A framework for evaluating Academic Website's quality
From students' perspective

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Tsigereda W. Mebrate

A framework for evaluating Academic Website quality
From students' perspective

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By

Tsigereda Worku Mebrate
born in Gondar, Ethiopia

Web Information Systems Group
Department of Software Technology
Faculty EEMCS, Delft University of Technology
Delft, The Netherlands
http://eemcs.tudelft.nl

A framework for evaluating Academic Website quality
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Author: Tsigereda Worku Mebrate
Email: T.W.Mebrate@student.tudelft.nl
Student id: 1531565

Abstract

As organizations have become aware of the strategic importance of websites, the trend to use websites for various purposes has increased in different domains such as education, health, government and business. However, organizations seeking to obtain benefits from their websites need to create and maintain websites that are successful in supporting the interaction and communication of the organization with their users.

The main goal of this Thesis project was to design an improved website quality evaluation framework for academic websites from students' perspective. For this purpose, an extensive study of the literature on existing quality evaluation models, essential website success factors and criteria was made to identify necessary quality factors, sub factors and criteria. A new and improved quality evaluation framework consisting of five high-level quality factors (*Content, Usability, Reliability, Efficiency* and *Functionality*), hierarchically arranged into sub quality factors and criteria was designed.

The proposed framework was applied on a case study academic website (TU-Delft University website) to assess its effectiveness and at the same time to evaluate the quality of the website. It is observed from the results of the case study conducted to evaluate the proposed framework, that the new framework has a better construct of quality factors and sub factors as compared to the ISO 9126-1 evaluation model. However, further study should be conducted on some of the sub factors such as identity, authority, multiple language support and functionality.

The results of evaluating the TU-Delft website showed that the website in general has a good quality of reliability and efficiency characteristics, while having moderate quality in its content, usability and functionality features.

Keywords: Academic website quality evaluation, website evaluation, website quality framework

Graduation Committee:
Prof. dr. ir. G.J. Houben, Faculty EEMCS[1], TU Delft
Ir. B.R.Sodoyer, Faculty EEMCS, TU Delft
Dr. K.van der Meer, Faculty EEMCS, TU Delft
Ir. H.J.A.M Geers, Faculty EEMCS, TU Delft

[1] Faculty of Electrical Engineering, Mathematics and Computer Science

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Tsigereda Mebrate
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Delft, The Netherlands

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1. Introduction

Website development has been done at a fast pace in recent years for wide ranges of purposes in different domains such as education, government, museum, business, entertainment and health [1-3]. There are millions of websites today but a small percentage of these websites reach far above the ground level in satisfying their users' requirements and needs. Some of the reasons contributing for this problem are related to the rapid advancement in web technologies, the easy use of web-oriented languages and the tolerance of browsers to display incorrect code. Other reasons contributing to the problem are limited experience and background of designers and developers, less time and resources allocation for website design and development projects [4]. Despite the fact that many websites lack the quality of satisfying their user's needs, the reliance to use websites for different purposes such as finding information, shopping online, communicating with people or performing other different tasks has augmented. Moreover, existing websites in different domains have become application oriented and they are not just only document oriented any more. As a result, they are complex systems [5]. Subsequently, there are increasing concerns and challenges about website design, implementation and evaluation techniques [6] [7].

The design and performance of websites at present times is different from how websites looked and performed few years back. There are speculations that the shift will occur in the future as well. Regardless of all these changes, one thing that is expected to remain the same is that websites providing the best performance, easiest and most intuitive user experiences will continue to be visited by users[8]. Websites that fail to provide their users with the most favourable experiences possible cannot keep their visitors and users to use the website. Hence, selecting to use or develop high quality websites is of high importance.

Several website design guidelines, usability assessment techniques, and quality assurance models have been developed and used for designing as well as evaluating websites[4, 8-16]. While several website design guidelines have been widely adopted and used for the purposes of improving the design and development processes of websites, website quality evaluation standards and models remained to be rather not largely used. Needless to say that most of the website quality evaluation models introduced over the years merely provide lists of broad quality characteristics structured in a hierarchical way. Most of the models neither directly address quality factors related to particular properties of websites in different domains nor do they consider the different viewpoints of users of the website under consideration. Furthermore, the quality factors (characteristics) extremely focus on usability features of websites while neglecting other necessary quality factors such as quality of information, performance and functionality. In spite of that, evaluating the quality of a website is important to ensure whether or not the website is successful in meeting its intended purposes for its intended users.

One of the domains where websites are most widely used nowadays is the academic domain. Academic institutions use websites for wide variety of purposes, which includes the distribution of information to the public, delivering online learning facilities to students, promotion of their educational and research programs and the like. Generally speaking, regular users of academic websites are students, professors, employees, journalists, and parents. Each of this user group has their own specific requirements and expectations from the website. Hence, evaluating the quality of academic websites needs to take into account the needs of these different user groups.

1.1. Problem statement

As stated in the introduction section, evaluating the quality of a website helps to assess whether or not the website is meeting its intended purpose for the intended users. Besides, the results of the evaluation can help to understand the parts of the website that need modifications to bring an improvement in the website.

Evaluating quality of a product in general requires a set of quality factors that describe what is expected from the product's characteristics. The set of the characteristics and the relationship between them form a quality evaluation model. In order to be able to evaluate the quality of websites, it is necessary to study which quality factors to take into account, which kinds of evaluation approaches to utilize and which viewpoints of users to consider for the evaluation purpose [2]. While evaluating the quality of a website, different approaches can be adopted. The most common approaches being: to evaluate quality of a website during the development process or after the website is made operational [2], [9]. Evaluating the overall satisfaction of the users of the website is also another approach used to evaluate the quality of a website.

There are several website quality models currently available, even though most of them only provide broad website quality factors and only few are designed for the purpose of evaluating websites in particular domains like museums [17], tourism [18], hotels [19], government [20] and commerce or business[21-23]. However, the number of website quality evaluation models that can be used right away for evaluating the quality of academic websites is limited. As a result, the general quality models are used to evaluate the quality of academic websites. The general website quality evaluation models do not consider the requirements or needs of specific users of the website under consideration (evaluation), except listing broad quality factors and sub factors.

Users of academic websites expect specific type of information in the website and a short period of time to access the information they want. Generally speaking, the users of academic websites are students, professors, researchers, journalists, parents, webmasters and developers. All of these users have different user experiences, background, and user needs in using the website. It is noted in the literature that most of the users of academic websites are concerned with two basic questions [6]:

- "Can I find the information I am looking for in the website?"
- "Can I find the information in a timely manner?"

These indicate that the users of academic websites are concerned more about whether or not they can find the information they are looking for in the website and how long it would take them to find that particular information.

Nevertheless, as comprehensively discussed in the introduction section, there is no particular website evaluation model for academic websites that considers requirements of different user groups. Thus, there is a need to design a framework that provides a guideline for evaluating quality of such kinds of websites from the perspectives of different user group of these sites. The main aim of this project is to design an improved academic websites quality evaluation framework from the perspective of student users.

1.2. Research Objectives and Research Questions

1.2.1. Research Objectives

The general objective of this thesis work is to design a quality evaluation framework for academic websites. The student's user group's perspective is considered for designing the evaluation framework. The new evaluation framework designed will be applied on a case study website (TU-Delft website) to test how effective the framework performs. The specific objectives of this Thesis project can be summarized as follow:

- To design a quality evaluation framework for academic websites from students perspective
- To apply the proposed evaluation framework on the TU-Delft website
- To assess the effectiveness of the proposed quality evaluation framework
- To provide suggestions for improving the proposed website quality evaluation framework

1.2.2. Research Questions

To achieve the objectives of this Thesis project the following research questions were asked:

- What is website quality?
- What are the characteristics of existing software and website quality models?
- Which website quality factors are characteristics for academic websites?
- Which website design guidelines are important for evaluating quality of websites?
- How effective is the TU-Delft website in satisfying the information needs of its student users?

1.3. Delimitation

The project is limited on designing a framework for academic websites from students perspective, and therefore the focus will be on website quality characteristics that reflect the needs of these users.

1.4. Relevance of the project

The relevance of this thesis project can be seen from the societal and economical point of view.

Societal

Generally speaking, the main users of academic websites are students (either currently enrolled or prospective students), parents, companies and other similar educational institutions. If academic websites make use of this simplified quality evaluation framework to assess their website's quality, then the users of the website could benefit from the improvements that would be made on the website based on the result of the evaluation. Consequently, users of the website can easily navigate through the website to search and find the information they want to look for on the site without difficulty.

Economic

The proposed academic website quality evaluation framework can also bring an economic benefit to academic institutions. Using the evaluation framework, academic institutions can assess the quality of their websites and hence be able to understand the degree of their user's satisfaction in

using the website. The results of the evaluation can also point towards the parts of the website where there is a need to make improvements for achieving the intended purposes of the website at the same time for enhancing users' satisfaction. Improved functionality of websites can help users who are not familiar with the website and who do not have much experience in using websites to easily use the website. Thus, attracting new users to visit the website, perhaps potential future users of the website (new students, research companies, professors, journalists etc). As a result, it opens a new opportunity to increase the return on investment of the institution.

Moreover, quality accreditation institutions can directly make use of the framework or adopt parts of the framework for the purpose of ranking websites of academic institutions from student's perspective.

1.5. Report structure

The results of this Thesis are presented in 6 main chapters. A brief overview of these chapters and general structure of this Thesis report is summarized in the following paragraphs.

Chapter1 gives a brief introduction to the project by explaining the problem statements, objectives, research questions, delimitations and relevance of the Thesis project.
Chapter2 discusses a summary of the review of the literature conducted to explore generic software and website quality models. Different types of software and website quality evaluation models are discussed in this chapter. A summary of each quality models is given at the end of the chapter.
Chapter3 gives an overview of how the evaluation framework is constructed. It explains general quality factors for website success and necessary quality factors and sub factors selected from existing models. It also describes the criteria considered for the sub quality factors.
Chapter4 presents the general methodology used to apply the framework and test the proposed evaluation framework. It gives an explanation about the steps used to construct the questionnaire and analyse the responses.
Chapter5 focuses on the analysis result of the Questionnaire conducted to evaluate the effectiveness of the evaluation framework. This chapter gives detail statistical analysis to show the result of the case study.
Chapter6 gives conclusions of the work done in this Thesis by explaining the key results of the project. It also provides recommendations for improving the proposed framework as well as the quality of the TU-Delft website. General recommendations for evaluating quality of academic websites are also given at the end of the chapter.

References, definitions of key terms, acronyms and appendices are presented at the end of the report.

2. Review of the Literature

In this chapter, a review of the literature regarding key topics in the project is explained in a brief manner. First, general definitions, importance and perspectives associated with quality are explained followed by a discussion that explores existing software and website quality models. Finally, summary of existing quality models and their high-level quality factors are presented.

2.1. What is Quality?

Quality is an intangible concept. It is not easy to define it in an operational way, yet everybody feels it when it is missing. The terms good quality and poor quality are used in our everyday life to tell how good or bad a product functions. Most people can recognize quality easily but they find it difficult to give a clear description of the term [24, 25]. Sometimes quality indicates luxury, taste, and expensive products. A product that is expensive is perceived to have good quality, while a product with cheaper price is considered to have poor quality. This outlook shows that people consider quality as something that can be felt, understood and judged but cannot be measured and hence cannot be controlled. Regardless of this observation, in order to improve the acceptance and use of a product, its quality should be defined, measured and controlled [26].

Quality can be seen as the abstract relationship between attributes of an entity [2]. These attributes of entity of interest (for example a software product or a website) include the viewpoint on that entity and the quality characteristics of the entity. While the term is ambiguous and obviously misunderstood, there are many perspectives and approaches to define and measure quality.

2.2. Different perspective of Quality

Based on diverse perspectives on quality, different definitions are given to quality [24, 27, 28]. Five fundamental perspectives of quality as introduced by Garvin [27] define quality in different ways. These five perspectives and the definitions they give to quality are described below:

Transcendental
This view associates quality with the "innate excellence" of a product. It emphasizes on the idea that quality is universally recognized and measureable, which indicates high achievements and inflexible standards2. This perspective designates the fact that product development always strives for producing the ideal "best" characteristics of a product the user wants and the attempt to achieve the ideal, although the ideal best product may not be produced at the end. This strived for ideal "best" characteristic of a product is the transcendental viewpoint of quality.

User based

This perspective of quality focuses on users' satisfaction. A product is said to have a good quality when users are satisfied in using it. This is to mean that if the product meets the purpose for which it was designed and developed in the first place and users are satisfied in using it, then it has a

[2] This view relates much to "the ideal" theory of Plato or Aristotle's concept of "form". This view sees quality as something that can be recognized but not defined.

good quality [28]. Users have different views on product usability depending on their needs. This view of quality indicates a more personalized view of users on product quality in a specific context of operation and functionality of the product.

Conformance to requirements (Manufacturing based)

This is another perspective that defines quality as the "conformance to requirements". A product should conform to specific set of design requirements established at the beginning of the production. Any deviation from the requirements indicates low product quality.

Product based

In this approach, quality of a product is determined based on its internal characteristics and the weights assigned to them according to their level of importance. Attaching weights to the attributes is a cumbersome task. In addition, since the selection of the attributes and assigning values might be susceptible for subjectivity, it may be difficult to arrive at an agreed up on definition of quality, which is acceptable by all types of users. Nevertheless, this perspective is advocated by experts who believe that measuring internal quality can give a context-independent evaluation and help to improve the external quality or quality in use of a product [28].

Value based

In this approach, quality is defined in terms of the relations between the value and cost of a product. A product with good quality provides performance at an acceptable price and conformance at an acceptable cost.

Existing quality definitions fall into one of the 5 basic perspectives though the views of users and product manufacturers would be different. The implication of different perspectives of quality indicates the different viewpoints of users and developers. High quality for users is related with high performance and improved features of a product/service that satisfies their needs. Producers/developers on the other hand take a different line of thought; a product to be referred as having high quality, it has to conform to outlined specifications [27].

2.3. Software Quality and Website Quality

Software quality is defined in two different ways [26]: conformance to requirements and meeting user needs. Conformance to requirements defines quality of software based on its capability to satisfy sets of requirements and specifications set by the designers and developers at the beginning of the software development. Meeting customer needs on the other hand defines the quality of a software product based on the capability of the software to meet intended users' needs and expectations. Generally, the quality of a software product is measured by its effectiveness to satisfy its user's requirements and the intrinsic product quality, which is characterized by the rate of defects in the product and its reliability.

Websites are seen as an artefact or products having distinguishing features from traditional software products. Web quality, similar to the broad definition of quality, it is largely an undefined concept. Several research works in web quality explain web quality in a descriptive way without defining its key characteristics or providing a tested measurement scale [29]. The intended purpose of a website for which the website is designed in the first place can be used to determine

the quality requirements of that particular website. Seeing it from the perspective of users, a website need to be easy to use, easy to understand, equipped with necessary functionalities and navigation aids. The design and development of websites involves several fields of study including information architecture, navigation, psychology, computer science, human interaction and graphics design [30]. Tasks done in all these fields should be integrated to design an effective website that can satisfy the intended users. It is also advised to evaluate the quality of websites using different quality assessment techniques starting in the earlier stages of the website design, during the intermediate design stages and the deployment (operational) stages [2].

Software quality assessment has been around as a discipline for the last three decades. Software quality assessment models have been developed to evaluate the quality of software products. However, quality assessment of hypermedia and web applications has been a neglected issue [5]. Yet, quality evaluation is not an easy task in either the software or web engineering field. It is challenging to consider all quality characteristics for the quality evaluation purpose, unless there are good quality evaluation models or frameworks. The quality evaluation models provide lists of quality characteristics and show the relationships between these characteristics, which provide a basis for identifying quality requirements and evaluating quality of a product. Although there are differences and similarities between software products and websites, in the past, software quality evaluation models have been used to evaluate quality of websites. Adopting software quality models to evaluate quality of websites requires to first be aware of the similarities and differences between software products and websites [31]. Websites or web applications, taken as a product have their own features that distinguish them from traditional software, specifically [2],[31]:

- Web applications are interactive and user centred, hypermedia based applications where the user interface play a great role
- Aesthetic and visual features that are more artistic and creative skills than technical skills are part of web applications development than it is in software development. There is a great connection between art and science in web applications development
- Internationalization and accessibility of content for users with various disabilities are real and challenging issues in Web applications
- Web applications are content driven and document oriented. Most websites continue to deliver information as this is one of the features of the early web, which is also supported by the semantic web initiative
- An experimental environment for software may be hard and expensive where as for web applications it is simple and cheaper
- Maintaining software product is a recommended practice, while maintaining a website is necessary to keep it alive
- In case of technical flaws, a website may continue to function with less quality where as this is not necessarily true with software products
- The medium where Web applications are hosted and delivered is generally more unpredictable than the medium where software applications run. For instance, unpredictability in bandwidth maintenance, or in server availability, can affect the perceived quality that users could have.

Web applications have the above distinctive characteristics making them different from software products. However, similar to software products, web applications consist of source and executable codes, list of requirements, design and testing specifications. Thus, the quality factors in the software quality models can be equally applicable for evaluating quality of websites as well. Apart from the software quality models, there are also website quality evaluation models introduced over the past few years [31]. These include website quality evaluation models like Web-QEM, 2QCV3Q (7Loci), Minerva and MiLE.

These website quality evaluation models provide hierarchical lists of broad quality characteristics, sub characteristics and criteria. Although the two most common definitions of software quality given at the beginning of Chapter 2 are the fundamental definitions given to the meaning of software quality in software engineering, there is no consensus on what constitutes quality in the general sense [32]. Nonetheless, there is a requirement for a proper management of quality throughout the life cycle of software development, while the requirements for quality can vary depending on the type of services the product provides, user's viewpoint and context of use [2]. A quality evaluation model to support these requirements, it should have the capability to support both the definition of quality requirements and their subsequent evaluation methods.

2.4. Existing Software and Website Quality Models

2.4.1. Software evaluation models

Many researchers portrayed quality in a hierarchical way to understand and measure software quality. These models are comprehensive tools applicable for assessing quality of any type of software product at any stages of its development life cycles. The models illustrate how software quality characteristics relate one another and the evaluation approaches that should be employed to assess quality. In this section, some of the foremost software quality models are briefly reviewed.

1. **McCall's model**

McCall's model (also known as McCall's triangle of quality) is one of the software evaluation models from the early 70's. It provides three different perspective of software quality or property according to the major three processes in software life cycle:

- Product operation (basic functionalities)
- Product revision (ability to change)
- Product transition (ability to adopt new environment)

The model is shown in figure 1. McCall identified 11 quality factors broken down in to three (functionality, modifiability and adoptability) according to the major three processes in software development cycle. For each of these three factors one or more quality criteria are defined. As shown in figure 1, on the first column that contains the three operations in software development life cycle, quality factors that cannot be measured directly are placed. The quality criteria on the right side indicate the tangible and specific attributes of software products to which values can be assigned to measure the higher levels quality factors [32]. This model proposes a subjective measurement method, which uses a system of assigning quality factors a value with in the ranges from 0 (low) to 100 (high).

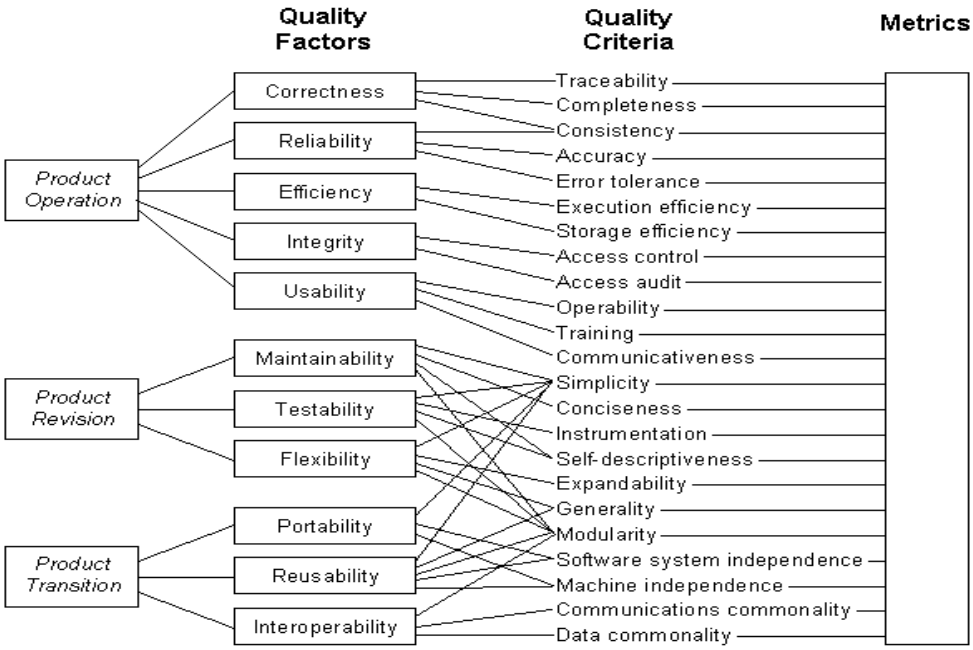

Figure 1: McCall's Software Quality Model

The quality factors describe features of a system and the quality criteria are the result of simplifying the factors into more specific measurable attributes. Some of the quality criteria are attributed to one or more quality factors. The metrics placed on the last column to the right are used to assign measurement values to the quality criteria. The values for these metrics are achieved by answering series of "Yes" and "No" questions about a certain criterion and generating a summary on the relation between the answers [12].

2. Boehm's model

This model has the same characteristics like the McCall's model in that it represents a hierarchical list of quality characteristics categorized as high-level characteristics, intermediate characteristics and primitive characteristics. The high level characteristic is named "General Utility" and it indicates the overall system quality. It consists of three categories of characteristics, namely:

- Portability (ease of adopting to new environment)
- Maintainability (ease of identifying what needs to be modified and the ease of retesting)
- As-is utility (ease of use, reliability and efficiency)

The intermediate characteristics consist of seven quality characteristics each related with the three high level characteristics.

Portability refers to the property of a software product that it can still continue to function, even if it is transferred to a different environment. Maintainability indicates how easy it is to modify the product, re-test and understand the changes. As-is utility (Usability) indicates the efficiency, reliability and easy to use characteristics of a product [12], [33]. The intermediate characteristics consist of 7 quality characteristics shown in the middle of the model in Figure 2. The primitive characteristics at the lowest level of the hierarchy indicate a foundation for defining quality characteristics.

