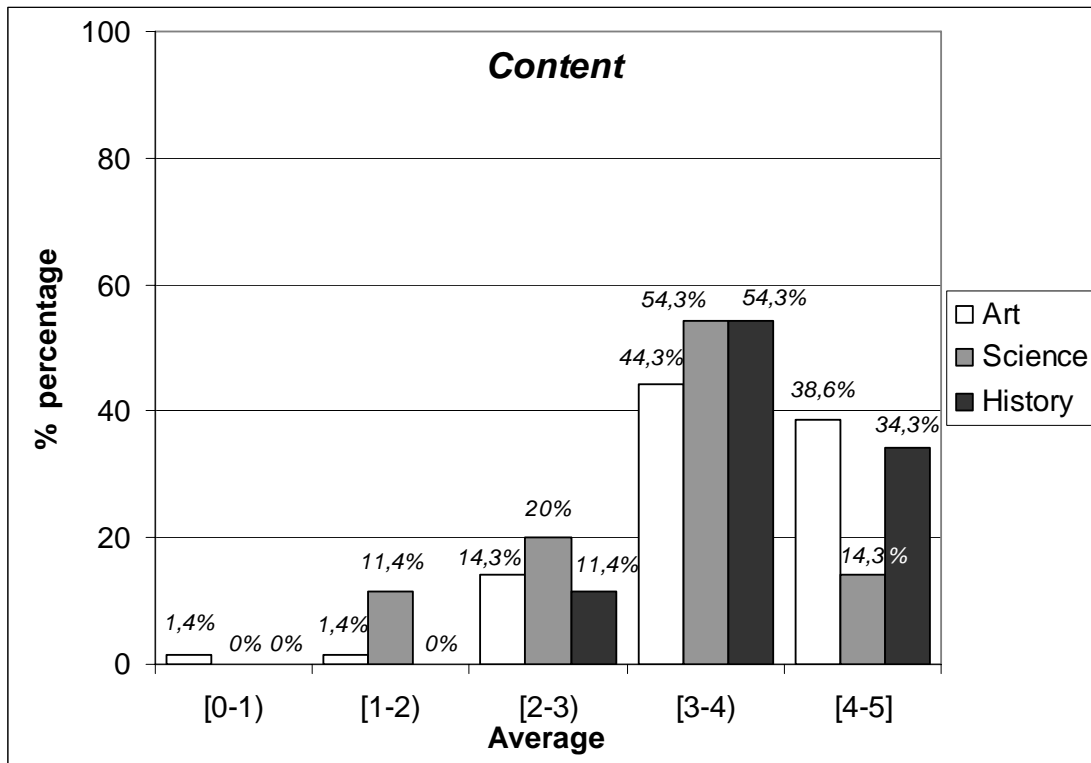
Figure 1: Score distribution regarding Content criteria.
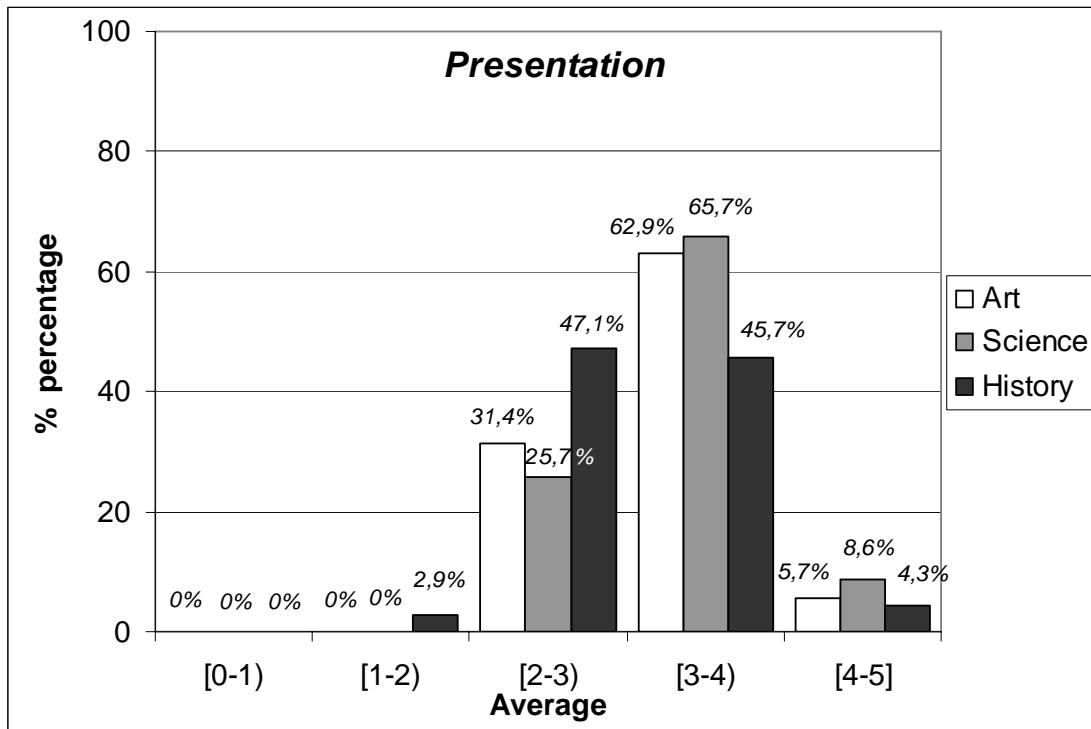