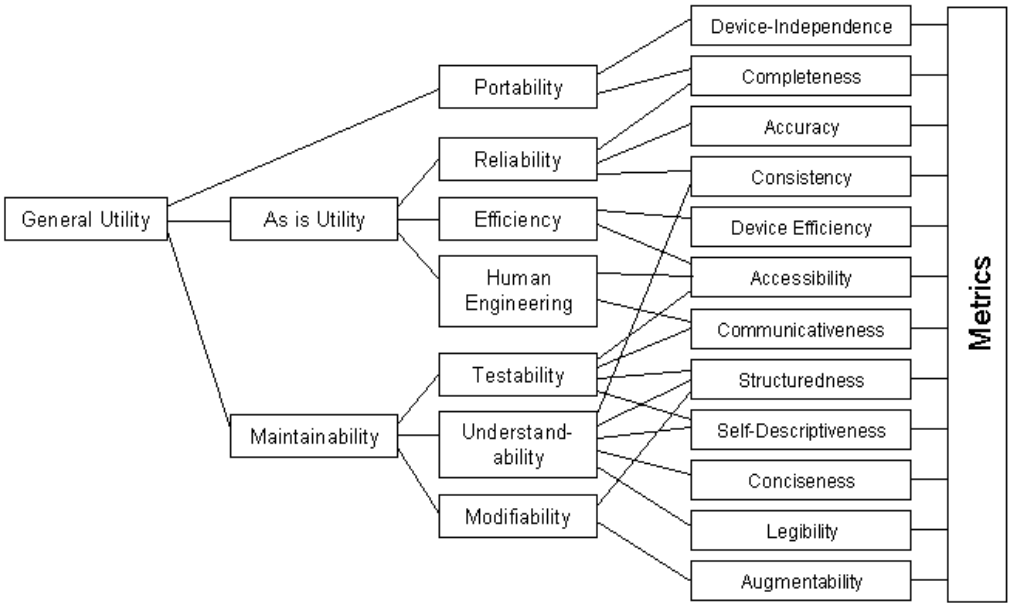

Figure 2: Boehm's software Quality Model

One significant difference between the McCall's and Boehm's model is that the Boehm's model prescribes end-users requirements at the top and technical requirements are addressed at the bottom as opposed to the McCall's model. Another difference is that the Testability factor in the Boehm's model is a criterion for the Maintainability factor where as in the McCall's model; both factors are taken as separate and factors with no direct relation. The model tried to capture various quality characteristics not included in the McCall's model and added measurement or metrics techniques.

3. FURPS/FURPS + model

This model classifies quality characteristics as functional (F) & non-functional (URPS). These requirements can be used both as software design requirements and software evaluation requirements as well. FURPS (FURPS+3) stands for: functionality, usability, reliability, performance and supportability. Functionality consists of the capabilities and security characteristics that correspond with the purposes of the software and the security mechanisms at which the product operates. Usability includes consistency, user interface, and aesthetics of the product. Reliability indicates the frequency of failure, recoverability, accuracy and mean time between failures. Performance of a product indicates the functional requirements of the product like: speed, efficiency, availability, accuracy, response time, and recovery time. Supportability consists of the characteristics like testability, adaptability, maintainability, compatibility, etc. This model does not include the portability quality characteristic. It does not also clearly show the metrics or evaluation approaches to use.

4. Dromey's model

This model emphasizes the idea that software quality attributes necessary for evaluating quality of software products should match properties of the software product. Dromey views a software

[3] FURPS+ is the extended version of FURPS model by IBM Rational software. It consists of design requirements, implementation requirements, interface requirements and physical requirements

product as having different components; each one carrying tangible quality properties. The model consists of three basic elements:

- Components of the product model
- Tangible quality carrying properties
- High-level quality attributes

The model assumes that the components of a product model consist of the following four fundamental properties [32]:

- Correctness: evaluates if some basic principles are violated
- Internal: measures how well a component has been deployed according to its intended use
- Contextual: deals with the external influences by and on the use of a component
- Descriptive: measures the descriptiveness of a component (for example, does it have a meaningful name?)

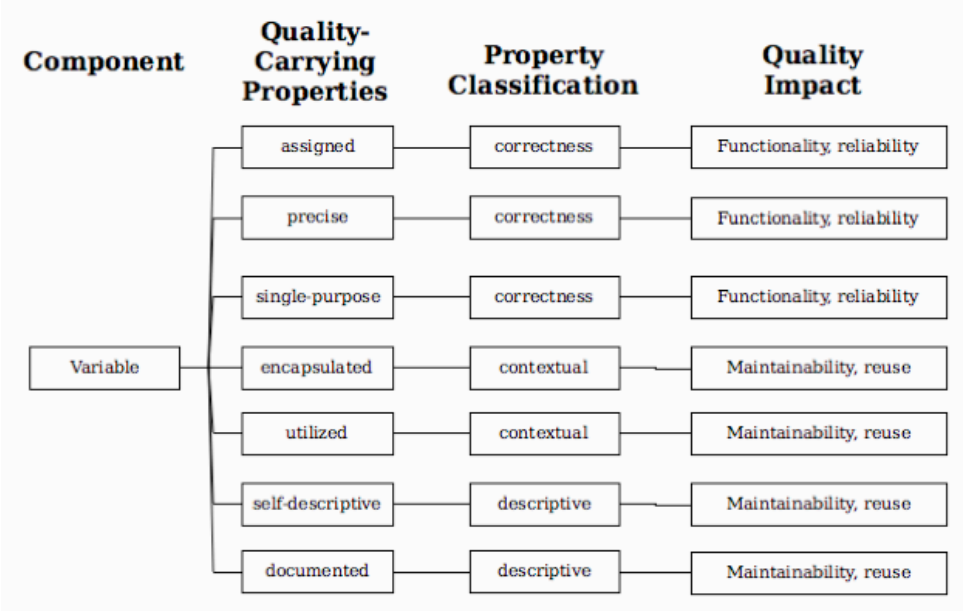

Figure 3: Dromey's Evaluation model

Dromey's model focuses on the relationship between the high level characteristics and the sub characteristics as well as the relationship between the general software quality and the properties of a product. As shown in Figure 3 above, the properties listed are used to evaluate the quality of the software components. It does not however explicitly give explanation about the metrics or evaluation approaches to be used.

5. ISO 9126-1 quality standard

The International Standardization Organization (ISO) set this model initially in 1991 and it was later refined in the past 10 years by ISO Software Engineering experts [34]. It follows from the McCall's and Boehm's model, incorporating the features of both models. It prescribes six quality characteristics (quality requirements): Functionality, Usability, Maintainability, Reliability, Portability and Efficiency to evaluate software quality. The quality definition given in this standard is "The totality of features and characteristics of a software product that bears on its ability to satisfy stated or implied needs" [2].

The ISO 9126-1 series of standards (ISO 9126, 2001-2003) address software quality from the product perspective through its four parts4. Part I of the model was revised to specify a quality framework that distinguishes three different approaches to software quality: internal quality, external quality and quality in use. The three approaches in this model can be summarized as follows:

- **Internal Quality**
  It is defined as "the totality of attributes of a product that determine its ability to satisfy stated and implied needs when used under specified conditions" [2]. It can be measured and evaluated by a set of documents, like specification of requirements, architecture, design or piece of software code. This includes characteristics like testability, flexibility and fault tolerance.

- **External Quality**
  It is defined as "the extent to which a product satisfies stated and implied needs when used under specified conditions" [2]. It is the quality of the product from the external view. It can be measured and evaluated by dynamic properties of the product by running the application or simulating the execution of the application in a seemingly actual environment. This is the result of the combined behaviour of the software application and the computer system. This includes characteristics like performance, reliability, usability, accuracy and integrity.

- **Quality in use**
  It is defined as "the extent to which a product used by specified users meet their needs to achieve specified goals with effectiveness, productivity and satisfaction in specified context of use" [2]. It can be measured and evaluated by the extent to which the software meets specific user needs in the actual context of use. Quality in use indicates the effectiveness, productivity, safety, and satisfaction of users in using the software in the actual context of usage rather than measuring the quality of the software [32].The three quality approaches in the ISO 9126-1 model refer to software operating under specific conditions and context of use. This illustrates that software quality is not an absolute concept; rather it is dependent on the situation and context of use. Moreover, all the three approaches are interrelated.

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[4] ISO 9126-1 has four parts:
Part-I: Quality model
Part-II: External model
Part-III: Internal model
Part-IV: Quality in use model

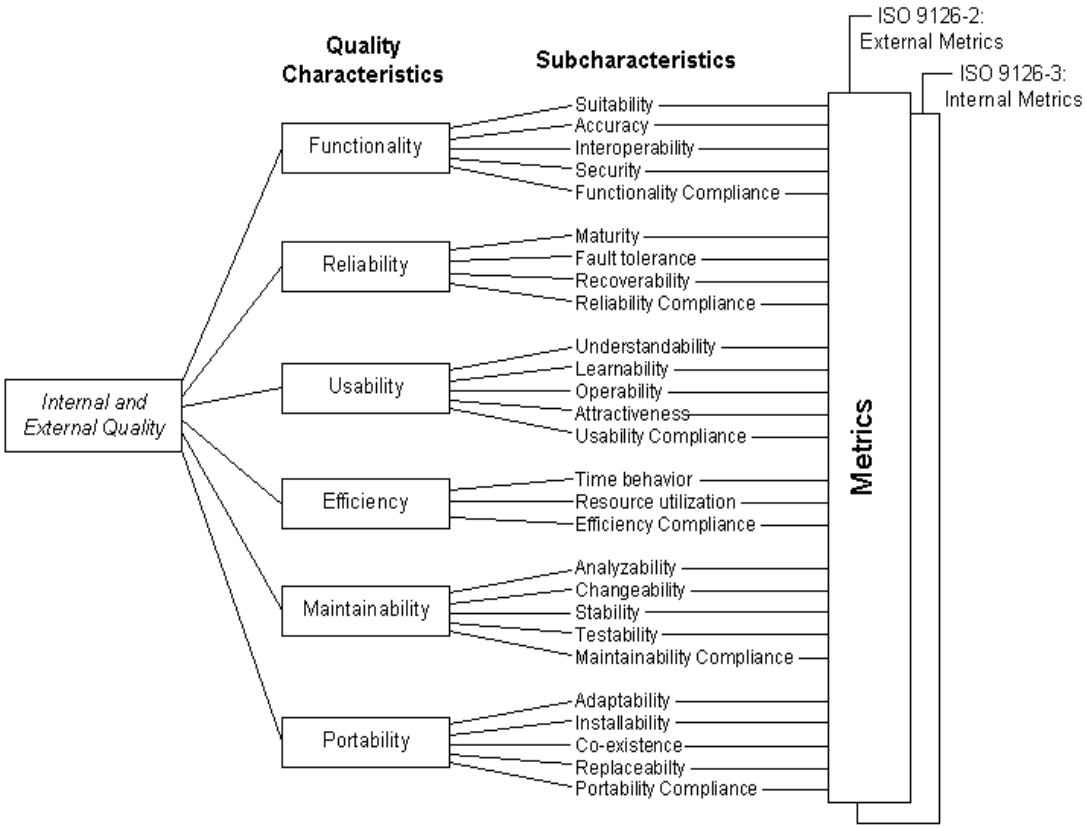

Figure 4: ISO 9126-1 Quality Standard

The external and internal quality characteristics are shown with the three layers in Figure 5 below. As can be seen from the lists of the quality characteristics, the model shares similar quality characteristics from McCall and Boehm's models. Even though it consists of characteristics, sub characteristics and quality measures; the quality characteristic list is not complete and fixed. So that according to the type of the software under evaluation and the reasons behind the evaluation, necessary characteristics, which are not mentioned in the model, can be introduced. The ISO model therefore acts as a starting point for conducting software evaluation; it can be adopted to include essential quality characteristic of the software product under consideration, so to speak.

Figure 5: ISO 9126-1 model external and internal quality approaches

Figure 6: ISO 9126-1 Quality in use model

2.4.2. Website quality models

Software quality evaluation was given high emphasis than quality evaluation of website and web applications. Recently however, there have been significant developments in the Web Engineering, which shifted the focus of quality evaluation, from the offline world to the online world [4] based on the basic software quality evaluation models. In this section, some of the website quality models are discussed briefly.

1. **Web - QEM (Web Quality Evaluation Model)**

This model was a result of quality assessment first made on museum websites. Afterwards, it was applied to academic websites and other domains. The quality characteristics in this model are based on the ISO 9126-1 model and therefore its characteristics include usability, reliability, efficiency and functionality [2, 5]. The evaluation process in the model involves the following basic steps:

- Selecting a website or sets of websites to compare or evaluate
- Specifying evaluation goals and intended user's view point
- Defining the quality characteristics and sub-characteristic attributes requirement tree
- Defining criterion function for each attribute, and applying attribute measurement
- Aggregating elementary preference to yield the global website quality preference
- Analyzing, assessing, and comparing partial and global outcomes

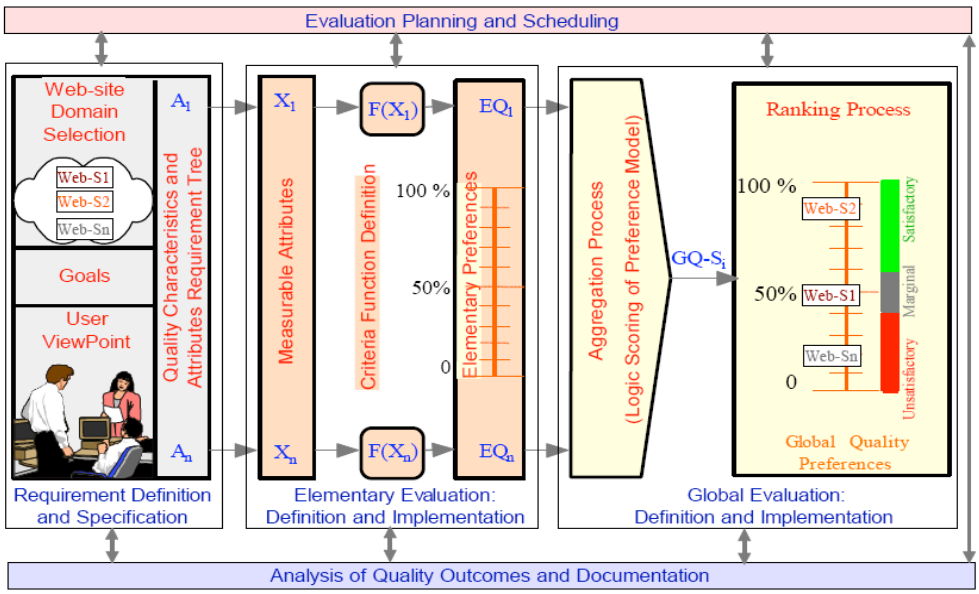

Figure 7: W-QEM model

What makes this model unique is that it gives a domain specific approach and a step-by-step procedure to accomplish the evaluation of the chosen website. Further, the model provides the method that should be used in each of the steps, as shown in Figure 7 above. It uses the Logic Scoring Preference (LSP) approach of evaluation. LSP is a method used to quantitatively measure attributes of a product through logic scoring [35]. Although end users participate at the earlier stages of the assessment to help the identification and specification of user requirements, the rest of the evaluation process engages only experts. Thus, the evaluation process may result in a pile of subjective opinion of the experts that do not represent the usability experience and satisfaction of the end users of the website.

2. 2QCV3Q-model (7 Loci)

This is a conceptual model consisting of 7 dimensions to evaluate quality of a website: who-what-why-when-where-how and feasibility (with what means and devices). The model takes its name from the rhetorical principles of Cicerone loci, which begin with Auxiliis (feasibility), Quis (identity), Quid (content), Ubi (individuation), Quando (management) and Quomodo (usability) [36]. The quality characteristics and attributes of this model are shown in the table 1 below.

Table 1: 2QCV3Q model [37]

CICERONIAN LOCI	ATTRIBUTES AND SUBATTRIBUTES
QVIS (*Persona:* Who?) **IDENTITY**	*Identification* – Brand or Charisma, Image – Target users' profiles *Characterisation* – Design – Personalization
QVID (*Factum:* What?) **CONTENT**	*Coverage* – Domain referred to owner's and users' goals – Value of information and links *Accuracy* – Quality of information – Source(s), author(s)
CVR (*Causa:* Why?) **SERVICES**	*Functionalities* – Functions needed by owner and users – Adequacy to owner's and users' goals *Control* – Correctness – Security, ethics and privacy
VBI (*Locus:* Where?) **LOCATION**	*Reachability* – Intuitive URL – Retrieval *Interactivity* – Contact information – Community building
QVANDO (*Quando:* When?) **MAINTENANCE**	*Corrective maintenance* – Check-up, links, dates – User assistance *Adaptive Maintenance* – Enhancement – Reengineering
QVOMODO (*Modus:* How?) **USABILITY**	*Accessibility* – Hardware and Software requirements – People with disabilities *Navigability* – Structure, Orientation – Download times *Understandability* – Languages – Level of terminology
QVIBUS AVXILIIS (*Facultas:* With what means and devices?) **FEASIBILITY**	*Resources* – Financial and Human Resources – Time *Information and Communication Technology* – Hardware (computer, networks) – Software (implementation, integration)

3. MiLE (Milano-Lugano)

This model shows a clear distinction between application dependent and application independent evaluations. It proposes technical inspection for evaluating application independent aspects. It suggests to use user-experience and scenario based testing for the application dependent aspects of a website [4]. This model is a usability focused evaluation method based on the combination of inspection from expert evaluators and user's empirical testing. It bases its evaluation on two heuristics: abstract and concrete evaluation heuristics [36]. It categorizes different levels of analysis: content, services, navigation, cognitive features of the interface, aesthetic/graphic level and technology level [38]. Content means the quality of the information the website contain and its communication level. Services mean all the functionalities the website offer to its users. Navigation means two basic things: the first one is the different ways users reach to specific piece of information and the second one is the logical structure of information for passing from one piece of information to another. Cognitive features of the interface indicates how users understand, perceives and remembers the website structure. This is somehow related to usability characteristics mentioned in the other models. Aesthetic/graphic level indicates the graphic design and layout of the website interface, the type of font, colour, size, image and the distribution of the graphic elements in the pages. Technology level indicates the compatibility of the website to perform well in different types of browsers, the security level of the server hosting the website and the interaction between the website and the remote database.

4. MINERVA (Ministerial Network for Valorising Activities in Digitization)

MINERVA is a network of European states' ministries for cultural heritage. This model is proposed for evaluating quality of cultural websites (museum, archives, libraries, and other cultural institutions) [17]. In this model, quality is defined in terms of accessibility and usability. The purpose of the quality criteria in this model is two-fold. The first one is they are used to represent the quality characteristics for evaluating quality of cultural websites, and the second one is that they support the design and evolution of cultural websites [36]. The model supports the use of 10 quality principles: transparent, effective, maintained, accessible, user-centred, responsive, multi-lingual, interoperable, managed and preserved [4].

Transparent means the website must clearly indicate its purpose, mission and its identity to not confuse users. Effective central principle in this model is content. A website must offer a valid and relevant content that provides appropriate supporting information. Maintained indicates content and technical maintenance of the website. It specially is focuses on the currency of content and improving technical functionalities of a website. Accessible indicates a characteristic of a website to help all the users community access the website without any difficulties. Thus, a website must consider users that are blind or with partial sight seeing problems and hearing disabilities. The website should also not rely on one technology to present its information to its users [17]. It should support different types browsers, operating systems and devices.

User-centred means the website must satisfy user's needs and users must find the website useful, easy to use and attractive. Responsive indicates the capability of the website and the website owners to respond to questions users forward. It also means users can participate in producing content and participating to answer questions in a forum discussions. Multi-lingual means a website should offer multiple languages for its users. Language can be an important barrier to website access, so there is a need to consider this characteristic. Interoperable refers to a characteristic of a website to interact with other websites. If a website is developed based on standard technologies and techniques and data models, interacting and interoperating with other websites and online entities would be easy. Managed indicates legal issues related to protecting Intellectual Property Right (IPR) and privacy. Preserved indicates long-term preservation of the website and the ways to facilitate preserving the contents of the website.

Problems with the generic software and website quality models

The quality models discussed in the previous sections share common drawbacks that using these models for quality evaluation of websites does not seem to be reasonable. The problems can be summarized as follows:

- The models present general characteristics lacking justification that describe which factors to determine for evaluating a particular software product or a website in a specific domain.
- Lack of underlying principle for deciding which specific quality characteristic relate to which high level quality criteria
- No clear way that shows how the sub characteristics are composed for the overall assessment of the website and the method that should be used to measure the general quality assessment

Table 2: Common high level quality characteristics of software & website Quality models

No	High level quality characteristics	Software quality Models					Website Quality models			
		McCall	Boehm	FURPS	Dromey	ISO9126-I	W-QEM	MiLE	2QCV2Q	MINERVA
1	Functionality			*	*	*	*		*	*
2	Efficiency	*	*		*	*	*			*
3	Usability	*		*	*	*	*		*	*
4	Performance			*						
5	Reliability	*	*	*	*	*	*			
6	Portability	*	*		*	*	*			
7	Content						*		*	*
8	Feasibility								*	
9	Maintainability	*	*		*	*	*		*	*
10	Modifiability		*							
11	Testability	*								
12	Understandability		*				*	*	*	*
13	Integrity	*								
14	Flexibility	*								
15	Supportability			*						
16	Correctness	*								
17	Interoperability	*				*				*
18	Reusability	*			*					
19	Transparency									*
20	Navigation						*	*	*	*
21	Presentation									*

Summary

Software quality is given two different definitions: “conformance to requirements” and “meeting customer needs”. The former defines software quality as the characteristics of a product to fulfil sets of specifications as defined by the developers, while the later defines software quality as the characteristic of a software product to satisfy user needs. Evaluating quality of a product requires having a good evaluation model that consists of essential quality characteristics and evaluation methods.

The existing software quality models and website quality models as discussed in the previous section, in one way or another consist of similar characteristics, although some of the models focus on a particular property of a product and while few others present a very broad and high level quality characteristics that are vague and difficult to measure. In addition, there are specific quality factors that exist in one model with one name and with a different name in another model, but still representing the same concept. For instance, this is true for the “accessibility” factor, which is a high level factor in the MINERVA website quality model and a sub quality factor in the Boehm’s software quality model. Rarely, different models use the same term to represent a similar quality factor.

3. Construction of the framework

This chapter discusses how the proposed academic website quality evaluation framework is designed. Website quality characteristics and sub characteristics of the base model (ISO 9126-1 quality evaluation model) are discussed first followed by the explanation given about the essential website quality characteristics as collected from the reviewed quality models are discussed briefly. Finally, significant quality criteria recognized as important for evaluating the essential quality factors chosen for evaluating the quality of academic websites are explained.

In designing the evaluation framework, the uses of academic websites and the different types of users of such websites are identified. Existing website and software quality evaluation models as well as previous usability studies [7], [37] were analysed to identify essential quality factors for evaluating academic websites. The conceptual model to construct the evaluation framework is shown in figure 8 below:

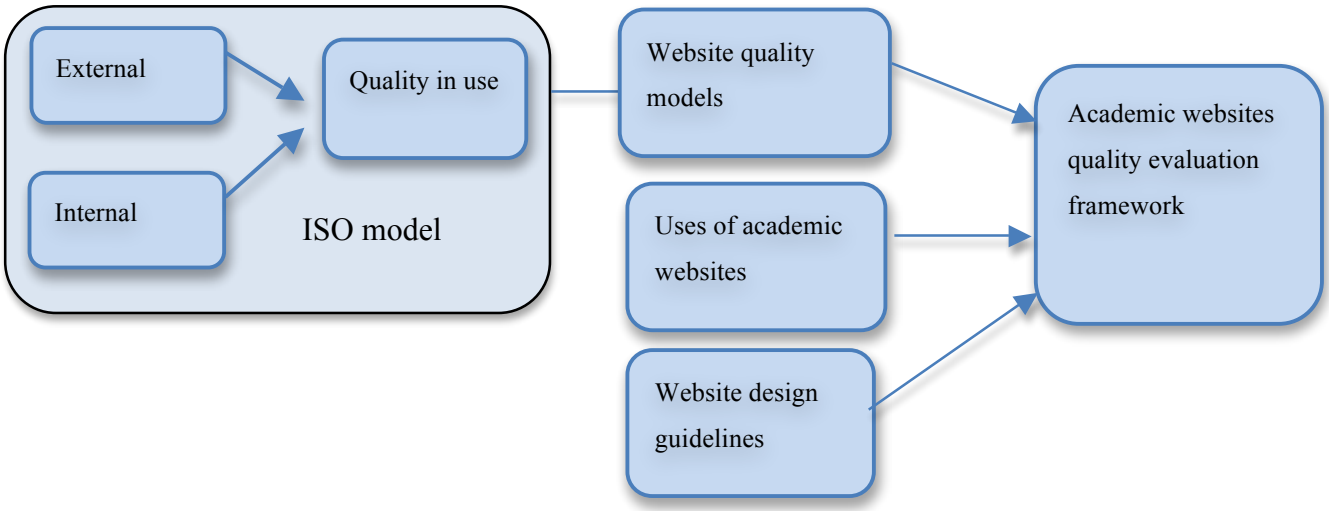

Figure 8: Conceptual framework for designing the evaluation framework

Website design guidelines [13],[39],[40] were also used to carefully categorize quality factors with similar implication into categories while eliminating redundant quality factors. The website design guidelines also helped to identify criteria necessary to evaluate the quality factors.

3.1. Uses of academic websites

The general objective of this project was to design a framework for evaluating quality of academic websites. Quality of websites can be evaluated from different user's perspectives using different methods. Some of the main uses of academic websites relate in one way or another to the following tasks:

- Promotion of research and education programs (Bachelor, Masters and PhD)
- E-learning support to students
- Communication means towards the public community
- Advertising vacancies for different positions in the university

Promotion of research and education programs of the academic institution is the fundamental purpose of academic websites. Faculties or schools in a university can use the website to advertise

their education programs to future students aspiring to study in one of the fields of study the university offers. Information such as entrance requirements to a specific program, application procedures, fee, contact information and important dates the students should know can be made available on the university's website to ease the communication of information to students. The website is also used to facilitate the teaching learning process by providing e-learning support. The academic institution also uses the website to disseminate important achievements in completed research projects, changes in education programs and the like to the public. Research companies that are interested to work in collaboration with the university can also get specific information they want from the website. The website is also used to advertise open positions in the university.

There are different groups of users of academic websites. Each user group has different requirements and expectation from the website. Main users of academic website include:

- Students
    - Current students
        - PhD
        - Masters
        - Bachelor
    - Prospective students
        - PhD
        - Masters
        - Bachelor
- Professors
- Researchers
- Journalists
- Schools
- Companies
- Parents

The students user groups, not only students that are already enrolled in the institution but also those who want to study at the university and are looking for information to make decision are the most frequent users of academic websites. In this project, the perspectives of student user groups of academic websites are considered and hence the focus of the project revolves around the perspectives of student users.

3.2. Quality characteristics of the ISO 9126-1 quality model

An evaluation task commonly requires the use of criteria and an existing quality standard or model that tells the extent to which the criteria used are accurate, effective, economical and satisfying [31, 41]. Therefore, after studying the existing software and website quality models, the ISO 9126-1 model is preferred to be the base model for designing the evaluation framework. This model consists of quality factors arranged in a hierarchical structure. It uses unambiguous terms for the quality factors, which apparently is not the case in most of the website quality evaluation models studied. Although the model is basically used for software quality evaluation, it is observed from the reviewed website and software models characteristics that this model has a complete list of common quality factors that are also part of the website models. In fact, some of the website models were designed based on the ISO model quality characteristics [7].

This model sets out six basic high-level quality characteristics (usability, reliability, efficiency, functionality, portability and maintainability) and three different approaches of quality: external quality, internal quality, and quality in use. The external quality can be evaluated when the software product is being used during normal testing procedures. The internal quality can be evaluated using the software internal product specification properties. The quality in use approach on the other hand can be evaluated after the software is put into operation or after users start using the software. The quality in use approach is related to users' point of view in using the product while performing a task in a specific context. Where as the internal and external quality approaches are related to the quality of the product or in other words, the intrinsic property of the product [2, 34]. The quality in use approach in this model considers user's view or the experience of users in using the software product [21]. Quality in use is also perceived as the "broad view of usability" [2], which highly relates to what extent users are satisfied in using the software product in specific context of use [42]. It consists of the sub quality factors such as satisfaction, effectiveness, security, and productivity.

The model assumes that the quality factors in the external and internal quality approaches affect the quality factors in quality in use approach. Consequently, evaluating and measuring the quality factors of a product quality in use approach requires taking the quality characteristics of the two quality approaches in the model into consideration. As discussed in Chapter 2, using the different quality approaches in this model, it is possible to perform an evaluation of any kind of software product from different user's perspectives (developers, end-users and designers) as needed by the website evaluators and the purpose of evaluating the website. The high level quality factors and sub quality factors in the ISO 9126-1 model are presented in table 3 below.

Table 3: ISO 9126-1 high level quality factors and sub quality factors

No	**High level characteristics**	**Sub characteristics**
1	Usability	- Understandability - Learnability - Operability - Attractiveness
2	Reliability	- Maturity - Fault tolerance - Recoverability
3	Efficiency	- Time behaviour - Resource utilization
4	Functionality	- Suitability - Accuracy - Interoperability - Security
5	Maintainability	- Analyzability - Changeability - Stability - Testability
6	Portability	- Installability - Adaptability - Co-existence - Replaceability

The meanings of each high level quality factors and sub quality factors of the ISO 9126-1 quality evaluation model are briefly discussed in the following few pages.

Usability

Usability in the ISO model is defined as "the ease of use for a given function" [43]. It consists of four sub-characteristics: operability, learnability, understandability and attractiveness. Operability indicates the capability of the product to be easily operated by the user. Learnability indicates the learning effort users put to learn use the product. Understandability indicates the capability of the software product to assist users to understand how to use the website for specific tasks and conditions. Attractiveness indicates the capability of the software product to provide a pleasant interface to the users.

Reliability

According to the ISO 9126-1 model, reliability is defined as "A set of attributes that relate to the capability of software to maintain its level of performance under stated conditions for a stated period of time" [12]. This characteristic consists of three sub characteristics: maturity indicates the capability of the software product to avoid failure due to errors in the product. Fault tolerance indicates the capability of the product to maintain a certain level of performance during either faults in the product or infringement of its interface and recoverability indicates the capability of the product to re-establish to a certain level of performance and recover data affected during failure.

Efficiency

The ISO 9126-1 model defines Efficiency as " a set of attributes that convey to the relationship between the level of performance of the software and the amount of resources used, under stated conditions" [12]. This characteristic consists of two sub characteristics: Time behaviour and resource utilization. Time behaviour indicates the time the product takes to perform tasks and throughput rates. Resource utilization indicates the capability of the software product to use appropriate type and amount of resources when performing its functions under stated conditions.

Functionality

The ISO 9126-1 model defines functionality as "the capability of the software product to provide functions, which meet stated and implied needs when the software is used under specified conditions" [43]. It consists of four sub characteristics: suitability indicates that the product provides sets of appropriate functions for specific user's requirements and objectives. Accuracy indicates the capability of the product to deliver accurate results with intended degree of precision. Interoperability on the other hand indicates the capability of the product to interact with one or more number of specified applications. Security refers to the capability of the product to control unauthorized access of information and data.

Maintainability

The ISO 9126-1 model defines Maintainability as "the capability of the software product to be modified"[43]. Modifications may include corrections, improvements, or adaptation of the software to changes in environment, and in requirements and functional specifications. The sub characteristics under Maintainability are analyzability, changeability, stability and testability. Analyzability means the capability of product to enable the diagnosis of causes of failure in the product or to identify part of the product to be modified. Changeability indicates the capability of the product to enable implementation of specific modifications. Stability refers to the capability of

the software product to avoid unexpected effects due to modifications of the software. Testability indicates the capability of the software product to enable modified software to be validated.

Portability

The ISO 9126-1 model defines Portability as "the capability of the software product to be transferred from one environment to another" [43]. The sub characteristics under portability are adaptability, installability, co-existence and replaceability. Adaptability indicates the capability of a product to be adopted in specific environments with out using additional effort. Installability indicates the capability of the software to be installed in specific environment. Co-existence means the capability of a software product to co-exist with independent software sharing common resources. Replaceability means the software product can be used in place of another software for a similar purpose.

The ISO 9126-1 model provides hierarchical list of very broad quality characteristics and sub characteristics and it does not show the necessary quality characteristics for specific kinds of products. It only presents the quality characteristics and the relationships between them. Using only the highest-level abstractions of quality characteristics like Usability, Reliability, Functionality, Efficiency, Portability and Maintainability is not sufficient to evaluate the overall quality of a web applications [2]. Moreover, the ISO 9126-1 model is basically designed for software quality evaluation and hence the quality factors under this model characteristics are not complete for evaluating quality of a website. Therefore, there is a need to study quality factors of websites to identify necessary quality factors.

3.3. Website success key quality factors

The success of a website is determined by several factors. There is no one element that determines the success of a website, rather the success of a website is ultimately based on the characteristics and tasks of the website parts working together to create a website that can be found, interact with users and provide user satisfaction. There are several research works on website success, each highlighting different factors necessary to build a successful website. Cox and Dale[44] claim that the following factors highly influence the success of a website: clarity of Website's purpose, design (valid links, consistent page layout, text, navigation, communication and feedback, search, interface), accessibility and speed, content, customer service and customer relationship.

According to [45], content quality, design quality, organization quality and user-friendly quality are considered the most important quality dimensions for evaluating all kinds of website used for any kind of purpose. Content quality obviously indicates the quality of the information in the website, the relevance of the information, whether or not it is current, accurate and supports multiple-language support. Design quality on the other hand refers to the attractiveness of the interface, appropriate colour and graphic use. Organization includes factors such as the arrangement of links, appropriate labels, use of site map that show the navigation structure of the website. User friendly mainly indicates the appearance of the website's interface. These include use of consistent colour, arrangement and placement of links and menu items. A website with a good user friendly interface helps users to search and find information that is available in the website. It includes usability, reliability and interactivity features as sub quality factors.

Alkan [46] points out that content is the most decisive quality factor for quality of websites followed by design, navigation, community and technology; based on a survey conducted to

identify which factors are the most decisive ones for the success of a website. Another study that focused on e-commerce website's success by [47] showed that website design is the key factor for the success of a website. It gives emphasis on the idea that successful website design or factors affecting the usability of a website enhance the level of user satisfaction. Other authors like [48] mentioned lists of factors such as usability, website design, keywords used, content, search optimization plan and use of inbound links as the key factors for the success of websites.

A study that focused on identifying factors necessary for the evaluation of quality of websites from user's perspective, identified quality factors such as Technical adequacy, web content and web appearance [29]. Technical adequacy includes sub factors such as the navigation features of the website, browser compatibility, reliability, valid links, multi-lingual support and interactivity, while web content is mostly related to the usefulness, up-to-date information, and appropriateness of the content the website provides and web appearance refers to the attractiveness of the interface of the website, proper use of colours, fonts, graphics, good labelling, proper alignment of page elements, layout and presentation. Accessibility, content and Trust are also taken to be the top 3 key quality factors of a successful website [49].

W3C provides guidelines regarding how to evaluate and improve content accessibility for disabled users of a website [50]. These guidelines are divided in 3 different versions, the recent one being version 1.3, which asserts the relationship between different components of website development such as content, browsers, media, assistive technologies and tools used by developers bring a cumulative effect on the accessibility of a website's content as shown in Appendix H. Purpose, clarity, usability, user-focus, navigation, accessibility, and appearance are mentioned as the 7 most important success factors for websites[5]. Wang and Huang [51] summarized the success factors of websites in five categories, based on the work of [52] about information systems quality. The categories are information quality, appeal, efficiency and identification. These main factors also consist of lists of sub factors, which are explained in Appendix I. The three most common success factors repeatedly mentioned in different research works can be summarized as follows in Table 4 below.

Table 4**:**The most common website success factors

Quality Factors	**Sub items**	**Supporting references**
Content	Usefulness of content, appropriateness of content, currency of content, understandability, reliability of content, website purpose	[44], [45], [46], [48], [29], [49], [52]
Design	Usability, user friendly interface, accessibility, organization, customer relationship (interactivity)	[44], [45], [46], [47], [29], [52], [49]
Technology	Reliability, use of valid links, browser compatibility, navigation, multilingual support, search, keywords, speed, technical adequacy	[29], [44], [45], [46], [48], [52]

[5] http://vandelaydesign.com/blog/web-development/success-factors/

3.4. Previous related works in academic websites evaluation

There were several number of previous works related to specific characteristics of the website like usability and accessibility. Previous studies carried out to evaluate the general quality of academic websites are quite few. Selected previous studies are described in this section.

Educational websites were studied from different perspectives. For example, Lautenbach.et.al [53] evaluated usability of a university website using two defined criterion for usability: survey ability (user perception of satisfactory layout) and find ability (observed ease of use), while other studies took specific features of websites. A good example is a study that designed criterion for evaluating scholarly web resources with in the art history field [54]. It outlined quality factors such as content, authority, organization and accessibility. A similar study conducted to evaluate the usability of Lund University's research and home pages outlined quality factors in two categories: user experiences and website success. Under user experience, quality characteristics such as usability, functionality, content and branding. It outlines quality characteristics such as design, content, navigation and web technology as part of the second category. Design indicates the layout of the website, appropriate use of graphics, animation and media used to assist the presentation of content. Content indicates obviously the quality of information the website offers. As a sub factor, it consists of the understandability of the language, attractiveness of the presentation. Navigation indicates the methods of navigating in the website, menu types, and link names that help users to easily move around the website. Web technology indicates the models and standards used in the website [51].

A usability evaluation study on academic websites of Jordanian university listed out quality factors in 5 main categories [6] :

- Content, organization and readability,
- Navigation and links
- User interface design
- Performance and effectiveness and
- Educational information

To assess how the student's acceptance of course websites is influenced by the usefulness and ease of use construct of websites, an empirical study that took website usage as an acceptance indicator revealed that website usefulness has direct impact on the acceptance of course websites. The study emphasized that educational institutions should give focus on ease of use and the usefulness of course websites. Further, the study identified three critical determinants of course websites ease of use [55]:

- Consistency
- Flexibility and efficiency
- Interactive facilities to help communications
- Availability of essential course materials and
- Understandability

A case study used to apply the WebQEM quality model for evaluating six well known academic websites[6] located in four different continents, identified 4 main quality factors: usability,

[6] University of Chile (http://www.uchile.cl/)
UPC Spain (http://www.upc.edu/)

functionality, reliability and efficiency [7] as they form the quality evaluation model quality characteristics tree. These factors were further divided into sub factors and attributes forming a quality tree consisting a total of more than 121 factors. The quality factors in the previous evaluation works are summarized in Table 5 below.

Table 5: Quality factors in previous academic websites evaluation research works

Previous academic websites' evaluation works	**Quality factors**
[7]	Usability, reliability, efficiency, functionality
[6]	Content, organization, readability, navigation and links, user interface design, performance and effectiveness, educational information
[51]	Design, navigation, web technology, usability, functionality, content, branding
[53]	Survey ability, find ability
[54]	Content, authority, organization, accessibility
[55]	Consistency, flexibility and efficiency, interactive facilities to help communications, availability of essential course materials and understandability

Analysing the characteristics of existing website quality models and website usability studies [5], [9], [37, 38], showed that the most common website quality characteristics in the models are:

- Usability
- Content,
- Functionality (services)
- Efficiency and
- Navigation

Some of the quality characteristics in the models have similar semantics though they are given different names. For instance, the characteristic "services" in 2QCV3Q & MiLE is similar with the functionality characteristic in the Web-QEM model. Content in the Web-QEM and 7 Loci have a similar meaning with the Effective characteristic of the MINERVA model. A summary of the high level characteristics of the 4 website models reviewed are presented in Table 6 below:

UTS Australia (http://www.uts.edu.au/)
Stanford USA (http://www.stanford.edu/)
NUS Singapore (http://www.nus.sg/)
UQAM Canada (http://www.uqam.ca/)

Table 6: High level quality characteristics of existing website quality models

Website quality models and their high level characteristics				
Website Quality models	**Web-QEM**	**2QCV3Q (7 Loci)**	**MiLE**	**MINERVA**
High level characteristics	-Usability -Efficiency -Reliability -Functionality -Content -Navigation	-Usability -Feasibility -Maintenance -Services -Content -Identity -Location	- Services - Content - Navigation - Aesthetics/graphics - Cognitive feature of the interface - Technology	-Transparent -Accessible -Responsive -Multi-Lingual -Interoperable -Managed -Preserved -Effective -Maintained -User-centred

The quality factors that are not totally included in the ISO 9126-1 model but that are present in the website models are content, navigation, identity, transparent, location and multi-lingual. It is also noted that website quality factors such as correctness, interaction, navigation and presentation, accessibility and management are considered to be essential factors for website quality [4], [36].

3.5. The proposed framework

In order to design the new evaluation framework, a careful study on key quality factors for websites, previous related works in academic websites evaluation and the quality factors in the reviewed website models was made to identify necessary high-level quality characteristics, sub characteristics and criteria. Based on the main quality factors of the chosen base model (ISO 9126-1), the quality factors were rearranged to group factors with an equivalent semantic meaning into one category by eliminating existing repetitions and different factor names.

The high-level quality factors in the proposed framework are usability, content, reliability, efficiency and functionality. Except the content high-level quality factor, the rest are part of the ISO 9126-1 quality model. Table 7 below shows how the quality factors classified as key factors for the success of a website in previous related works and also in the existing quality models are mapped into the ISO 9126-1 hierarchy to form the new framework.

Table 7: Arrangement of identified essential quality factors into the base model

Quality factors	**References**	**High level quality factor**	**Sub quality factors**
- User friendly interface - Interactive facilities to help communications, - Organization - Accessibility - Consistency - Multiple language support	[7],[44], [45], [46], [47], [29], [49], [52], [55],	Usability	-Understandability - Learnability - Interactivity - Operability - Interface attractiveness - Multiple-language support
- Availability of essential course materials and understandability - Branding - Authority - Educational information - Readability - Usefulness of content - Currency of content - Reliability of content - Website purpose - Understandability of content	[7],[6],[29], [44],[45],[46], [48],[49], [51], [52], [51], [55]	Content	- Relevance of information - Accuracy of information - Up-to-date information - Authority - Identity
- Navigation and links - Use of valid links - Web Technology used	[7], [45], [52],	Reliability	- Fault tolerance - Recoverability - Availability
- Flexibility and efficiency - Browser compatibility - Performance and effectiveness - Technical adequacy	[7], [6],[29], [55]	Efficiency	- Time behaviour - Accessibility
- Navigation - Search - Survey ability - Find ability - Keyword	[7],[6],[51]	Functionality	- Navigation - Search - Suitability

The Framework first outlines necessary high quality characteristics, which are further classified into sub characteristics and criteria. Common quality characteristics taken from the ISO-9126-1 software quality standard and the website quality models make up the high level characteristics and sub characteristics. The criteria indicate factors identified as important for making judgement on the feature of the quality factors. The proposed framework constructed is shown in Figure 9.

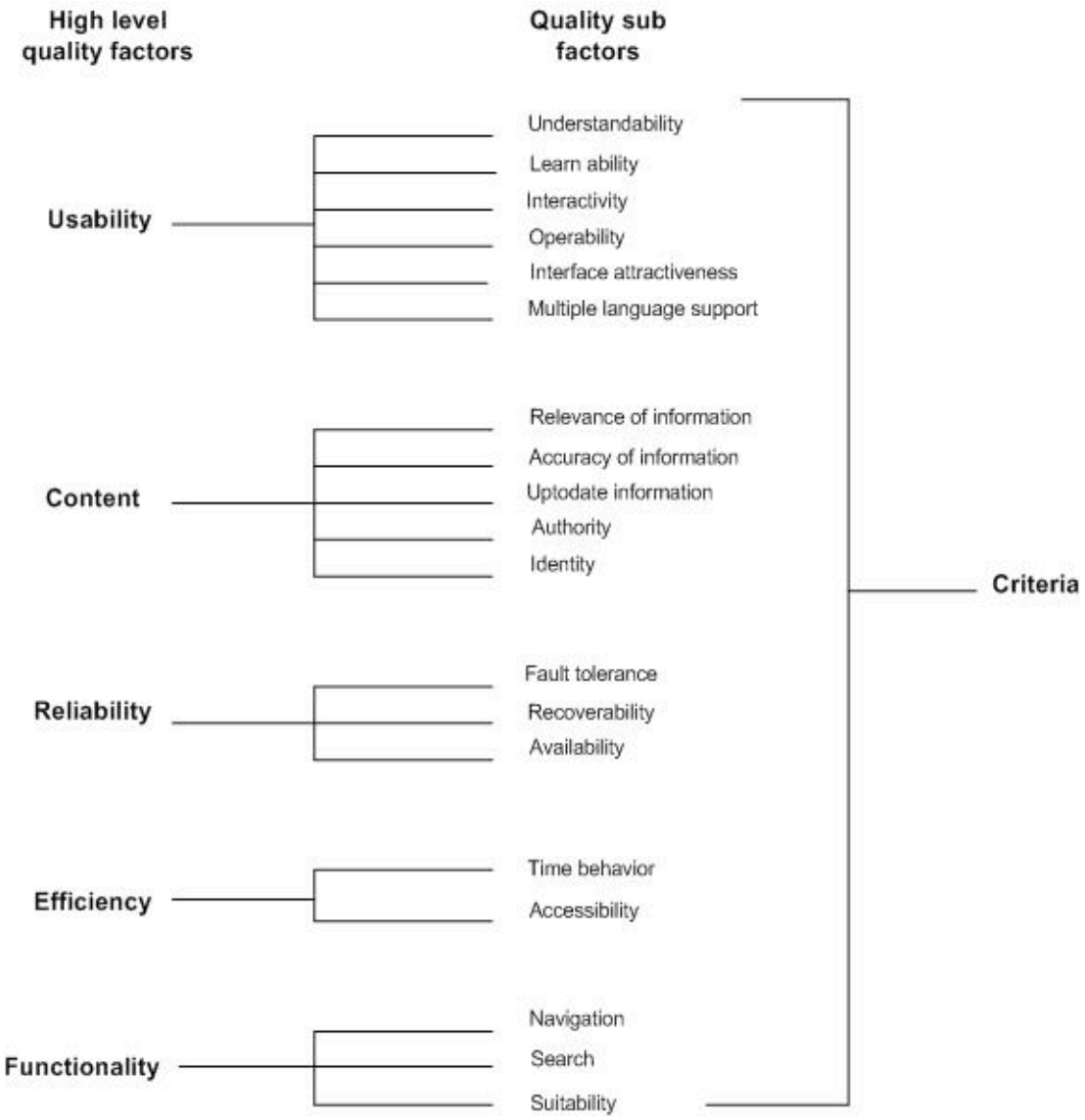

Figure 9: Academic website quality evaluation framework

3.6. Sub quality factors of proposed framework

The high-level quality factors of the proposed framework are further decomposed into number of sub characteristics or sub quality factors. Brief descriptions of the high level characteristics, their sub characteristics and how the sub characteristics under each high level characteristic were compiled and regrouped under each high level characteristic are explained in the following sections.