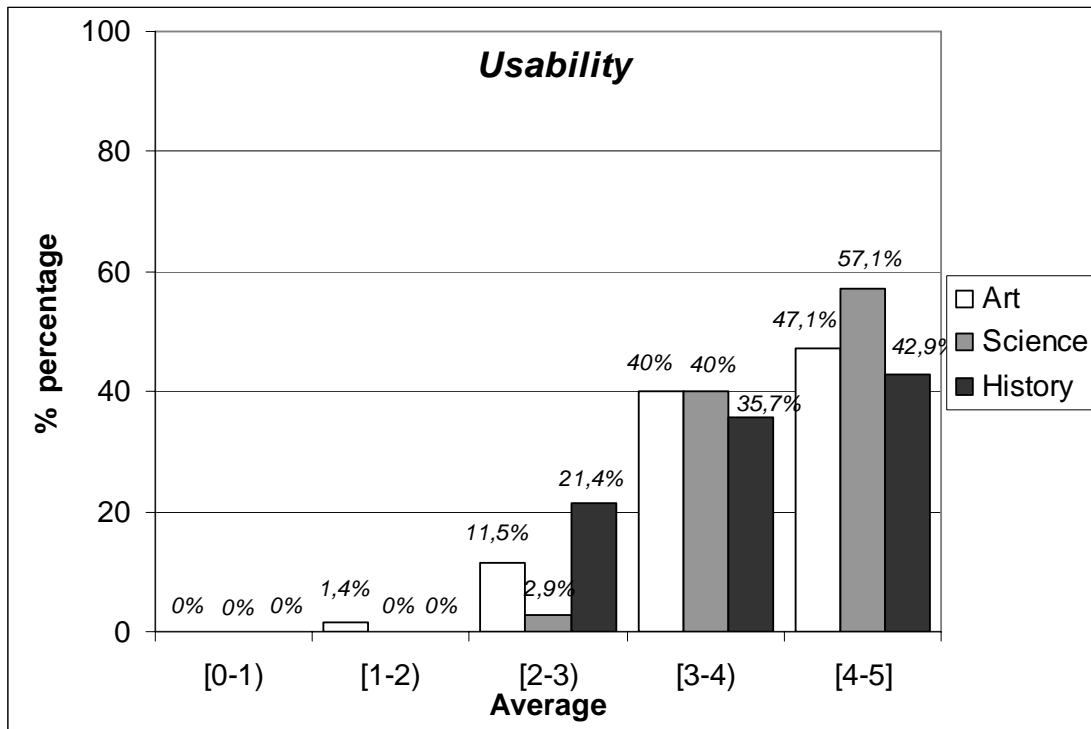Figure 2: Score distribution regarding Presentation criteria.