3.6.1. Usability

Usability in general is defined as a quality characteristic that assesses how easy user-interfaces are to use [56]. Website usability is defined as the combined effect of several design goals like easy to learn, easy to remember, easy to understand, easy to find and effective to use it. It consists of these quality components: learnability, efficiency, memorablity, errors, satisfaction and utility. Learnability indicates how easy it is for users to accomplish basic tasks the first time they come

across the design. Efficiency indicates how quickly users can perform tasks, once they have learned how to use the design. Memorability refers to how easily users can re-establish their proficiency when the return after a period of not using the design. Errors refer to how many errors users make, how severe these errors are, and how easily they can recover from the errors. Satisfaction shows how pleasant the design of the product is while utility indicates how well the design performs to satisfy users need in using it [10]. The ISO model prescribes understandability, learnability, attractiveness and operability, as sub characteristics of usability. These characteristics are taken as they are and other sub characteristics from the website models were identified. The Web-QEM model adds internationalization, style issues and feedback & help features to the list of the ISO sub characteristics [7].

The MINERVA model prescribes the responsive characteristic, which is similar to the feedback & help features in the Web-QEM model. The same concept in the 2QCV3Q model is represented with the interactivity characteristic, which is placed under the Location high-level characteristic. Therefore, feedback & help features and responsive are eliminated and replaced by interactivity sub characteristics. The characteristic Multi-lingual in MINERVA is mentioned as one quality factor, which refers to the characteristic of a website to support multiple languages for international users. A similar characteristic, internationalization is mentioned in the Web-QEM model as a sub characteristic of usability. Based on the sub characteristics in the ISO model, the reviewed website models, and other related works [2], [5], the sub characteristics identified for usability are:

- Understandability
- Learnability
- Operability
- Aesthetics
- Multi-lingual support (internationalization)
- Interactivity

1. **Understandability**

A website should make it easy to help users understand how to use the website for a specific task under specific context of use. The organization of the website also forms part of this sub quality factor. The arrangement of the labels, links and terms used in the website should match to user's terms so as not to confuse the user of the website[45].

2. **Learnability**

The website should not be cumbersome for users to learn how to use it. Necessary help documents other supplemental materials describing how to use the website, how to find particular kind of information or how to perform a certain type of task on the website should be available to help users easily learn to use the site.

3. **Operability**

Operability indicates the capability of a website to be easily operated by users. Users of the website must be comfortable with the manner through which services and content are presented in the website and be able to use the website easily without being frustrated or confused.

4. **Interactivity**

A website must provide facilities for users to interact with the Webmaster, a particular professor or an author of a content in the site. Providing FAQ that summarizes answers to frequently asked questions, clear error messages and contact information are one of the possible methods to facilitate the interaction of users with the website [7], [57]. Interactive feedback systems email

communications and toll free call systems are basic tools to support the interaction of users with the website [58].

5. **Aesthetics (attractiveness)**

The user interface of the website should be attractive, enjoyable and pleasant enough for users to create an emotional appeal to use the site [45]. In addition, the choice of colour, label names and font types used must be consistent through out the website. Except for titles, the fonts used be the same throughout the website. The WebPages should not also be overcrowded or overloaded, white spaces should be effectively used to avoid overcrowded pages [59].

6. **Multiple- language support** (Internationalization)

Language can be a barrier for website access. It is essential to reach out for large number of users to increase the value of the website [17]. A website should provide the facility for users to choose the language they would prefer to access information on the website or perform a particular task in the website. So, the website can be able to entertain all its users without their cultural background or country [45].

3.6.2. Content (Website Information Quality)

This characteristic is not part of the base model, but it is part of the website quality models studied and it is frequently mentioned in previous related studies of evaluating academic websites. Content is the information provided on a website. Most authors articulate the importance of this characteristic with this motto "Content is king". Without a doubt, providing good usability, navigation or accessibility to wrong content is waste of resources as well as waste of user's time and effort. Because, content is one of the reasons users come to a website. Especially in academic websites, users come to the website looking for a particular information. The saying "content is king" thus is a plausible argument.

The main nature of web applications is that they are a combination of information, services or functionalities. Information provided on a website should be relevant, engaging and appropriate to users [39]. Content is the most critical part of a website. Users come to a website primarily looking for a specific kind of information, they give less attention to the navigation, visual design and interactivity of the site[40]. This is because of the fact that users are goal oriented and they only look for the information they already have in mind when they come to the website. Consequently, they do not give much attention about other aspects of the website design than the content of the website.

Taking into account previous works that identified criteria for evaluation of information content of web resources, sub characteristics included under content are accuracy, authority, objectivity, currency, coverage and intended audience [60], [41]. Accuracy is a quality characteristic that indicates the correctness of the information in the website and whether it is not ambiguous to understand and it does not have grammar and spelling mistakes that could alter the meaning of the information. Authority indicates the expertise level of the person who is responsible to add or update content in specific part of the website. Objectivity indicates whether the information the website offers meets its intended goals, Currency indicates the extent whether the information posted on the website relates to the situations that occur in the current time frame or the content is up to date in general. Coverage indicates the level of detail a topic is explored and explained. Intended audience refers to. These criteria can be used to assess whether and to what extent the information placed on a website satisfies user's needs.

In a case study made on academic websites, the Web-QEM model considers content relevancy as part of the functionality characteristics [7]. Content relevancy indicates the capability of the website to offer user-oriented contents. This quality factor entirely indicates a property related to that of the information the website offers and it gives more sense to include it as a sub characteristic of content than functionality. Comprehensibility, usefulness, appropriateness is also included as sub factor for content in previous related works on academic websites evaluation [45], [46], [61].

In another literature, other sub characteristics for the content quality factor identified are: information suitability, accessibility and legal compliance [2]. Information suitability emphasizes the consideration of users' context in delivering information. Appropriate information must be delivered to the right users based on their intended use and the context of use in a concise, up-to-date and complete manner. This characteristic is more similar with the objectivity and intended audience as well as relevance of information. Therefore, all these characteristics can be merged under relevance of information sub-characteristic. Information accuracy is a characteristic that indicates the extent to which the information is correct, unambiguous, reputable, objective and verifiable. If a piece of information posted on a website is believed to be inaccurate, then the website is supposed to have fewer added values and will have reduced visits from its users.

Accessibility is concerned with technical facilities websites provide to support users with different disabilities access the website. As already discussed under the usability characteristics, it is better to consider the accessibility sub characteristics under efficiency. Therefore, accessibility is also discarded from the content characteristics. Legal compliance refers to the capabilities of the website whether the information format follows standards and legal norms related to intellectual property rights. Quality of information also consist of sub characteristics like Identity, which tells about the organization or institution who owns the website.

After reorganizing the sub characteristics into categories based on their definitions, the following sub characteristics are identified as sub characteristics for content:

- Relevance of information
- Information accuracy
- Up-to-date information (currency)
- Identity of the organization
- Authority

1. Relevance of information

Information provided in the website should be relevant and engaging to users. Unless the information in the website is important to students, the interest to use the website may decrease. As a result, the website may not achieve its objective. In academic websites, the information should be student-oriented, useful, comprehensive, appropriate and with in the expected level of detail [45], [52].

2. Information accuracy

Students rely on the information in the website and hence it is important to ensure the accuracy of the information made available on the website. Information academic websites provide on their websites include contact information of professors, information about particular upcoming activity, opening hours of buildings, news about the university and the like. The information should be correct to not mislead students. Grammar and spelling errors that could alter the meaning of the information should be avoided [62]. If the content of the website is accurate, this can boost the confidence of the users to rely on the information the website offers.

3. **Up-to-date information (currency)**

The website must deliver current information related to current situations in the university or institution (upcoming events, news, etc). There should also be some means for users to know that the website is updated. Displaying the date when exactly the content was last updated is one approach to help users recognize that the specific time when the information was released and hence relate to the situations that occur during that specific time.

4. **Identity of the organization**

The logo of the organization (academic institution) which owns the website must be available and clearly visible in every page. This will give assurance to users that the website is managed by the organization identified in the logo and the institution is responsible for all the information posted in the website.

5. **Authority**

The information about authors who edit the contents of pages in the website should be available for any kind of reference users would lie to make. Making available these information increase the credibility of the content. References used from other sources outside the academic institutions should also be indicated by citation or putting a direct link to the reference.

3.6.3. Reliability

Reliability is mainly concerned with the performance of the website. This characteristic is not explicitly included in the website models reviewed; rather it is shadowed with a different name taken as sub characteristics under different high-level characteristics. According to the ISO model, reliability consists of three sub characteristics: maturity, fault tolerance and recoverability [43]. Fault tolerance and recoverability are considered to be part of the new framework as sub characteristics of reliability while maturity is excluded, as the relevance of including the sub factor was not feasible. Reliability is all about the performance of the website and the performance of the website starts with the fact whether the website is available to users or not to the capability of the website to recover quickly at times of any kind of problems [4]. The sub characteristics identified as necessary for the reliability high-level quality factor are:

- Fault tolerance
- Recoverability
- Availability

1. **Fault tolerance**

The capability of the website to keep a certain level of performance even when there are major faults. A website should not have dead links. Links should work properly to lead users to the places he/she wants to go in the website [36],[45].

2. **Recoverability**

The capability of the website to recover the website to a previous state after the occurrence of faults or errors.

3. **Availability**

The website should be available for users to access at any time. The percentage of time the website is available for use is ideally 24hours/day and 7 days/week.

3.6.4. Efficiency

Efficiency indicates the time it takes the website to perform a task or the throughput of the website. This characteristic is not included in the website models reviewed, with an explicit term. In the ISO model, Efficiency consists of two main sub characteristics: time behaviour and resource utilization. As comprehensively discussed in chapter 2, time behaviour indicates the amount of time the product takes to execute tasks. Resource utilization indicates the amount of resources the product uses to operate and perform required activities. However, this is not much of a concern to student users compared to the website owners. Therefore, this sub characteristic is not considered for inclusion. Accessibility emphasizes on the technical capability of the website to support users with various disabilities.

1. **Time behaviour**

The amount of time the website takes to load or perform tasks should be short. Users should be able to open pages within few clicks [4], [61].

2. **Accessibility**

The website should be technically capable of supporting people with different disabilities access the website. It also should avoid use of plug-ins and proprietary extensions. Accessibility also indicates the capability of the website to support multiple browsers, hardware platforms (e.g. mobile phone, PDA) and screen settings [4], [61].

3.6.5. Functionality

Functionality indicates to the capabilities that the product can perform based on the stated or implied needs of users [24]. The ISO9126-1 model defines functionality as "A set of attributes that relate to the existence of a set of functions and their specified properties". The functions indicate specific tasks that help to accomplish stated or implied needs [12]. In the ISO model, the sub characteristics of functionality are suitability, interoperability, accuracy and security. Accuracy is already grouped under the content high level characteristics and therefore it is excluded here. Even though suitability is slightly represented in the accuracy sub characteristics, it is included as a sub factor for functionality since it indicates whether or not the services provided in the website are suitable for users. It can help to evaluate the satisfaction of users in the functionalities the website provides.

Interoperability and security are taken directly as sub characteristics of functionality in the new framework. Interoperability is only mentioned in the MINERVA model. It indicates a characteristic of a website to interact with other websites or online applications. To achieve this, a website must follow international standards like the Dublin core, make use of standard web technologies such as XHTML, HTML and XML [17]. Security is not mentioned in none of the models studied, though the ISO model puts it a sub characteristic of functionality. Considering security as well as interoperability sub characteristics as necessary for the evaluation of academic websites from student's perspective was not found to be plausible. Therefore, these two sub characteristics were not included as sub quality factor of functionality.

The Web-QEM model considers navigation, search & retrieving as sub characteristics of functionality. Navigation and search are chosen to be part of the sub characteristics of functionality. In the quality characteristics tree, Functionality is decomposed into the following sub characteristics:

- Navigation

- Searching and retrieving issues,
- Suitability

1. **Navigation**

A good navigation structure helps users to browse through the website in finding the information they look for with out getting lost or being frustrated [63]. The Web in general is perceived as a space to move around in, an environment where we can get things done, despite the fact that it cannot be touched, smelled or tasted [64]. This space can be compared with the environments one can find in a store building, parks or museums. People need a clearly marked path to move around and do what they want to do without unnecessary barriers.

Organizations as well as individuals put lots of information on their website by spending considerable amount of time and money without even knowing whether how or who will access it. The navigation structure of a website must be well constructed, easy to use and intuitive. It is the path that leads users to locate and link to a destination page in a website [39]. To help users not get lost while navigating, breadcrumbs, sitemaps, index, meaningful link names and backward navigation methods can be employed [4].

2. **Search**

The search functionality in the website that help users look for different kinds of information through various search options. Search functionality should also be available to assist users find information easily. Although search is considered mostly as one type of navigation, it is sometimes considered as a separate functionality of a website to easily understand the two functionalities [63].

3. **Suitability**

In the ISO model, suitability is defined as "the appropriateness of the functionalities the website provide to users" [43]. In other words, users must be satisfied in the functionalities provided by the website to be used in a particular context of use.

Summary

The proposed framework is constructed after a comprehensive study on the uses of academic websites, key success factors of websites, quality factors, previous works related to evaluation of academic websites and existing website quality models. The constructed framework consists of 5 high level factors (usability, content, reliability, efficiency and functionality). Each of the high level factors is divided into a total of 19 sub factors and criteria are identified for evaluating the factors.

3.7. Quality criteria for the new framework

The lists of the characteristics and sub characteristics are shown in Table 8.

Table 8: Relationship between criteria and quality characteristics

No	High level characteristics	Sub Characteristics	Criteria	Descriptions
1	Usability	Understandability	- The website must help users to understand how to move around the website -Terms used in the site are understandable -Information organization in the website is understandable	-To help users understand the structure of the website easily and make use of the website, the overall organization of the website should be presented in different methods (sitemaps, alphabetical indexes or table of contents, image maps) - Label terms used must be simple to understand for users -Terminologies used in help documentation should be related to user's terminologies
		Learnability	- Ease of learning how to use the website	- Learning how to use the website should be easy for users
		Operability	- Ease of use of the website	- Operating the website should not be a nightmare for users. The website should be easy to handle that would make uses feel in control while using it
		Interactivity	- A facility that help users ask questions should be available	- To facilitate the interaction of users with the people responsible for handling the website, facilities like FAQ, Feedback and contact information should be available
		Aesthetic (attractiveness)	- Consistent text layout, page layout, font size and font colour	-Spacing of characters, font size used, colours used for labels, fonts, backgrounds, positions of navigation elements must be visually consistent -Users prefer consistent alignments for page elements like text boxes, rows, columns, paragraphs -To facilitate finding information, pages should not be over crowded with items of information
		Multiple - language support	- Easy to switch between languages	-Multiple language feature to support international users
2	Content	Relevance	- Student-oriented information (e.g. enrolment information, faculty information, course description)	- Information posted in the website should be relevant to users
		Accuracy	- Unambiguous information - Grammar and spelling error	- Information provided in the website should not be ambiguous - Grammar & spelling errors should be avoided to not confuse users
		Currency	- Website last update indicator - Up-to-date news stories - Upcoming events - Authors information - References to outside sources	-The time when a page's content is created and updated must be displayed. - Up- to-date information should be made available
		Identity	- Website's mission - Website's property - University's logo (brand) - Copy right information	- The university's identity should be present

		Authority	- References to citations used - Credentials of authors of pages	- The credentials of authors who wrote pages in the website should be available for any kind of reference users would like to make Citations/ reference to resources used should also be available
3	Reliability	Fault tolerance (Non- deficiency)	- Link error - Orphan pages	A link should always take users to a valid page. There should not be dangling links, invalid links or orphan pages
		Recoverability	- Mean recovery time	The website should take less time to recover back to its last stage after a problem has occurred
		Availability	- Downtime/uptime	The website must be available 24/7
4	Efficiency	Time behaviour	- Load time	- Time delay for finding the website and displaying its pages must be 3-15 seconds (reasonable)
		Accessibility	- Information accessibility - Technology support	- Information should be accessible in text only version of the website - The website should support mobile and hand held devices - The website should support different browser platforms
5	Functionality	Navigation	- Finding home page - Current location orientation - Backward navigation	-Many users return to the home page to begin a new task or to start a task over again. Returning to the home page from any point in the site must be obvious and easy. - Users should know where they are when they reach at one location in the website - There should be a clearly marked exit back to parent pages or the home page
		Search	- Scoped search - Global search	- Users want to use their search result to continue solving their problem. The search result should provide precise information the user is looking for and what the user expects - Search option should be available on all pages of the site where it may be useful, so that users do not have to go to the home page - Including search hints helps to increase search performance - Website scoped search options (course, programs, people, faculty) so that users can customize their search retrieving level
		Suitability	Appropriate functionalities are provided to users	Users must be satisfied with the services the website offers

4. Testing of the new framework

In this project, comprehensive analysis of website quality evaluation and usability literature have been made to understand website quality characteristics and quality models. This has helped in the design of the academic website's quality evaluation framework. The following methods were proposed to evaluate the new evaluation framework:

- Applying the proposed framework for evaluating TU-Delft website as a case study using a questionnaire and analyzing the responses of the questionnaire to prove the consistency of the responses using reliability analysis methods such as Cronbach's alpha

- To gather students' perception over the quality of the university website and compare their responses with the outcome of the WEBUSE analysis

- Using lists of requirements to judge whether the quality factors included in the quality evaluation framework exhibit the properties of an evaluation framework

The first and second options were used as the principal methods to test the framework. It was not possible to make use of the third option, as it was not possible to find lists of requirements for evaluation frameworks in the literature. Therefore, the first two options used for assessing the effectiveness of the proposed quality evaluation framework are discussed in the following sections of this chapter.

4.1. Applying the proposed framework in a case study

To assess the effectiveness of the proposed framework, a survey was conducted to evaluate the quality of a case study academic website. The chosen academic website is the Technology University of Delft (TU-Delft) website. Similar to other university websites, this website facilitates the communication between TU-Delft students, TU-Delft stuff, stuff and student's of other universities, journalists, research companies and the public in general. The quality evaluation framework focuses on the perspective of students and therefore to apply the proposed framework on the TU-Delft website, a survey involving students of the university was conducted.

4.1.1. Preparation of Questionnaire

A Survey study consists of questionnaire and interviews as the major tools of gathering data from respondents. According to Oppenheim [65], the purpose of a questionnaire is "measurement" and the main types of questions can be classified into three: factual, attitudinal and classification. Factual questions request response concerning known facts. Attitudinal questions request response concerning opinion, feeling or belief. Classification questions are special types of factual questions concerning personal characteristics that allow dividing data into categories. In a more broad way, open-ended and close-ended questions are the two common types of questions.

While designing a questionnaire, it is necessary to make sure that it is inline with the objective of the study and the information required to be collected from the respondents. Questions should not be leading or loaded [66]. Leading questions are questions that direct the respondent to one specific answer; whereas loaded questions are questions consisting of abstract terms that could mislead the respondents to interpret the question in different ways from what the researcher intend

to mean. Other point to consider while constructing questionnaires is to make questions more appealing and interesting to respondents; so that the response rate of the questionnaire will increase. This can be achieved by designing close-ended questions with pre-given answers that could give respondents the impression that the questionnaire is simple and easy to finish. Open-ended questions on the other hand can be frustrating for respondents, hence affecting the response rate of the questionnaire.

Questions framed in either positive or negative wording lead to information bias, which will affect the responses users give. Hence, leading to discrepancies in the responses of users. Thus, such questions should be avoided in a questionnaire [67]. The most efficient method of gathering data through survey is the Likert scale and semantic differential scales. It is a psychometric analysis method that is used to gather the perception, attitude of people over an issue. Respondents are given statements to show their level of agreement on a 5-point, 7-point or 10-point scale levelled from strongly agree to strongly disagree, one of the central points indicating a neutral point [68]. A 5-point scale of agreement like below is usually used in the Likert scale [69]:

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

Using the Likert scale, either a positive or negative statement is used to capture the level of agreement of the respondents on the statements. The statement reflects the respondent's belief or attitude towards the attitude object considered for the survey. Likert scale items should not include adverbs like very, extremely, absolutely in their statements. This may decrease the likelihood of strong agreement [65]. Therefore, care must be taken in the words used for the agreement statements. While designing the questionnaire, these guidelines were given a careful consideration. Questionnaires used in previous studies [70] for the purpose of usability analysis and website quality evaluation were also studied while designing the questionnaire.

The questionnaire was finally designed and it had two parts, totally making up 40 questions. Out of which the 20 items were designed to address the properties of the new quality factors introduced in the new evaluation framework. The first part consisted of 5 questions that were used to collect demographic data about the students (sex, program of study, field of study, faculty and frequency of using the website). The second part consisted of 35 Likert-type questions in a 5-point scale (1 indicating Strongly Disagree and 5 indicating Strongly Agree). Since the aim of conducting the case study was to show how effective the proposed evaluation framework performs better than the base model in evaluating the case study academic website, an emphasis was given to the questions designed to address the new quality factors.

The high-level quality factors and their sub quality factors in the new quality evaluation framework and their subsequent questions designed to address the properties of each factor is presented in the table below. The grey cells in the table indicate the quality factors that are introduced in the new framework but that are not part of the ISO model.

Table 9: Quality factors in the new framework and the ISO model

High level quality factors	Sub quality factors	ISO 9126-1	New framework	Questions
Usability	Understand ability	√	√	16, 17, 20
	Learn ability	√	√	18
	Interactivity		√	21
	Operability	√	√	19
	Interface attractiveness	√	√	24, 25, 26, 27
	Multiple language support		√	22, 23
Content	Relevance		√	2
	Accuracy		√	1
	Up to date information		√	3, 4, 5
	Authority		√	6, 7
	Identity		√	8
Reliability	Fault tolerance	√	√	9
	Recoverability	√	√	10
	Availability		√	11
Efficiency	Time behaviour	√	√	12, 13
	Accessibility		√	14, 15
Functionality	Navigation		√	28, 29, 30, 31
	Search		√	33, 34
	Suitability	√	√	32

The full questionnaire is presented in Appendix C.

Before sending the questionnaire to the sample population chosen, the questionnaire was revised and improved by using two methods:

- A pilot test was conducted using five students. The feedback collected from the pilot test helped to improve some questions and revise the structure of the questionnaire in general.

- A question utility checklist was used to make sure whether or not each questions designed are effective enough to collect the required response from the students. The checklist consists of serious of questions such as whether or not a given item is easy to be understood by the respondents or it helps to achieve the objectives of the questionnaire[71]. The checklist is presented in Appendix A.

The improved questionnaire used for the case study is presented in Appendix B.

Sample selection

The respondents for the questionnaire were current Masters and PhD students at the EEMCS faculty of the TU-Delft University. The rational behind using students for the case study is because of the fact that the new framework proposed focuses on the perspectives of student users. In a typical usability study, a minimum of 30 participants is required as cited in many usability analysis related works [72]. To conduct the evaluation case study, a sample of 50 students studying in Informatics and Electrical Engineering sections of the EEMCS faculty were chosen.

Consideration of Ethics

In conducting a survey, one of the things to consider is the privacy of the respondents. To keep the respondents privacy, the respondents were only asked to provide their demographic information and the responses gathered were analyzed anonymously.

4.2. Data Analysis Methods

Using the quality factors in the proposed framework, a small survey was conducted on the case study website (TU-Delft) website to test the designed evaluation framework and at the same time to evaluate the quality of the website from current students' perspective. The questionnaire was developed and administered to current Masters and Bachelor students of the EEMCS faculty. The questionnaire enabled to explore the opinions of the EEMCS faculty students in using the TU-Delft website and assess the effectiveness of the evaluation framework designed.

4.2.1. Reliability Analysis of Item scores

Data gathered through the questionnaire were analyzed based on simple statistical techniques using SPSS 17 and Excel. The usefulness of the items constructed were carefully analysed before distributing the questionnaire to students. Reliability of the items in each of the quality factors are analysed for the consistency of the responses gathered from students by using Cronbach's alpha and item-total correlation. Cronbach's alpha is a reliability analysis method that is used to analyse the consistency of item scores across the population of a questionnaire. Item-total correlation is used to understand the relationship between each item and the rest of the items in the scale. This helps to compare the implication of each item included in the scale on the rest of the scale [73].

4.2.2. WEBUSE usability analysis method

A usability analysis method called WEBUSE was used to make a more valuable analysis of the case study evaluation. The method basically was applied practically for evaluating the usability of websites by using questionnaire [6, 9, 74] in the form of Likert scale items. In this rating method, first, questions are grouped into categories based on the quality factors they address; a category indicates one high-level quality factor. The method uses questions in Likert scale format, which enquires users to show their level of agreement to a given statement. Then, a merit value for each response of the questions is assigned according to the responses gathered as shown in the table below.

Table 10: Response options for questions and corresponding Merit values

Response options	Merit points
Strongly Agree	1.00
Agree	0.75
Neutral	0.50
Disagree	0.25
Strongly Disagree	0

Then the Merit points for the high-level quality factors will be accumulated as follows:

n

$$\mathbf{X} = \sum_{i=1} \frac{\text{(Merit point of each question of a high-level quality factor)}}{\text{(Total number of questions for the quality factor)}}$$

Finally, to calculate the overall quality of the website, the mean average of the high-level quality factors will be computed as shown below:

$$\mathbf{Q} = \sum_{i=1}^{n} xi / n$$

Where,

- x, is the average merit point of a high-level quality factor
- Y, is the total number of high-level quality factors,
- Q, is the mean average of the overall quality of the website and
- n, is the total number of items in the questionnaire

The values of the merit points of the quality factors range between 0 and 1, which are divided in to five categories to indicate five different levels of quality (bad, poor, moderate, good and excellent). The quality merit points determine the quality levels of the website. The meanings attached to the ranges varies in the literature [9, 74]. However, the following was adopted for analysing the responses gathered for the case study website.

Table 11: Quality points and levels

Average merit Point, x	**Quality level**
$0 \leq x < 0.2$	Bad
$0.2 \leq x < 0.4$	Poor
$0.4 \leq x < 0.6$	Moderate
$0.6 \leq x < 0.8$	Good
$0.8 \leq x < 1.0$	Excellent

The quality levels of quality characteristics of the case study website were determined based on the above quality points and quality levels of the WEBUSE method. The results of the analysis are discussed in Chapter 5.

5. Results of the case study

In this chapter, the effectiveness of the proposed framework is discussed based on the results of the responses of the questionnaire used for the case study. The result showed that the item scores for most of the factors in the proposed framework are consistent while the item scores for some of the factors showed poor consistency. The case study was mainly used to assess the effectiveness of the proposed framework. General description of the response is explained in section 5.1 followed by the analysis of the reliability of the item scores and WEBUSE method.

5.1. Response rates

The questionnaire was made available online from June 28 – July 12, 2010. The questionnaire was sent to 50 Bachelor and Masters students in three different study groups at the EEMCS faculty. With in the two weeks period of time, 34 valid responses were gathered, thus making a response rate of 68%. 32 students who participated in the questionnaire were Masters students, comprising 94.1% of the response, the rest (5.9%) being Bachelor students (Appendix D). The number of female students who participated in the questionnaire was only 8, while that of the male students were 26. There was an expectation that almost all of the fifty students would participate in the case study. Unfortunately, that did not happen, perhaps because of the fact that the last exam period was underway at the time when the questionnaire was sent.

Although all of the students are from the EEMCS (EWI) faculty, from the results of the questionnaire, 26.5% of the students were from Computer Science department, 17.6% of the students were from Media and Knowledge Engineering department, 14.7% from Electrical Power Engineering department, another 14.7% of the students were from Microelectronics, 11.8% of students were from Applied Mathematics, and the rest of the students were from Computer Engineering department.

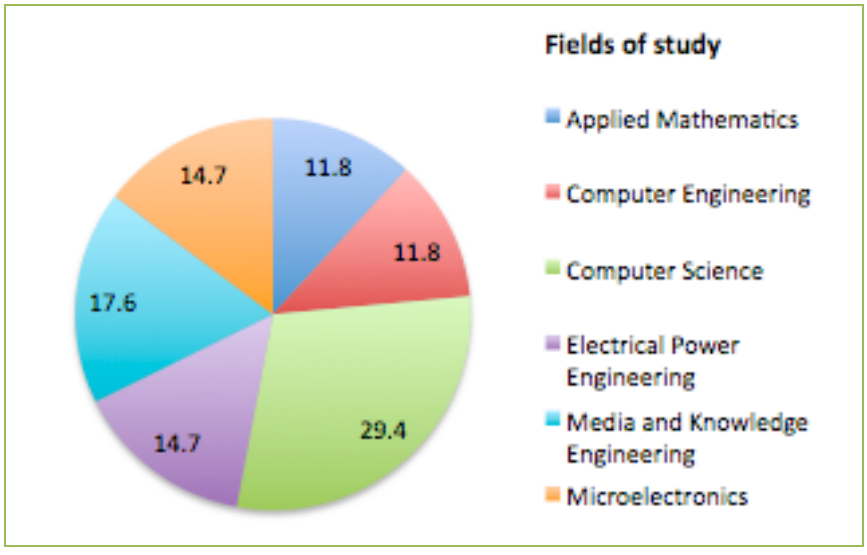

Figure 10: Student's fields of study

The frequency of the student's visits to the website varies in the response gathered. The options given to the students to choose from were, everyday, weekly, monthly, occasionally, never and other. One student responded saying thrice a week, so this response is added to the occasional option. Therefore, according to the responses gathered, the highest frequency of use is in a weekly and occasionally period with both options scoring response rates of 32.4%. The options monthly and everyday both scored a response rate of 11.6 %.

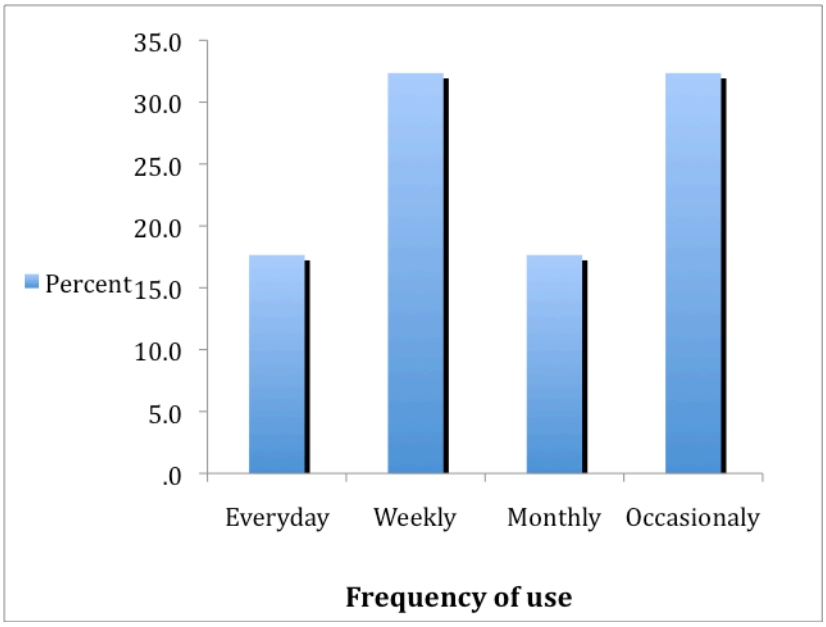

Figure 11: Students' frequency of using TU-Delft website

5.2. Reliability of item scores of the new quality factors

In order to investigate the consistency of the item scores for the new quality factors introduced by the new framework, statistical reliability analysis methods were used. Reliability analysis methods help to examine whether the results of a measure are consistent. It is not possible to exactly calculate reliability, it can only be estimated. There are four common types of reliability estimation methods [75]:

- Inter-rater (inter-observer)
- Test-Retest
- Parallel-forms
- Internal consistency

All the four types of reliability analysis methods determine reliability in different ways. The most commonly used reliability analysis method is the last one, internal consistency. This method takes one measurement scale that was administered to a group of respondents at some point. The reliability of the scale is estimated by how well the response of the items reflecting the same concept results with similar results [75]. Several internal-consistency measurement methods can be used, among which, one is the Cronbach's alpha method. Cronbach's alpha is a method mostly used for checking internal consistency of item scores in a questionnaire. Its value ranges from 0 to 1. A high Cronbach's alpha (1) of a questionnaire indicates that there is a high internal consistency between the individual items in the questionnaire. Usually the acceptable coefficient of alpha is

between (.7) and (1) [73]. The value of Cronbach's alpha increases as the internal correlation between items increases. By performing a reliability analysis of the questions that were designed to address the new quality factors in the proposed framework, it was possible to recognize which of the items were replied with a consistent answer and which ones did not measure any thing similar to the rest of the other items.

The reliability coefficients of the questions for the new factors in the proposed framework are presented along with the explanation of their meanings.

Table 12: Total Cronbach's alpha

Cronbach's Alpha	**Number of Items**
.893	34

The Cronbach's alpha coefficient of the total 34 items is .893, as also shown in Appendix D. This means there is a good consistency between the questions. The table below consists of four columns and the last two columns give the most important information regarding the consistency of each question. Scale if item deleted indicates what the mean value of the scale (the questionnaire) would become if an item or one question would be deleted. Scale variance similarly indicates what the variance of the questionnaire would become if a question item is deleted.

Corrected Item-Total correlation indicates the correlation between one item and the sum of the rest of the items in the questionnaire. According to the literature, a good corrected item-total correlation value should not be close to 0. Cronbach's alpha if item deleted indicates what the Cronbach's alpha value of the scale (the questionnaire) would become if a particular item is deleted. The Cronbach's alpha if item deleted value of each item (question) should not exceed the Cronbach's alpha of the scale. If the Cronbach's alpha if item deleted is higher than the value of the questionnaire's alpha value, then the item should be discarded, as it is not measuring a consistent value as the rest of the questions [73].

Table 13: Reliability statistics of the item scores of the new quality factors of the proposed framework

No	Quality Factors	Questions (Items)	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
1	Content	1.The information provided in the website is clear (not ambiguous)	109.00	250.400	.461	.890
		2. I think the website provides important information to students	108.90	246.557	.527	.889
		3. It is obvious to find creation and update time of contents in the website	109.32	250.759	.379	.891
		4. It is easy to find information about upcoming events in the university	109.19	241.628	.552	.888
		5. The website offers current & up to date information	109.26	250.731	.383	.891
		6. Author names of pages are available	109.29	257.946	.192	.894
		7. Links to outside references used in the website are given	109.06	252.129	.405	.891
		8. The name of the university, logo and copyright information are available	108.35	261.970	.079	.895
2	Usability	21. I know who I can contact for more information about any thing in the website	109.81	251.161	.345	.892
		22. It is easy to switch between languages in the site	108.87	264.449	-.028	.899
		23. Necessary supplemental reference materials (e.g. FAQ, contact information) are available in more than one language	108.97	257.299	.259	.893
3	Reliability	11. I can access the website at any time	107.87	254.583	.484	.890
4	Efficiency	14. The website does not use plug-ins or proprietary software	108.32	267.826	-.133	.899
		15. I can access the website from my favourite browser	107.90	253.824	.523	.890
5	Functionality	28. It is easy to go to the home page from any other page in the site	108.35	257.237	.188	.895
		29. While navigating, I can immediately tell where I am in the website	109.48	244.791	.507	.889
		30. I am able to move from one page to another page without getting lost	109.52	241.791	.604	.887
		31. I can easily navigate backwards through previously visited pages	108.90	248.090	.478	.889
		33. Search hints are provided when wrong keywords are used	109.58	255.718	.254	.893
		34. The website provides varied search options (e.g. by faculty, employees, courses, programs, etc)	109.52	247.525	.538	.889

1. Content

The base model does not include content as a quality factor. Although it is one of the key quality factors for academic websites as recognized in the literature [6]. Hence, this quality factor was integrated into the new framework. Since all the sub factors of this quality characteristic are not included in the base model, questions addressing the sub factors were constructed for the case study. Therefore, the reliability of the item scores of these questions is discussed below. Table 14 shows the results of the reliability analysis of the items designed for addressing the sub factors of content characteristic in the new framework.

Table 14: Cronbach's alpha results for content new sub quality factors questions

Sub Quality factors of Content	Questions	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Accuracy	1.The information provided in the website is clear (not ambiguous)	.461	.890
Relevance	2. I think the website provides important information to students	.527	.889
Currency of information (Up-to-date information)	3. It is obvious to find creation and update time of contents in the website	.379	.891
	4. It is easy to find information about upcoming events in the university	.552	.888
	5. The website offers current & up to date information	.383	.891
Authority	6. Author names of pages are available	.192	.894
	7. Links to outside references used in the website are given	.405	.891
Identity	8. The name of the university, logo and copyright information are available	.079	.895

Accuracy

Question 1 showed a Cronbach's alpha of .890, which is less than the total scale and a corrected-item total correlation of .461 with the rest of the summated scale. Thus the item scores for the accuracy sub characteristic showed a good consistency.

Relevance

Question 2 showed a high corrected-item total correlation and also a Cronbach's alpha of less than that of the total scale. Thus the relevance sub characteristic is a good measure to be part of the sub characteristics of content.

Timely information

Question 3, 4, & 5 all have a good Cronbach's alpha, greater than .8 and less than the total scale. Their corrected item-total correlation is also good, showing that these questions are measuring a consistent score related to the total scale.

Authority

Question 6 has a Cronbach's alpha of .894, which is slightly greater than the total scale's Cronbach's alpha. Its corrected-item total correlation is less than .2 and hence the item scores do not for this question do not show significant correlation with what the rest of the summated scale measures.

Question 7, which is also measuring Authority sub factor showed a Cronbach's alpha of .891 and a corrected item-total correlation of .4; therefore the item scores of this question show better consistency with the rest of the summated scale. Although the result of question 6 showed inconsistency, the item scores for question 7 indicate that authority sub factor gives a similar result with what the rest of the scale measures and hence it should be included in the framework.

Identity

Question 8 showed a very low corrected item-total correlation and high Cronbach's alpha than the total scale's alpha value. Hence it does not show a consistent result with the rest of the scale. Either this sub factor is less important for evaluating academic websites, or the item statement should be improved to check if students give different answers.

2. Usability

The new factors under usability in the new framework are interactivity, and multiple languages support. The questions for each of the sub factors, the Cronbach's alpha and the corrected Item-Total correlation are shown in table 14.

Table 15: Cronbach's alpha results for functionality new sub quality factors questions

New Sub quality factors under usability	Questions	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Interactivity	21. I know who I can contact for more information about any thing in the website	.345	.892
Multiple languages-support	22. It is easy to switch between languages in the site	-.028	.899
	23. Necessary supplemental reference materials (e.g. FAQ, contact information) are available in more than one language	.259	.893

Interactivity

Question 21 has a Cronbach's alpha of .892, which is less than the Cronbach's alpha of the total scale. The corrected item-total correlation is also good since it is greater than .2 Therefore the item scores for this items shows that the responses to this item are consistent for all the students. The item has a good corrected-item total correlation, which also shows that the item scores shows that there is a good correlation between the responses of the item and the rest of the items in the scale.

Multiple language support

Question 22 has below zero corrected item-total correlation, which shows that the item score for this question does not show a good correlation with the rest of the scales. The Cronbach's alpha for this item is also greater than the total scale's Cronbach's alpha (.893). Therefore, the item should be revised to formulate a new item that would be more understandable to most of the students and result with a consistent item score.

Question 23 is also a question related to multiple language support. The Cronbach's alpha for this item is equal to the Total scale's Cronbach's alpha. The corrected-item total correlation shows that the item has a correlation of greater than .2. Thus the item score for this item shows a better consistency among the students' response.

3. Reliability

The new sub factor that is introduced under reliability is availability of the website. Only one question was used for this sub factor.

Table 16: Cronbach's alpha results for reliability new sub quality factors questions

New Sub quality factors under usability	Questions	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Availability	11. I can access the website at any time	.484	.890

Availability

Question 11 resulted with a Cronbach's alpha of .890, which is less than the Scale's aloha value. Its corrected item-total correlation is .484 which is good and shows that the item scores for this particular item indicate there is a good consistency between the item's measurement value and the rest of the summated scale value.

4. Efficiency

The new factor introduced in this factor is accessibility. It indicated the accessibility of information and the accessibility of technology.

Table 17: Cronbach's alpha results for efficiency new sub quality factors questions

New Sub quality factors under usability	Questions	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Accessibility	14. The website does not use plug-ins or proprietary software	-.133	.899
	15. I can access the website from my favourite browser	.523	.890

Accessibility

Question 14 shows a poor Cronbach's alpha, which is far greater than the alpha value of the total scale. In addition, the correlation between the item and the rest of the scale is below zero. Therefore, the question needs to be reframed to give a better understanding to most of the respondents. Question 15 on the other hand resulted with a good corrected item- total correlation and a Cronbach's alpha of .890. Therefore the item scores of this question show there is a consistency of responses among students for this particular sub factor.

5. Functionality

New sub quality factors in the proposed framework are navigation and search. The questions used in the case study are mentioned in the table below.

Table 18: Cronbach's alpha results for functionality new sub quality factors questions

New Sub quality factors under usability	Questions	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Navigation	28. It is easy to go to the home page from any other page in the site	.188	.895
	29. While navigating, I can immediately tell where I am in the website	.507	.889
	30. I am able to move from one page to another page without getting lost	.604	.887
	31. I can easily navigate backwards through previously visited pages	.478	.889
Search	33. Search hints are provided when wrong keywords are used	.254	.893
	34. The website provides varied search options (e.g. by faculty, employees, courses, programs, etc)	.538	.889

Navigation and Search

Question 28 showed a very low correlation with the total summated scale. The statement in the question can be revised to check whether or not students could be able to give a different answer from their first response. The rest of the questions (question 29-34) showed a good correlation and alpha value. Thus the sub factors considered under functionality measure a consistent variable to the rest of the items in the questionnaire.

The reliability analysis results of the new factors in the proposed framework, it seems most of the questions resulted with a consistent outcome, except the question items 6, 8, 14, 22 and 29, which address the sub factors authority, identity, multiple language support and accessibility. These question items have a slightly higher Cronbach's alpha value than the value of the questionnaire. In addition, their corrected-item related correlation value is very low, which clearly indicates the fact that they do not measure anything related to what the rest of the items in the questionnaire measure. This may be a result of the questions not being framed in a direct and understandable way, which might have made the students to not give the right response. It may also indicate the

fact that the factors represented by these questions do not have a significant effect on the framework. Either way, it was observed that results for most of the items designed for the new quality factors in the proposed framework resulted with a reliable result.

Furthermore, the new quality factors made it possible to evaluate the quality of content, accessibility of information, availability of the website, navigation and search functionalities of the website. Thus the new quality factors introduced in the new framework improved the quality factors of the base model by including significant quality factors for academic websites, which resulted in a more complete and comprehensive website quality evaluation framework.

The results of the reliability analysis of the whole items in the questionnaire are presented in Appendix D.

5.3. Using WEBUSE analysis method

To give a more valuable analysis of the responses, a usability rating method from previous similar work is adopted. This rating method is called WEBUSE. The method uses Likert scale type questions to evaluate usability level of websites [9]. To be able to use this method, questions for each of the 5 high level quality factors were grouped under one category for the purpose of analysis. Thus, it was possible to find out the quality level of the case study website in terms of the five high-level quality factors.

Table 19: Results of the WEBUSE analysis method

No	High level quality factor	Sub quality factor	Merit value	Quality level
1	**Content**	Accuracy of information	0.61	Good
		Relevance of information	0.64	Good
		Currency of information	0.54	Moderate
		Authority of information	0.59	Moderate
		Identity of institution	0.75	Good
2	**Usability**	Understandability	0.52	Moderate
		Learnability	0.53	Moderate
		Operability	0.38	Poor
		Interactivity	0.40	Moderate
		Multiple language support	0.63	Good
		Interface attractiveness	0.62	Good
3	**Reliability**	Fault tolerance	0.69	Good
		Recoverability	0.57	Moderate
		Availability	0.83	Excellent
4	**Efficiency**	Time behavior	0.51	Moderate
		Accessibility	0.82	Excellent
5	**Functionality**	Navigation	0.57	Moderate
		Search	0.46	Moderate
		Suitability	0.48	Moderate

An explanation of the results of the WEBUSE analysis for each of the quality factors is given as follow.

Content

The quality level to the accuracy and relevance of information in the TU-Delft website have a good quality level, while the currency sub characteristic of the information in the website showed a moderate quality level. The Identity sub factor on the other hand showed a good quality, hence indicating the identity of the university is visible to all users

Usability

The understandability of the website showed a moderate quality level. Hence indicating that the terms used in the website might not be clear to most of the student users and the organization of the website elements is not easily understood by students. The learnability of the website also showed moderate level, which means that students find learning how to use the website to be difficult. The operability characteristic of the website showed a poor quality, which also indicates to the fact that students face difficulty to browse through the website in search of information or performing a specific task. The interactivity sub factor showed that the website has a moderate interactivity quality, while the responses showed that the attractiveness and multiple language support quality of the website are good.