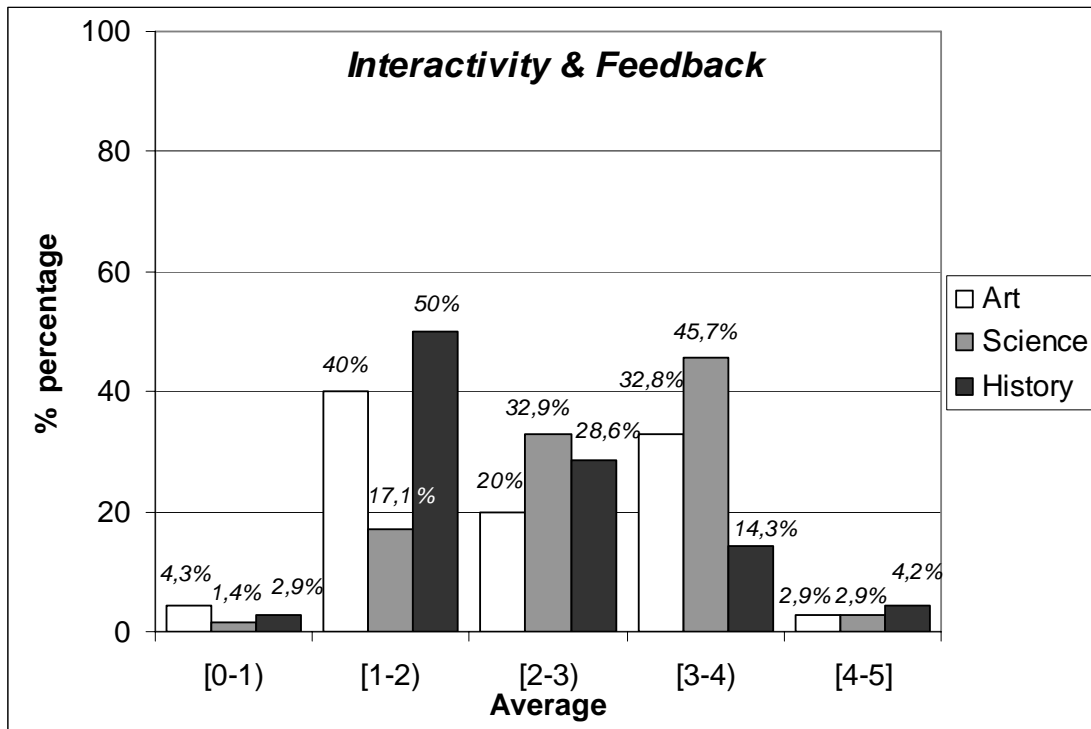Figure 3: Score distribution regarding Usability criteria.

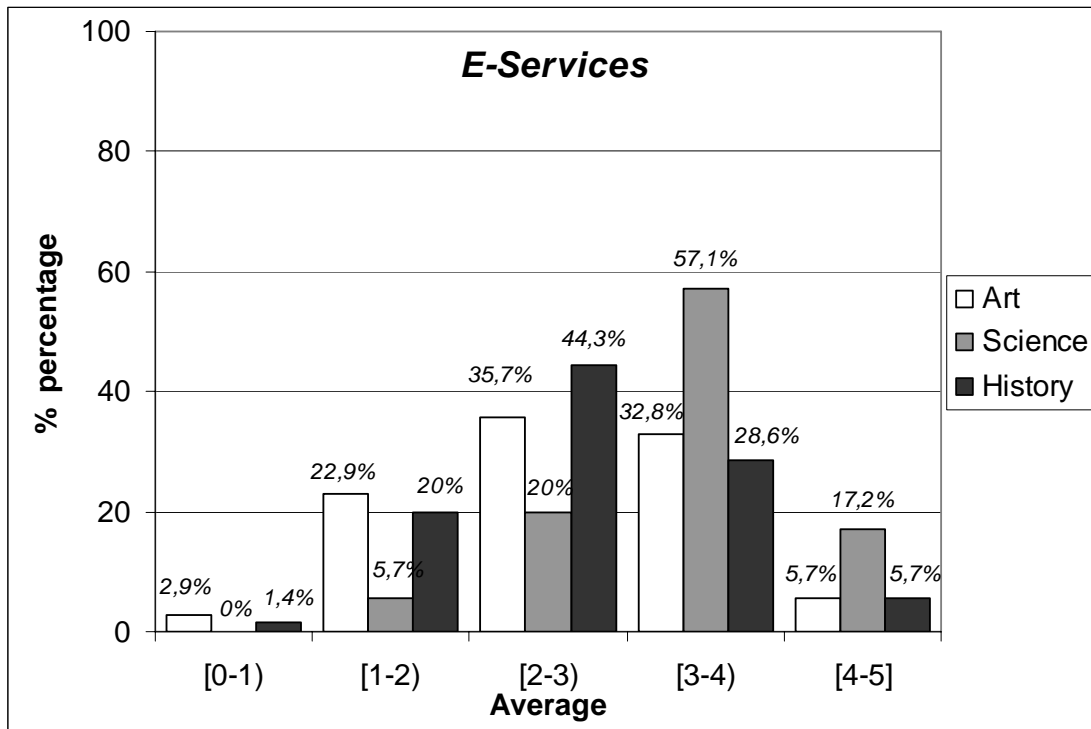Figure 4: Score distribution regarding Interactivity & Feedback criteria.

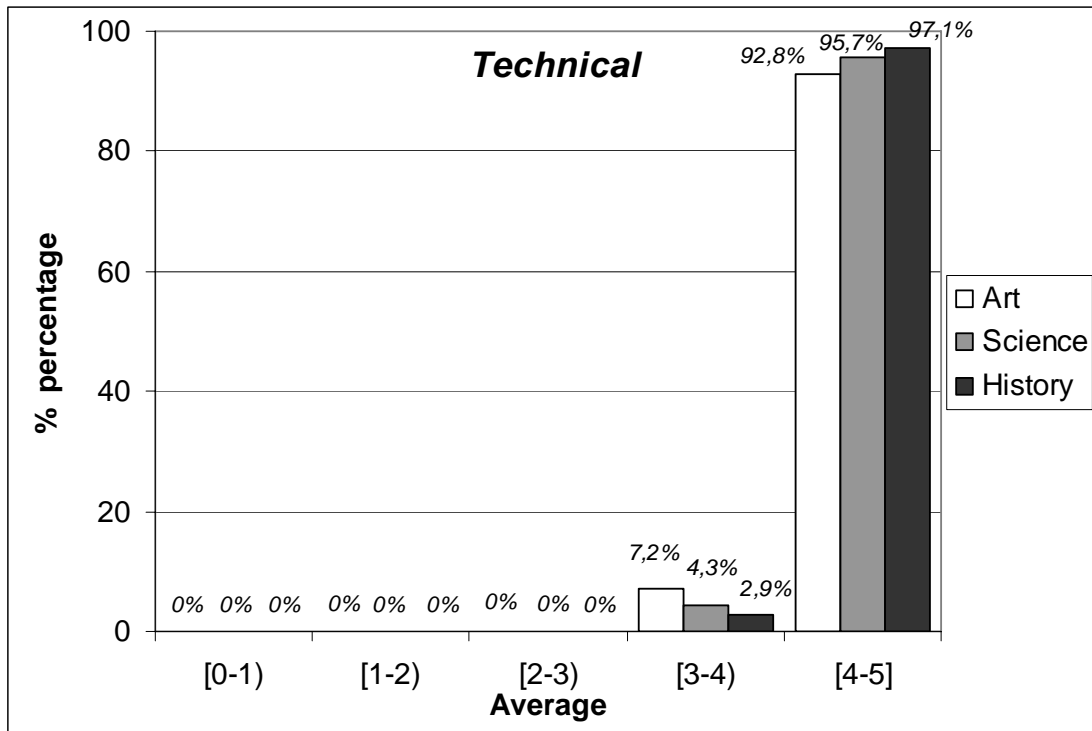Figure 5: Score distribution regarding E-Services criteria.

Figure 6: Score distribution regarding Technical criteria.