Reliability

The availability of the website showed an excellent quality level, which indicates that the students are very satisfied with the period of time the website is up and running. The fault tolerance characteristic of the website showed a moderate quality level. This indicates the website has a modest capability of tolerating errors or faults. The recoverability characteristic of the website showed that a good quality level, which showed that students think that the website has a good quality in restoring back to the original state, after some kind of error occurred.

Efficiency

The results of the time behaviour factor showed that the website has a moderate quality level. This means that students think the time the website takes to load pages and the time it took them to perform any task in the website is reasonable. The results for the accessibility sub factor showed that the website has an excellent quality. This indicates that students feel that it is simple and easy to access information in the website. Therefore, they are very satisfied with the accessibility of the website because they can access the website from different hardware platforms, mobile devices and browsers.

Functionality

The results for the navigation, search functionality of the website have moderate quality. This suggests that students are not comfortable with the navigation structure of the website as well as the search functionality. Moreover, the result for the suitability characteristic of the website showed a moderate quality level, which indicates that the functionalities of the website do not have the appropriate degree of quality as expected by students.

The WEBUSE analysis results indicated that the website has a good reliability quality followed by the efficiency quality factor. It is also noted that the website has a moderate quality in terms of content, usability and functionality quality factors. In general, the mean average of the quality merit value of each 5 quality factors showed that the website has a good quality.

Table 20: Quality merit and levels of the TU-Delft website

No	High level quality factor	Final quality merit	Quality Level
1	Content	0.59	Moderate
2	Reliability	0.70	Good
3	Efficiency	0.66	Good
4	Usability	0.54	Moderate
5	Functionality	0.53	Moderate
	Average	0.60	Good

Although, there are quality factors such as functionality, usability and content where some improvements need to be made, the result of the WEBUSE analysis showed that the website at this moment has an acceptable quality and students are satisfied with the quality of the website.

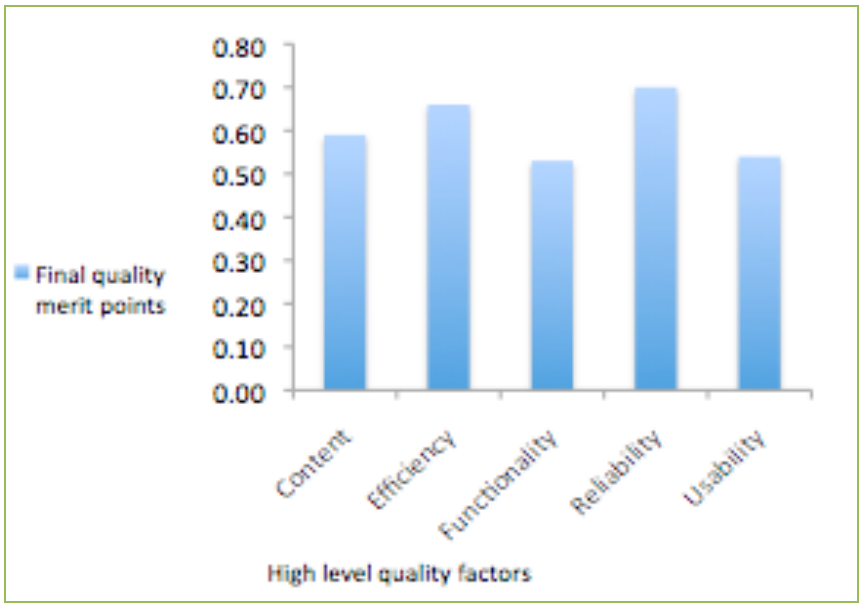

Figure 12: Quality merit points for each high-level quality factors

Comparison of student's perception of the quality of TU-Delft website and results of WEBUSE analysis

Apart from the Likert type questions, students were asked to give a rating to the overall quality of the TU-Delft website in the scale similar to the quality levels of the WEBUSE method (bad, poor, moderate, good and excellent). The responses gathered showed that 38.2% of the students rated the website as having good quality. 26.5% of the students rated the website as having a moderate quality, 23.5% of the students rated the website as having poor quality. 5.9 % of the students gave it as having a bad quality while another 5.9% of students rated the website as having an excellent quality. The highest percentage of the students rated the website as having a good quality.

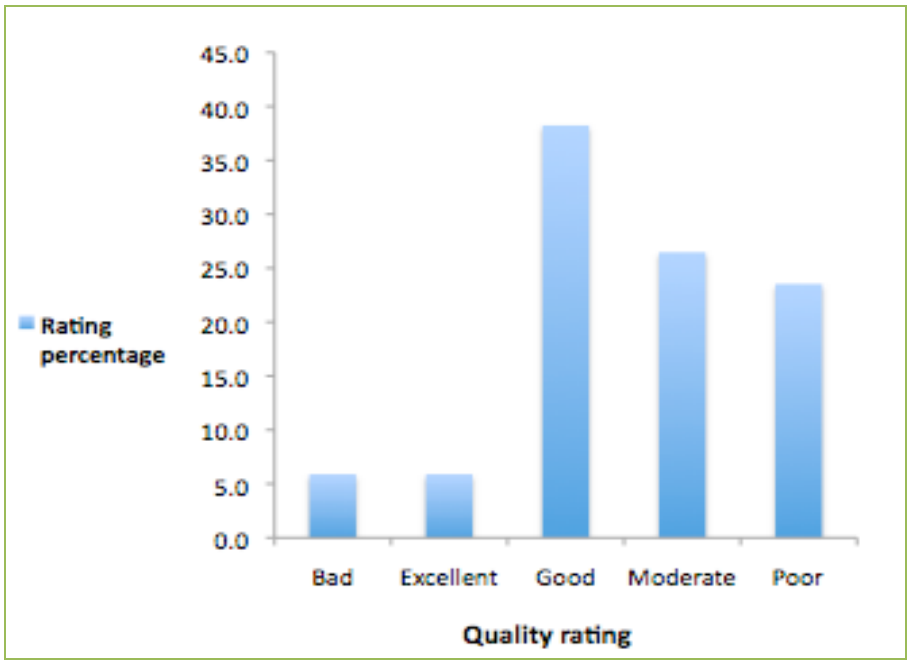

Figure 13: Results of student's quality rating of the TU-Delft website

The options chosen to test the effectiveness of the proposed evaluation framework is to compare the results of analysing the responses of the students using the WEBUSE method and the results of the student's quality rating of the case study website. By comparing the result of the WEBUSE analysis and the rating given by students, it is observed that both results are alike. The WEBUSE result indicated that the website has a good quality. Similarly, majority of the students rated the website as having a good quality, which reflect. This shows that the proposed framework gives a reliable result that matched with the student's perception of the quality of the case website.

5.4. Summary of the results of the case study

Although testing an evaluation framework in general may not be a one-time task, the results of the case study in this Thesis work showed that the new framework is more effective than the base model for evaluating the quality of academic websites from the student users perspective. This is due to the fact that the new evaluation framework consists of quality characteristics that are relevant for students to use academic websites. This is shown in the evaluation results of the TU-Delft website. Using the proposed quality evaluation model, it was possible to evaluate the essential attributes of the website such as content of the website, while this was not possible in the base model. The result of the case study gave an idea of which characteristics of the TU-Delft website students think need improvement; specifically a careful look at the content, functionality and usability characteristics of the website is crucial.

Moreover, from the results of the case study, it was observed that the hierarchical arrangement of the quality factors and sub factors in the proposed framework seemed to be better than that of the base model, ISO 9126-1. Nevertheless, further analysis should be made on the hierarchical structure of the quality factors and sub factors. Based on the result of the reliability analysis, sub factors such as: authority, identity, multiple language support, in particular showed deviations or inconsistencies from the rest of the factors and further work should give emphasis on refining these factors. Since this Thesis restricted itself to the perspectives of frequent users of academic websites (students), the quality factors such as portability and maintainability, which are part of the base model, were not considered in the new framework and hence in the case study. The

students who participated in the case study were from the same faculty and they more or less have a similar background of study. These may have a substantial influence on the outcomes of the responses gathered and the results of the questionnaire. Hence conducting a similar study by involving students from different faculties and departments is worthwhile.

Website quality evaluation can be done at any stages of website design [2]. 80% of cost in designing websites and maintaining them is spent after the design and implementation of websites. Studies suggest that these percentage cost can be reduced by evaluating the website at each stages of the website design cycle [10]. The idea is that the website design task is done in repeated cycles. In each cycle, the website is tested, and refined, where the testing output of one cycle feeds to the next cycle resulting in a product with an improved quality.

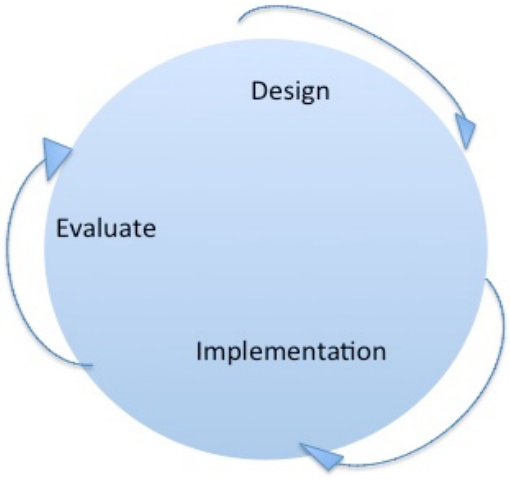

Figure 14: iterative website redesign cycle [13]

As shown in the diagram above, designing a website includes an iterative states of activities, which includes the design-implement-evaluate stages. In light of this idea, the evaluation activities at each stages of the design lifecycle of a website should incorporate users' needs and interests in the website.

6. Conclusions and Recommendations

In this chapter the results of the Thesis project and recommendations for future work are explained in the conclusion and recommendation sections respectively.

6.1. Conclusions

The main objective of this project was to design a quality evaluation framework for academic websites from students' perspective. To achieve this objective, existing evaluation models, existing software and website quality evaluation models were reviewed. An extensive literature study regarding software and website quality factors was made to identify necessary quality factors and criteria for academic websites. The study showed that most of the existing software and website quality evaluation models do not consider specific characteristics of a software or a website considered for evaluation. Besides, they do not adequately incorporate a particular viewpoint of users for the purpose of evaluation. Among the models reviewed, the ISO 9126-1 quality model was found to be more comprehensive than the rest of the models in the way it categorizes the quality factors and the descriptions it gives to the high-level quality factors and sub quality factors. Hence, it was chosen as a base model for constructing the new evaluation framework. Although the ISO 9126-1 model consists of extensive lists of quality factors, it lacks essential quality factors for academic websites.

Therefore, based on previous academic website evaluation works, success factors of websites in general and website design guidelines were studied to help the process of identifying necessary quality factors for academic website evaluation. Taking the students' users perspective and "satisfaction of users" as the definition of product quality, five high-level quality factors (four of them directly taken from the base model and one taken from other models studied and characteristics of academic websites) and 19 sub quality factors for academic websites were identified. Since this project focused only on the perspective of students user groups of academic websites, the quality characteristics such as portability and maintainability are not regarded as important to be included in the new framework.

The necessary quality factors and sub quality factors identified for evaluating academic websites based on students' perspective were arranged into a hierarchical structure. The structure is organized similar to that of the base model, which consists of three levels: *high-level quality factors, sub quality factors* and *criteria*. The high-level quality factors are broad and abstract quality characteristics at the first level of the framework. The second level consists of sub quality factors of the high-level quality factors. The third level consists of lists of quality criteria that indicate which specific attributes of the website to evaluate using each sub quality factors in the framework.

The second objective of the Thesis project was to apply the proposed framework on a case study academic website to evaluate how the framework performs compared to the base model. To address this objective, the proposed framework was used to evaluate the quality of the TU-Delft university website by means of a questionnaire. Likert scale type questions that address the quality factors and sub factors of the proposed quality evaluation framework were designed and distributed to students. The respondents who participated to fill in the questionnaire were composed of bachelor and Masters students at the EEMCS faculty of the university. The questionnaire used helped to explore students' opinion on the quality of the TU-Delft website.

The third objective of this Thesis project was to evaluate the effectiveness of the proposed quality evaluation framework. To realize this objective, two methods were used. The first method was to analyse the reliability of the item scores of the questions used to evaluate the case study website using Cronbach's alpha. The second method was to make a comparison between the quality rating students' gave regarding their satisfaction in using the TU-Delft website and the quality rating of the TU-Delft website as determined by adopting a website usability analysis method called WEBUSE.

The reliability of the item scores of the questionnaire was analysed using Cronbach's alpha method. Using this method, analysis for the internal consistencies of the item scores in the questionnaire revealed that most of the quality factors and sub factors in the proposed framework are well arranged according to the relationship that exists between the quality factors. This was reflected in the students' responses gathered in the case study. The responses gathered for most of the quality factors are consistent across the total number of students who participated in the case study. Nevertheless, there were cases in which the responses for some of the sub quality factors showed slight inconsistency from the total responses of the students. These sub quality factors were identity, authority and multiple language support, which are parts of the content and usability high-level factors.

The result of the case study in general showed that the new quality factors included in the proposed framework allowed students to properly evaluate the case study website. This can be taken as a successful achievement for the evaluation framework we designed. This was observed in the results of the rating students gave to the overall quality of TU-Delft website and the final analysis results of the WEBUSE method. High number of students rated the website as having good quality, at the same time the result of analysing the responses of the students obtained by the WEBUSE method was good quality level as well. Further, the results of the WEBUSE method showed that the reliability and efficiency quality of the TU-Delft website is good, while the content, functionality and usability quality of the website is moderate.

Finally, the last objective of the project was to provide suggestions for improving the proposed framework. In order to attain this objective, a careful revision was made on the approaches and used to design the evaluation framework and the results of the case study before drawing foreseeable recommendations and possible future works. The recommendations are further discussed in the next sub section.

6.2. Recommendations

The Thesis project focused on the perspectives of the most frequent user group of academic websites. Although this helped to narrow down the scope of the project and to look at the problem from definite perspectives, the proposed framework can merely be used to evaluate the perception of students on the quality of academic websites. In designing a particular type of website used for a specific purpose, it is not possible to satisfy all requirements. There are always tradeoffs to be made. In evaluating academic websites as well, based on the purpose of the evaluation, the perspective up on which the website is evaluated, there are definitely some quality factors that would have much more importance than the rest of the factors. Thus, identifying critical factors for the quality of the website under consideration is important. Moreover, while identifying the importance of the quality factors for evaluating the websites, the needs of different user groups need to be considered.

Therefore, the following points are recommended for future research work:

- The proposed evaluation framework focuses on only one group of users. The evaluation result of a given academic website using the proposed framework will only reflect the quality of the website from students' point of view. It is not possible to evaluate the quality of a given academic website from any other user point of views. Thus, it is important to consider different group of users' perspective to design a more comprehensive evaluation framework. In relation to this, the case study conducted on the TU-Delft website only used students from the same faculty (EWI) and with similar background of study. Perhaps, conducting the same study by using group of students from different faculty and different fields of study might bring different results. Therefore, it is worthwhile to carryout a similar study on different groups of students.

- As previously mentioned, different websites have critical quality characteristics. Some characteristics are more important than the others according to the type and purpose of the websites. The importance of the factors also differs for different types of users. Therefore, it is important to differentiate which of the quality factors are highly important for academic websites and which ones are less important. This can be done by assigning weight values for each of the quality factors in the framework based on the need and expectations of different user groups. Using decision-making methods like Analytic Hierarchical Process (AHP) and pair wise comparison, it is possible to assign weights to different quality dimensions [76, 77] by involving users to give their own opinion about the importance level of each factors. The needs of users can be gathered as user requirements of the website either at the beginning of the website development or after implementation.

- The proposed framework only consists of structured lists of quality factors. After assigning weights to the high level quality factors and sub quality factors, it would be interesting to design and develop a software tool that simplifies the evaluation activity.

- The quality factors and sub factors in the proposed framework are arranged based on their intrinsic definitions. However, in the case study it is shown that some of the sub factors reflect inconsistent item scores, which indicated that they do not measure a similar concept to the rest of the factors. To arrange the hierarchy of the factors in a more reasonable way, a factor analysis method can be used. Using factor analysis will help to get a well-refined and structured list of high-level quality factors and sub quality factors [78].

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Definitions

Quality factors (quality characteristics): indicates quality dimensions identified for evaluating the quality of websites.

High-level factors (high-level characteristic or top terms): refers to abstract quality factors that represent broader idea of quality.

Criteria: This refer to simplified quality attributes used to measure the quality factors/sub factors

Product: refers to website products and or software products, which is a result of a design and development of an artefact

Acronyms

ISO – International Organizations for Standardization

IEEE – Institute of Electrical and Electronics Engineers

MiLE – Milano Lugano Evaluation Method

MINERVA – Ministerial Network for Valorising Activities in Digitization

Web-QEM – Web Quality Evaluation Model

2QCV3Q - Quis (Identity), Quid (Content), Cur (Services), Ubi (Individuation), Quando (Management), Quomodo (Usability) and Quibus Auxiliis (Feasibility).

Appendix A - Question utility checklist

This appendix contains the question utility checklist that was used to analyse the usefulness of questions before sending to the students.

1. Does the question measure some aspect of one of the research questions?

or

2. Does the question provide information needed in conjunction with some other variable?

If NO to both drop question otherwise continue

3. Will most respondents understand the question and in the same way?

If NO revise or drop question otherwise proceed

4. Will most respondents have the information to answer it?

If NO drop question otherwise proceed

5. Will most respondents be willing to answer it?

If NO drop question otherwise proceed

6. Is other information needed to analyse the question?

If NO proceed If YES proceed if the other information is available or can be obtained from the survey

7. Should this question be asked of all respondents or of a subset?

If ALL proceed If a SUBSET, proceed if the subset id identifiable beforehand or through questions from the questionnaire

Figure 15: Question utility checklist [71]

Appendix B - Questionnaire

This appendix contains the final questionnaire used as a means to gather data from students. It was designed based on the quality factors and criteria of the proposed framework. The questionnaire contains 40 questions grouped in to two parts. The first part contained five basic questions. The second part contained eleven Likert type questions in a 5-point scale, (1) indicating strongly disagree and (5) indicating strongly agree.

Questionnaire to evaluate the quality of TU-Delft website

This questionnaire is designed to show how a proposed academic websites' quality evaluation framework can be applied in a case study. By academic websites, it only means university websites and faculty websites (It does not include sites like blackboard).

The proposed quality evaluation framework consists of lists of quality factors clustered in to 5 main high-level quality factors (Usability, Content, Reliability, Efficiency and Functionality). Each of this quality factors are further divided into number of quality sub factors. Your participation in this questionnaire helps to apply the quality evaluation framework for evaluating the website of TU-Delft.

The questionnaire is divided into two parts and it will take 10-15 minutes. In the first part, you will be asked to provide your personal information and answer basic questions. In the second part, statements addressing each of the quality factors in the framework are given. You have to show your level of agreement to each of the given statements. There is no right or wrong answer. You only have to reflect your opinion based on your experience in using the website.

Before answering the questions, please:
- visit the home page of TU-Delft (http://home.tudelft.nl)
- browse through the whole website (click as many links as you can) for 2-3 minutes

Should you have questions on how to fill in the questionnaire, you can contact T.Mebrate at T.Mebrate@student.tudelft.nl or tsegemebrat@gmail.com

Thank you for your cooperation!
T.Mebrate

Continue »

Questionnaire to evaluate the quality of TU-Delft website

* Required

Part- I
Basic Information

1. Faculty *
- ○ EWI
- ○ Other:

2. Program of study *
Bachelor

3. Field of study *

4. Sex *
- ○ Female
- ○ Male

5. How often do you visit the website? *

- ○ Everyday
- ○ Weekly
- ○ Monthly
- ○ Occasionaly
- ○ Never
- ○ Other:

« Back Continue »

Questionnaire to evaluate the quality of TU-Delft website

Part- II

In this part of the questionnaire, you are presented with statements addressing quality factors and sub factors of the evaluation framework. You have to show your agreement by choosing one of these options (Strongly agree, Agree, Neutral, Disagree or Strongly disagree).

From question 1- 3, please provide your opinion on the quality of information the website provides

1. Accuracy & relevance of information

1= strongly disagree, 2= disagree, 3= neutral, 4= agree, 5= strongly agree

	1	2	3	4	5
The information provided in the website is clear(not ambiguous)	○	○	○	○	○
I think the website provides important information to students	○	○	○	○	○

2. Currency (uptodate) information

1= strongly disagree, 2= disagree, 3= neutral, 4= agree, 5= strongly agree

	1	2	3	4	5
It is obvious to find creation and update time of contents in the website	○	○	○	○	○
It is easy to find information about upcoming events in the university	○	○	○	○	○
The website offers current & up to date information	○	○	○	○	○

3. Authority of content & Identity of univeristy

1= strongly disagree, 2= disagree, 3= neutral, 4= agree, 5= strongly agree

	1	2	3	4	5
Author names of pages are available	○	○	○	○	○
Links to outside references used in the website are given	○	○	○	○	○
The name of the university, logo and copyright information are available	○	○	○	○	○

From question 4 - 5, provide your opinion on the efficiency and reliability of the website

4. Reliability

1= strongly disagree, 2= disagree, 3= neutral, 4= agree, 5= strongly agree

	1	2	3	4	5
Clicking on a link takes to a valid page	○	○	○	○	○
Whenever some error occurs, the website recovers quickly	○	○	○	○	○
I can access the website at any time	○	○	○	○	○

5. Efficiency

1= strongly disagree, 2= disagree, 3= neutral, 4= agree, 5= strongly agree

	1	2	3	4	5
It is possible to find what I want with in a reasonable time	○	○	○	○	○
It is possible to switch between pages with in reasonable time	○	○	○	○	○
The website does not use plug-ins or proprietary software	○	○	○	○	○
I can access the website from my favorite browser	○	○	○	○	○

« Back Continue »

From question 6-8, provide your opinion on the usability of the website

6. Understandability, Learn ability & Operability

1= strongly disagree, 2= disagree, 3= neutral, 4= agree, 5= strongly agree

	1	2	3	4	5
I think the overall structure of the website is straightforward	○	○	○	○	○
Terminologies used in the website are understandable	○	○	○	○	○
I think it is easy to learn how to use the website	○	○	○	○	○
It is easy to find information I need on the website	○	○	○	○	○
Organization of information in the website is easy to understand	○	○	○	○	○

7. Interactivity & foreign language support

1= strongly disagree, 2= disagree, 3= neutral, 4= agree, 5= strongly agree

	1	2	3	4	5
I know who I can contact for more information about any thing in the website	○	○	○	○	○
It is easy to switch between languages in the site	○	○	○	○	○
Necessary supplemental reference materials (e.g. FAQ, contact information) are available in more than one language	○	○	○	○	○

8. Interface attractiveness

1= strongly disagree, 2= disagree, 3= neutral, 4= agree, 5= strongly agree

	1	2	3	4	5
I found the interface of the website pleasant	○	○	○	○	○
Pages are overcrowded with information	○	○	○	○	○
Similar fonts and colors are used throughout the website	○	○	○	○	○
I think the alignment of text and page elements is consistent throughout the website	○	○	○	○	○

From questions 9 - 10 , please provide your opinion on the functionality of the website

9. Navigation

1= strongly disagree, 2= disagree, 3= neutral, 4= agree, 5= strongly agree

	1	2	3	4	5
It is easy to go to the home page from any other page in the site	○	○	○	○	○
While navigating, I can immediately tell where I am in the website	○	○	○	○	○
I am able to move from one page to another page without getting lost	○	○	○	○	○
I can easily navigate backwards through previously visited pages	○	○	○	○	○

10. Search & suitability

1= strongly disagree, 2= disagree, 3= neutral, 4= agree, 5= strongly agree

	1	2	3	4	5
I am satisfied with the functionalities of the website	○	○	○	○	○
Search hints are provided when wrong keywords are used	○	○	○	○	○
The website provides varied search options (e.g. by faculty, employees, courses, programs, etc)	○	○	○	○	○

11. What overall rating would you give to the quality of the TU-Delft website? *

- ○ Bad
- ○ Poor
- ○ Moderate
- ○ Good
- ○ Excellent

« Back Submit

Appendix C – Questions for the new quality factors

In this appendix, the questions designed for addressing the new quality factors and sub factors that were added in the proposed framework are presented.

1. Usability

Understandability

16. I think the overall structure of the website is straightforward
17. Terminologies used in the website are understandable

Learnability

18. I think it is easy to learn how to use the website

Operability

19. It is easy to find information I need on the website
20. Organization of information in the website is easy to understand

Interactivity

21. I know who I can contact for more information about any thing in the website

Multiple language support

22. It is easy to switch between languages in the site
23. Necessary supplemental reference materials (e.g. FAQ, contact information) are available in more than one language

2. Content

Accuracy

1. The information provided in the website is clear (not ambiguous)

Relevance

2. I think the website provides important information to students

Up-to-date information

3. It is obvious to find creation and update time of contents in the website
4. It is easy to find information about upcoming events in the university
5. The website offers current & up to date information

Authority

6. Author names of pages are available
7. Links to outside references used in the website are given

Identity

8. The name of the university, logo and copyright information are available

3. Reliability

Fault tolerance

9. Clicking on a link takes to a valid page

Recoverability

10. Whenever some error occurs, the website recovers quickly

Availability

11. I can access the website at any time

4. Efficiency

Time behaviour

12. It is possible to switch between pages with in reasonable time
13. It is possible to find what I want in a reasonable time

Accessibility

14. The website does not use plug-ins or proprietary software
15. I can access the website from my favourite browser

5. Functionality

Navigation

28. It is easy to go to the home page from any other page in the site
29. While navigating, I can immediately tell where I am in the website
30. I am able to move from one page to another page without getting lost
31. I can easily navigate backwards through previously visited pages

Suitability

32. I am satisfied with the functionalities of the website

Search

33. Search hints are provided when wrong keywords are used
34. The website provides varied search options (e.g. by faculty, employees, courses, programs, etc)

Appendix D - Frequency table for basic questions

Table 21: Frequency table for basic questions

1. Faculty

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	CiTG	1	2.9	2.9	2.9
	EWI	33	97.1	97.1	100.0
	Total	34	100.0	100.0	

2. Program of study

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Bachelor	2	5.9	5.9	5.9
	Masters	32	94.1	94.1	100.0
	Total	34	100.0	100.0	

3. Field of study

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Applied Mathematics	4	11.8	11.8	11.8
	Civil Engineering	1	2.9	2.9	14.7
	Computer Engineering	4	11.8	11.8	26.5
	Computer science	1	2.9	2.9	29.4
	Computer Science	8	23.5	23.5	52.9
	Electrical Power Engineering	5	14.7	14.7	67.6
	Microelectronics	5	14.7	14.7	82.4
	Media Knowledge Engineering	6	17.6	17.6	100.0
	Total	34	100.0	100.0	

4. Sex

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	8	23.5	23.5	23.5
	Male	26	76.5	76.5	100.0
	Total	34	100.0	100.0	

5. How often do you visit the website?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Everyday	6	17.6	17.6	17.6
	Monthly	6	17.6	17.6	35.3
	Occasionally	11	32.4	32.4	67.6
	Weekly	11	32.4	32.4	100.0
	Total	34	100.0	100.0	

Appendix E - Reliability Statistics

This appendix contains the results of the reliability analysis of the items in the questionnaire. It mainly shows the Cronbach's alpha values of the questionnaire, each item and the correlation between an item and the rest of the items in the questionnaire.

Table 22: Total Cronbach's alpha

Cronbach's Alpha	N of Items
.893	34

The item-total correlation and the Cronbach's alpha result of each items in the questionnaire is presented in the table below.

Table 23: Item-Total Statistics

Questions (Items)	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
1.The information provided in the website is clear (not ambiguous)	109.00	250.400	.461	.890
2. I think the website provides important information to students	108.90	246.557	.527	.889
3. It is obvious to find creation and update time of contents in the website	109.32	250.759	.379	.891
4. It is easy to find information about upcoming events in the university	109.19	241.628	.552	.888
5. The website offers current & up to date information	109.26	250.731	.383	.891
6. Author names of pages are available	109.29	257.946	.192	.894
7. Links to outside references used in the website are given	109.06	252.129	.405	.891
8. The name of the university, logo and copyright information are available	108.35	261.970	.079	.895
9. Clicking on a link takes to a valid page	108.58	255.652	.256	.893
10. Whenever some error occurs, the website recovers quickly	109.06	245.129	.512	.889
11. I can access the website at any time	107.87	254.583	.484	.890
12. It is possible to find what I want with in a reasonable time	109.74	239.198	.602	.887
13. It is possible to switch between pages with in reasonable time	108.90	240.557	.656	.886
14. The website does not use plug-ins or proprietary software	108.32	267.826	-.133	.899

15. I can access the website from my favourite browser	107.90	253.824	.523	.890
16. I think the overall structure of the website is straightforward	109.84	247.340	.522	.889
17. Terminologies used in the website are understandable	108.84	250.540	.473	.890
18. I think it is easy to learn how to use the website	109.39	238.578	.612	.886
19. It is easy to find information I need on the website	109.87	237.516	.771	.884
20. Organization of information in the website is easy to understand	109.97	238.899	.753	.884
21. I know who I can contact for more information about any thing in the website	109.81	251.161	.345	.892
22. It is easy to switch between languages in the site	108.87	264.449	-.028	.899
23. Necessary supplemental reference materials (e.g. FAQ, contact information) are available in more than one language	108.97	257.299	.259	.893
24. I found the interface of the website pleasant	109.10	240.424	.695	.885
25. Pages are overcrowded with information	109.42	265.318	-.054	.900
26. Similar fonts and colors are used throughout the website	108.39	257.112	.352	.892
27. I think the alignment of text and page elements is consistent throughout the website	108.71	252.880	.397	.891
28. It is easy to go to the home page from any other page in the site	108.35	257.237	.188	.895
29. While navigating, I can immediately tell where I am in the website	109.48	244.791	.507	.889
30. I am able to move from one page to another page without getting lost	109.52	241.791	.604	.887
31. I can easily navigate backwards through previously visited pages	108.90	248.090	.478	.889
32. I am satisfied with the functionalities of the website	109.48	238.258	.785	.884
33. Search hints are provided when wrong keywords are used	109.58	255.718	.254	.893
34. The website provides varied search options (e.g. by faculty, employees, courses, programs, etc)	109.52	247.525	.538	.889

Appendix F – Descriptive statistics of the 34 items in the questionnaire

This appendix shows the descriptive statistics of the items in the questionnaire. The mean, standard deviation and variance of each item is presented in the table below.

Table 24: Descriptive statistics of items in the questionnaire

Items (Questions)	N	Mean	Std. Deviation	Variance
1.The information provided in the website is clear (not ambiguous)	34	3.44	.894	.799
2. I think the website provides important information to students	34	3.56	1.021	1.042
3. It is obvious to find creation and update time of contents in the website	34	3.09	1.083	1.174
4. It is easy to find information about upcoming events in the university	34	3.26	1.214	1.473
5. The website offers current & up to date information	33	3.18	1.044	1.091
6. Author names of pages are available	34	3.12	.913	.834
7. Links to outside references used in the website are given	34	3.35	.884	.781
8. The name of the university, logo and copyright information are available	34	4.00	.778	.606
9. Clicking on a link takes to a valid page	33	3.85	.972	.945
10. Whenever some error occurs, the website recovers quickly	33	3.36	1.141	1.301
11. I can access the website at any time	32	4.53	.621	.386
12. It is possible to find what I want with in a reasonable time	34	2.65	1.252	1.569
13. It is possible to switch between pages with in reasonable time	34	3.44	1.106	1.224
14. The website does not use plug-ins or proprietary software	34	4.00	.985	.970
15. I can access the website from my favorite browser	34	4.50	.615	.379
16. I think the overall structure of the website is straightforward	34	2.56	1.021	1.042
17. Terminologies used in the website are understandable	34	3.62	.888	.789
18. I think it is easy to learn how to use the website	34	3.12	1.297	1.683
19. It is easy to find information I need on the website	34	2.53	1.051	1.105
20. Organization of information in the website is easy to understand	34	2.47	1.107	1.226
21. I know who I can contact for more information about any thing in the website	34	2.59	1.131	1.280

22. It is easy to switch between languages in the site	34	3.56	1.078	1.163
23. Necessary supplemental reference materials (e.g. FAQ, contact information) are available in more than one language	34	3.44	.786	.618
24. I found the interface of the website pleasant	34	3.26	1.109	1.231
25. Pages are overcrowded with information	34	2.82	1.218	1.483
26. Similar fonts and colors are used throughout the website	34	4.00	.651	.424
27. I think the alignment of text and page elements is consistent throughout the website	34	3.74	.864	.746
28. It is easy to go to the home page from any other page in the site	34	4.03	1.029	1.060
29. While navigating, I can immediately tell where I am in the website	34	2.85	1.184	1.402
30. I am able to move from one page to another page without getting lost	34	2.82	1.167	1.362
31. I can easily navigate backwards through previously visited pages	33	3.52	1.004	1.008
32. I am satisfied with the functionalities of the website	34	2.91	1.026	1.053
33. Search hints are provided when wrong keywords are used	34	2.79	.946	.896
34. The website provides varied search options (e.g. by faculty, employees, courses, programs, etc)	34	2.88	.946	.895

Appendix G- Steps in WEBUSE usability Analysis

This appendix contains the steps used to make use of the WEBUSE usability analysis method. The method is adopted to analyse the quality level of the case study website. The steps used to make use of the method in this project are similar to the figure depicted below.

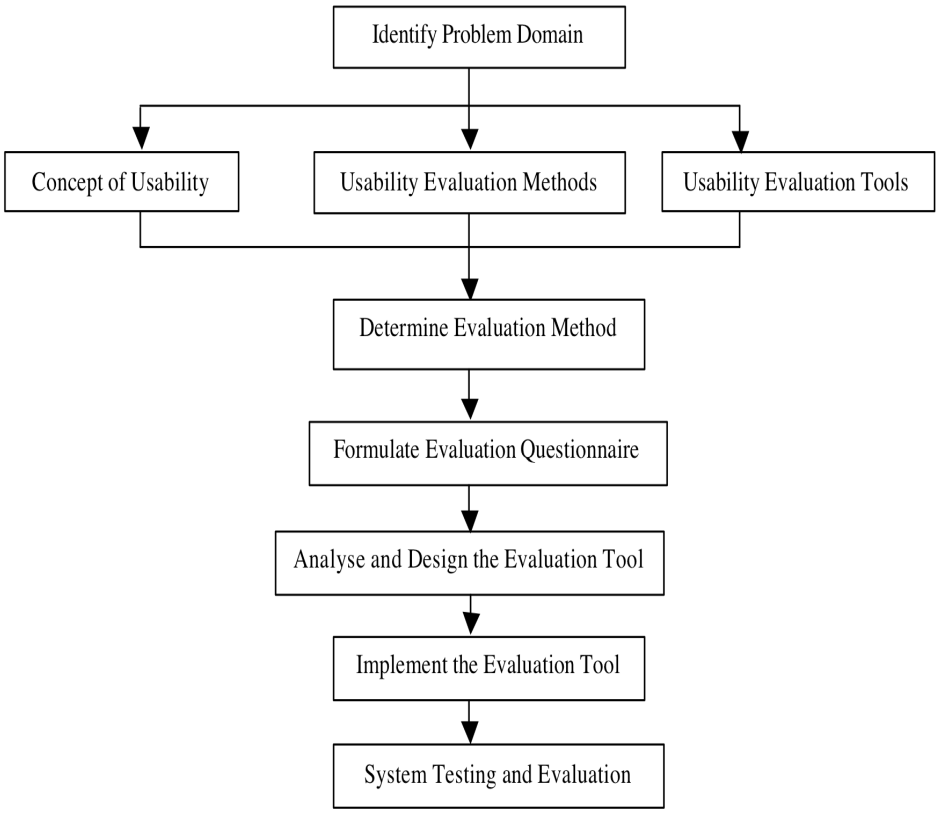


Figure 16: Steps in using WEBUSE

Appendix H- Screenshots of pages of TU-Delft website

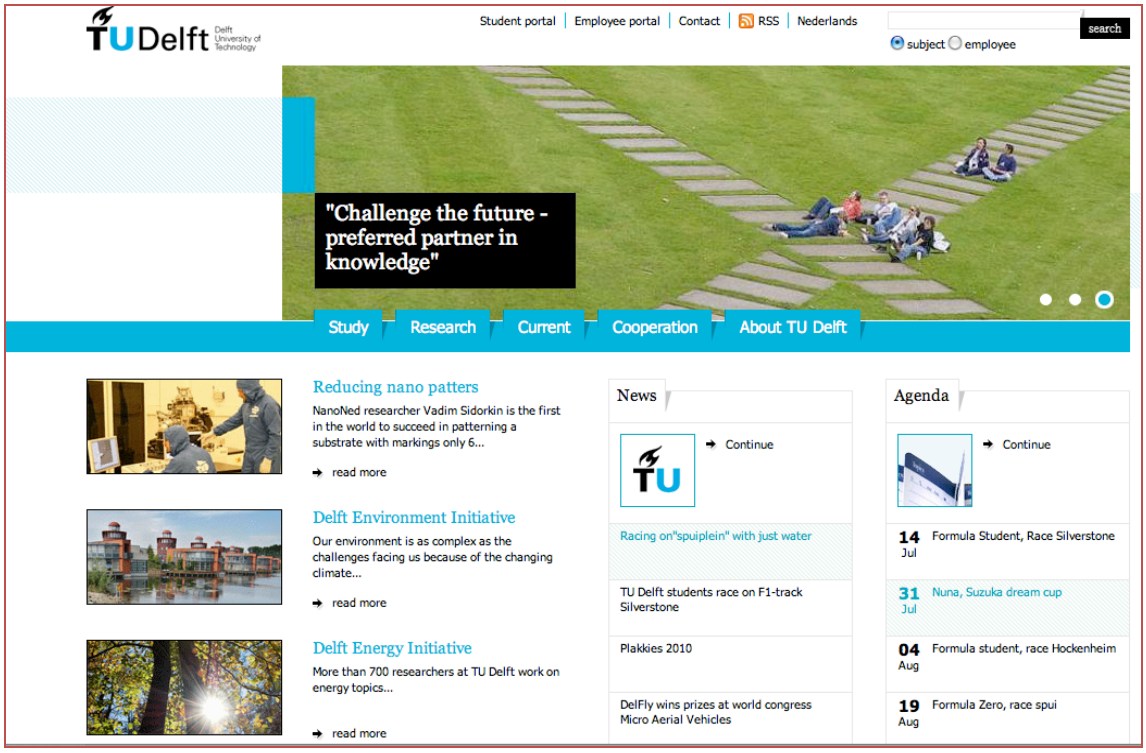


Figure 17: TU-Delft Website Home page

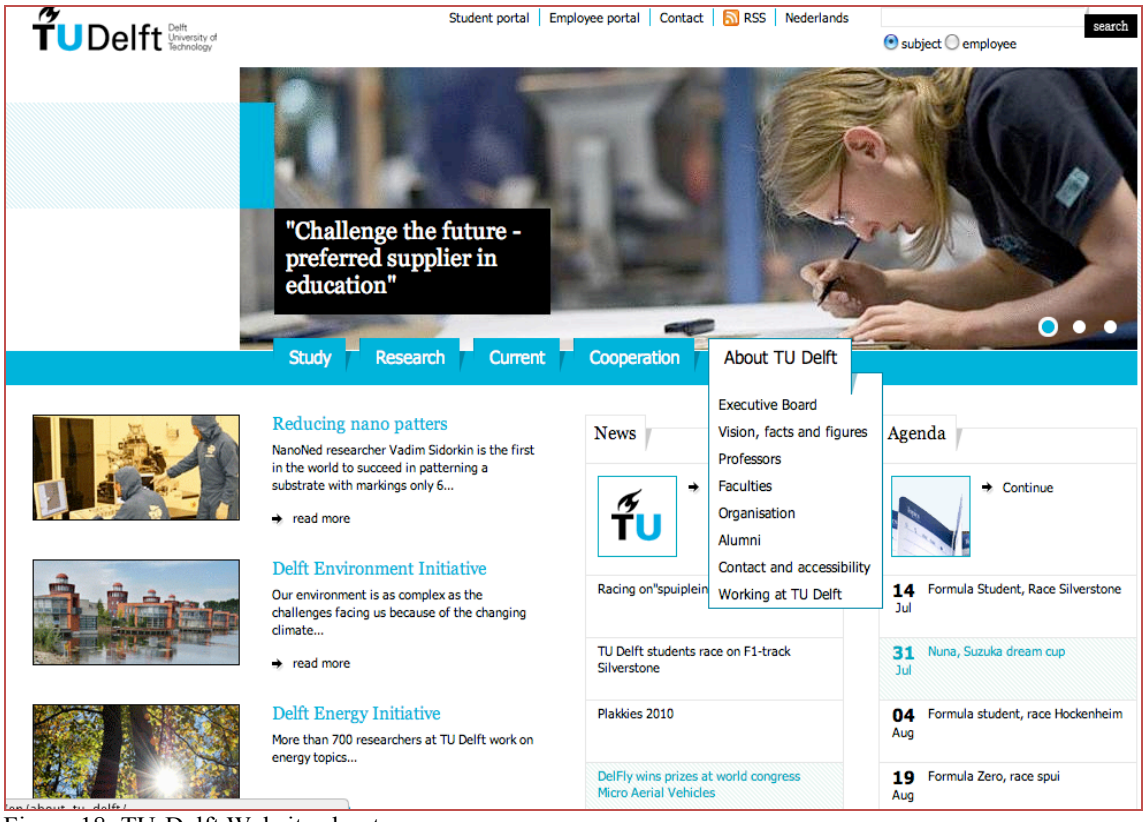


Figure 18: TU-Delft Website about page

Appendix I- Relations between components of web Accessibility

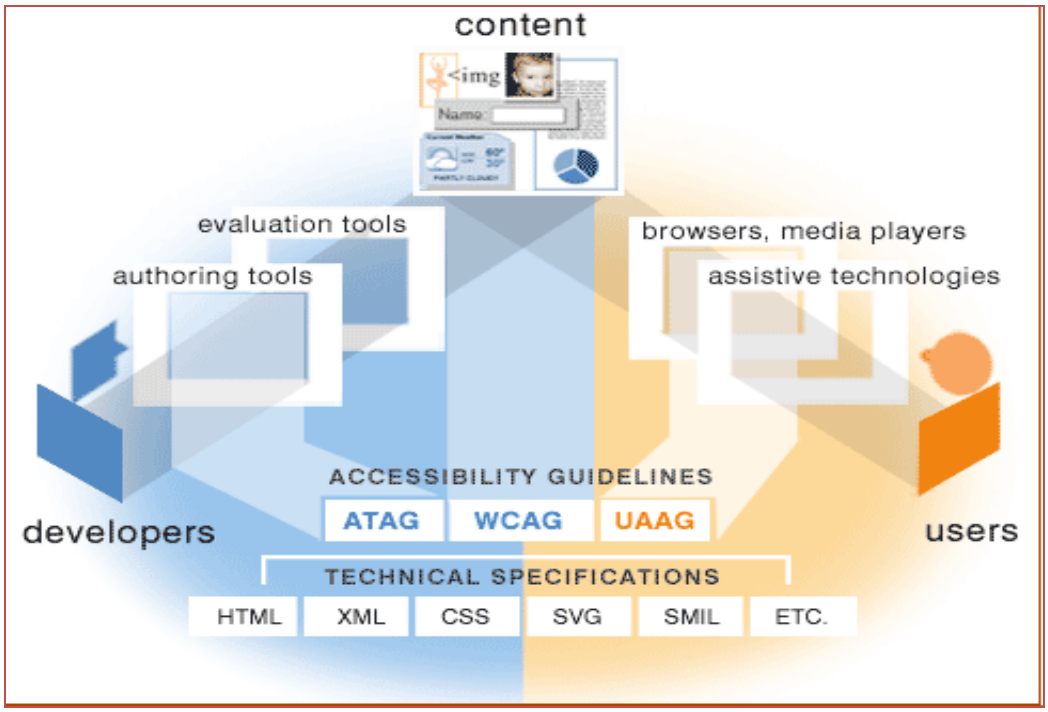


Figure 19: components of web accessibility and its components

Appendix J- 20 quality success factors for websites

This appendix contains 20 success factors for websites grouped in to four categories [51], [52].

Quality:

- Accessibility of the website (including accessibility to the poor, uneducated and disabled)
- Reliability of the services provided
- Reliability of the information provided
- Ease of use of the information provided
- Security of data
- Quality of content (completeness, relevance and accuracy)

Appeal:

- Appropriateness of the format of the information
- Appropriateness of the level of detail of the information
- Confidentiality of data
- Visual appeal of the website
- User friendliness of the website
- Attractiveness of website's appearance

Efficiency:

- Ease of navigation of the website
- Ease of use of the website
- Enjoy ability in use of the website
- Timeliness of information Service and functionality of the website

Identification:

- Sense of personalization created by the website
- Sense of community created by the website Reputation of the website

Appendix K- Website design guidelines

Some of the website design guidelines that were used to design the evaluation framework in combination with the base model are listed in this section. The website design guidelines were collected from different literature studied. These guidelines are part of the high-level quality factors and sub quality factors hierarchically arranged and organized in the proposed academic website's quality evaluation framework [9],[13],[30],[39].

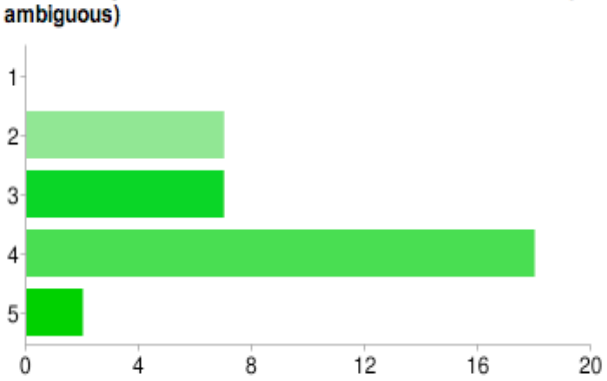
- Users should be able to access the website from different web browsers and operating systems.
- The information on the website should be up-to-date. Outdated pages should be replaced or archived.
- Users should be allowed to use the back button. Pressing back button to go back to previous pages accounts for 30-37% of navigational tasks.
- Navigation should be easy to learn and consistent throughout the website
- The website should offer search functionality to assist users easily find information in the website. This is particularly necessary if the website is large.
- The interface of the website should be visually appealing and the fonts used should be readable and visible. The typeface and font size should be similar across the website.
- The website should provide help and support facility (FAQ, email communications or forums) to assist users to learn how to effectively use the website. This will help users who need special assistance to use the website.
- Using clear and intuitive labels that are based on user's perspectives and terminology
- The use of sitemaps and menu should be consistent throughout the website to help users recognize them easily and follow the link.
- There should not be a restriction to use one type of operating system, browser and device. Users should be able to access the website from any type of device, operating system and browser.
- Web pages should not be overcrowded with information.

Appendix L- Results of responses

This appendix contains the results of responses to the Likert type questions used to evaluate the TU-Delft website. The responses reflect the perception of students on the quality of the website.

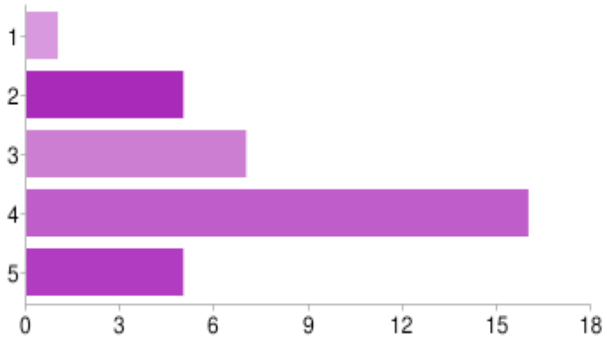
From question 1- 3, please provide your opinion on the quality of information the website provides

1. Accuracy & relevance of information - The information provided in the website is clear(not ambiguous)



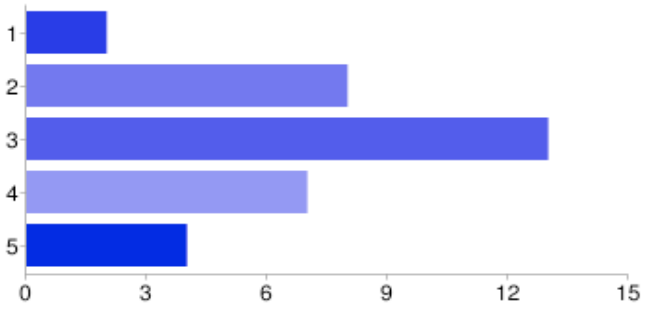
1	**0**	0%
2	**7**	21%
3	**7**	21%
4	**18**	53%
5	**2**	6%

1. Accuracy & relevance of information - I think the website provides important information to students



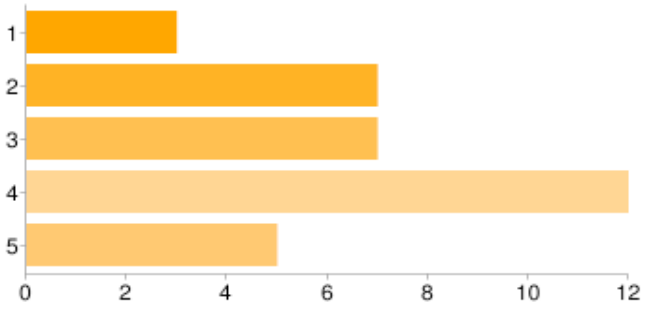
1	**1**	3%
2	**5**	15%
3	**7**	21%
4	**16**	47%
5	**5**	15%

2. Currency (uptodate) information - It is obvious to find creation and update time of contents in the website



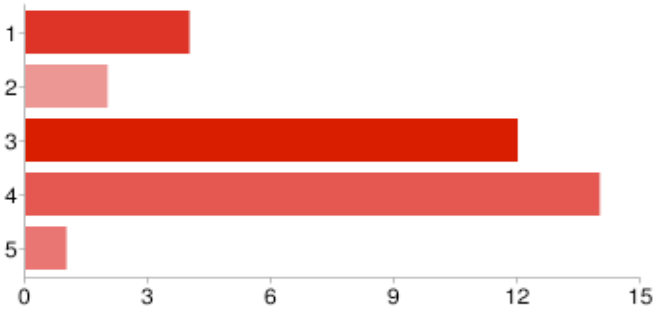
1	**2**	6%
2	**8**	24%
3	**13**	38%
4	**7**	21%
5	**4**	12%

2. Currency (uptodate) information - It is easy to find information about upcoming events in the university



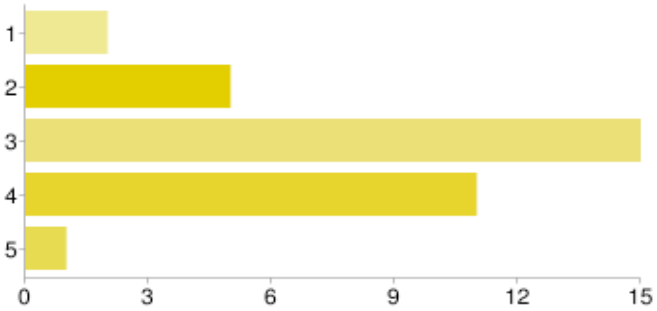
1	**3**	9%
2	**7**	21%
3	**7**	21%
4	**12**	35%
5	**5**	15%

2. Currency (uptodate) information - The website offers current & up to date information



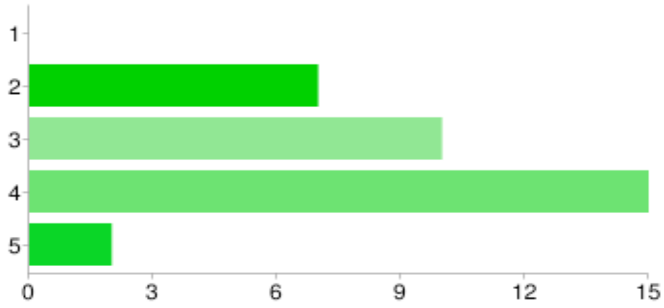
1	**4**	12%
2	**2**	6%
3	**12**	35%
4	**14**	41%
5	**1**	3%

3. Authority of content & Identity of univeristy - Author names of pages are available



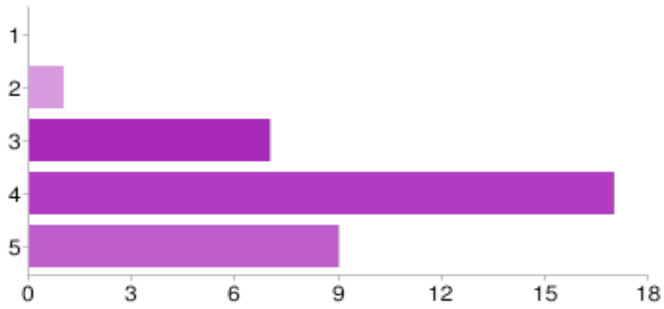
1	**2**	6%
2	**5**	15%
3	**15**	44%
4	**11**	32%
5	**1**	3%

3. Authority of content & Identity of univeristy - Links to outside references used in the website are given



1	**0**	0%
2	**7**	21%
3	**10**	29%
4	**15**	44%
5	**2**	6%

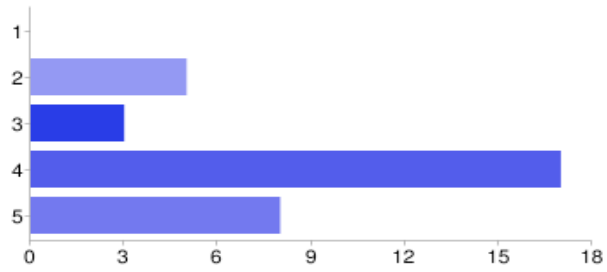
3. Authority of content & Identity of univeristy - The name of the university, logo and copyright information are available



1	**0**	0%
2	**1**	3%
3	**7**	21%
4	**17**	50%
5	**9**	26%

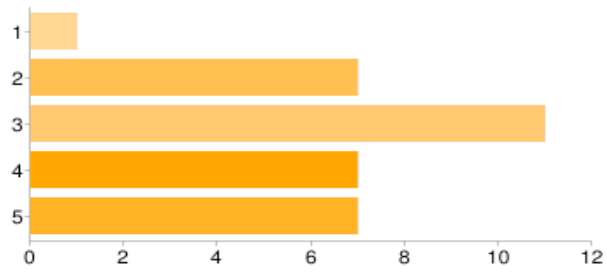
From question 4 - 5, provide your opinion on the efficiency and reliability of the website

4. Reliability - Clicking on a link takes to a valid page



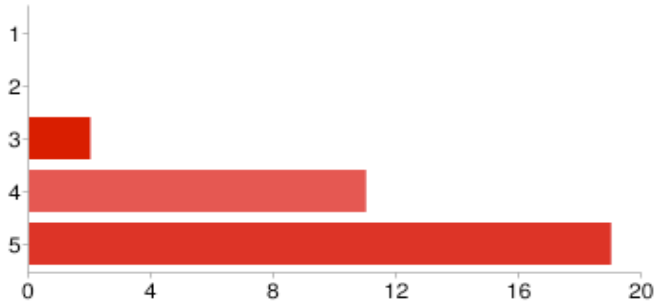
1	**0**	0%
2	**5**	15%
3	**3**	9%
4	**17**	50%
5	**8**	24%

4. Reliability - Whenever some error occurs, the website recovers quickly



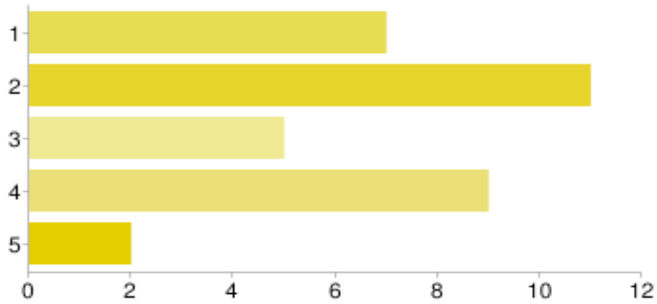
1	**1**	3%
2	**7**	21%
3	**11**	32%
4	**7**	21%
5	**7**	21%

4. Reliability - I can access the website at any time



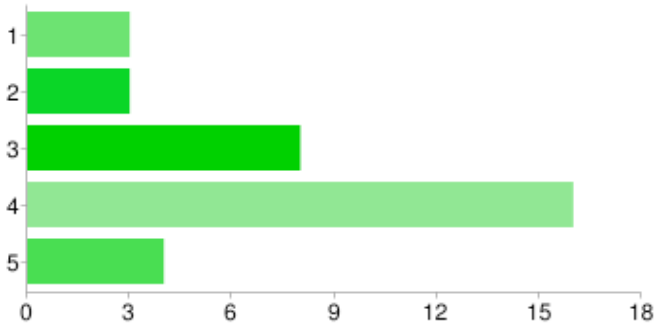
1	**0**	0%
2	**0**	0%
3	**2**	6%
4	**11**	32%
5	**19**	56%

5. Efficiency - It is possible to find what I want with in a reasonable time



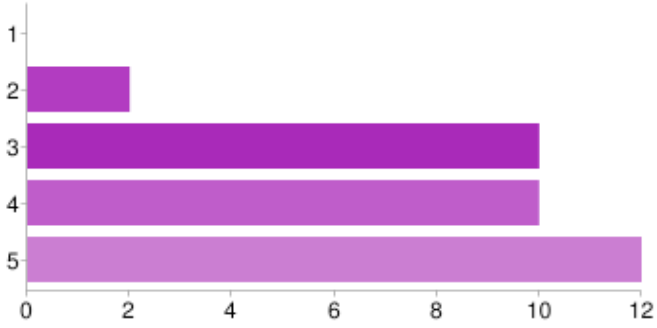
1	**7**	21%
2	**11**	32%
3	**5**	15%
4	**9**	26%
5	**2**	6%

5. Efficiency - It is possible to switch between pages with in reasonable time



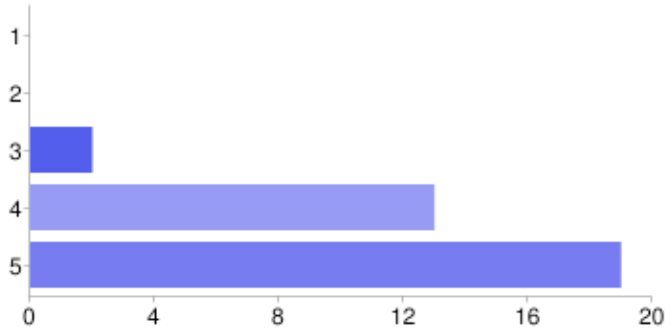
1	**3**	9%
2	**3**	9%
3	**8**	24%
4	**16**	47%
5	**4**	12%

5. Efficiency - The website does not use plug-ins or proprietary software



1	**0**	0%
2	**2**	6%
3	**10**	29%
4	**10**	29%
5	**12**	35%

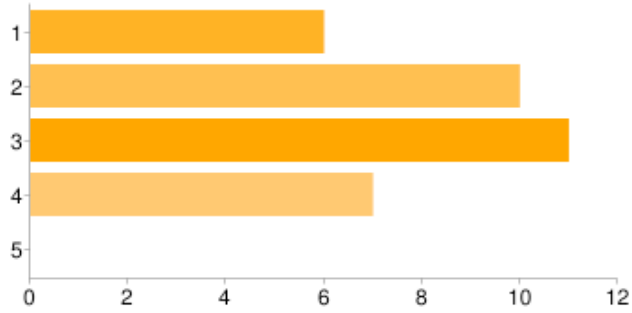
5. Efficiency - I can access the website from my favorite browser



1	**0**	0%
2	**0**	0%
3	**2**	6%
4	**13**	38%
5	**19**	56%

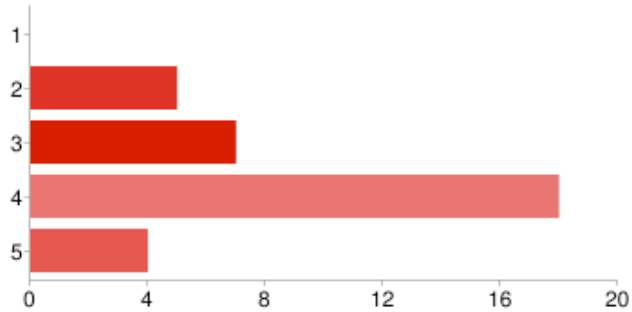
From question 6-8, provide your opinion on the usability of the website

6. Understandability, Learn ability & Operability - I think the overall structure of the website is straightforward



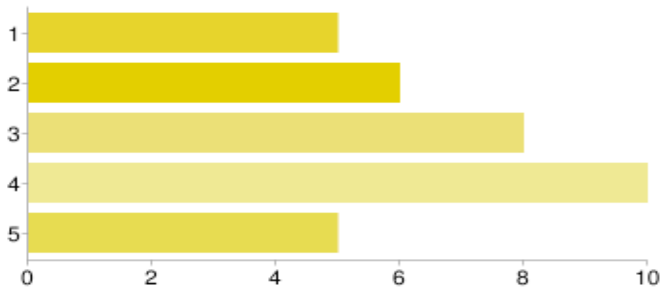
1	**6**	18%
2	**10**	29%
3	**11**	32%
4	**7**	21%
5	**0**	0%

6. Understandability, Learn ability & Operability - Terminologies used in the website are understandable



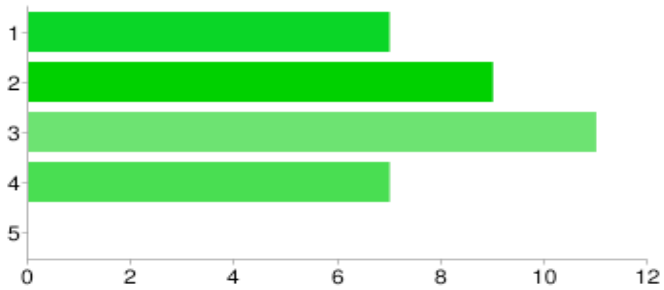
1	**0**	0%
2	**5**	15%
3	**7**	21%
4	**18**	53%
5	**4**	12%

6. Understandability, Learn ability & Operability - I think it is easy to learn how to use the website



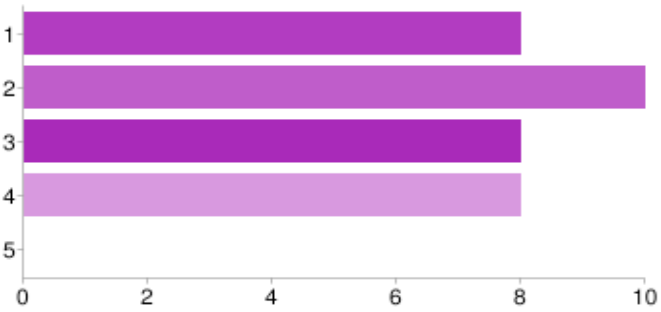
1	**5**	15%
2	**6**	18%
3	**8**	24%
4	**10**	29%
5	**5**	15%

6. Understandability, Learn ability & Operability - It is easy to find information I need on the website



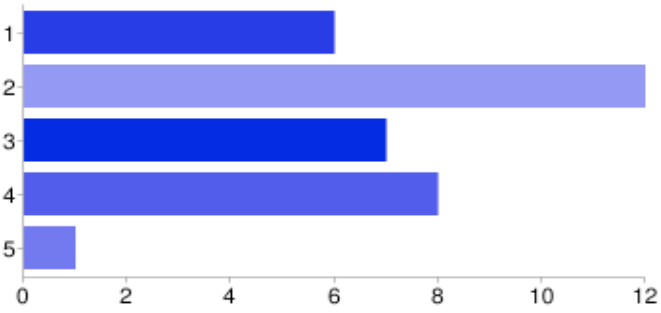
1	**7**	21%
2	**9**	26%
3	**11**	32%
4	**7**	21%
5	**0**	0%

6. Understandability, Learn ability & Operability - Organization of information in the website is easy to understand



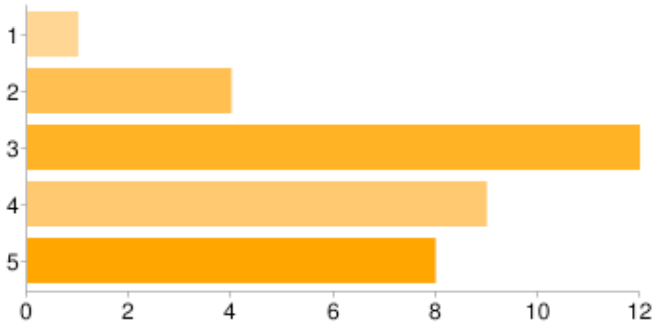
1	**8**	24%
2	**10**	29%
3	**8**	24%
4	**8**	24%
5	**0**	0%

7. Interactivity & foreign language support - I know who I can contact for more information about any thing in the website



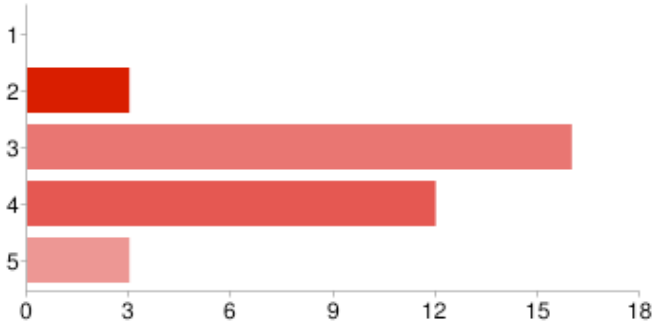
1	**6**	18%
2	**12**	35%
3	**7**	21%
4	**8**	24%
5	**1**	3%

7. Interactivity & foreign language support - It is easy to switch between languages in the site



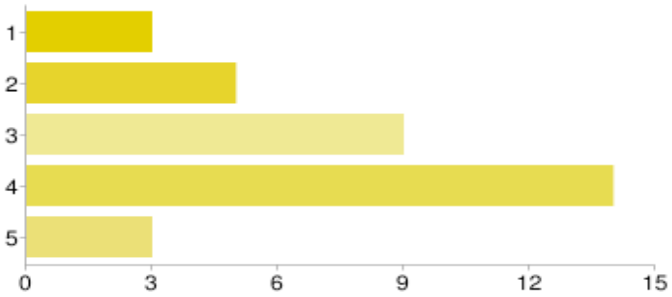
1	**1**	3%
2	**4**	12%
3	**12**	35%
4	**9**	26%
5	**8**	24%

7. Interactivity & foreign language support - Necessary supplemental reference materials (e.g. FAQ, contact information) are available in more than one language



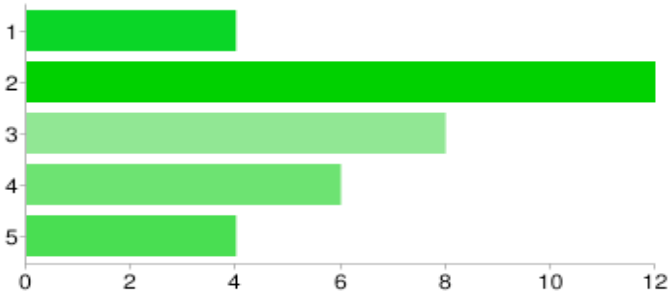
1	**0**	0%
2	**3**	9%
3	**16**	47%
4	**12**	35%
5	**3**	9%

8. Interface attractiveness - I found the interface of the website pleasant



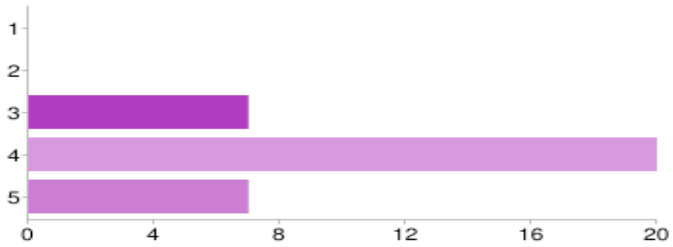
1	**3**	9%
2	**5**	15%
3	**9**	26%
4	**14**	41%
5	**3**	9%

8. Interface attractiveness - Pages are overcrowded with information



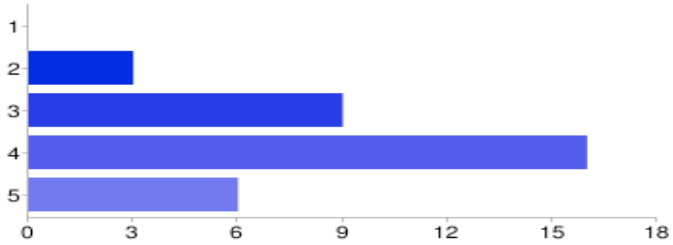
1	**4**	12%
2	**12**	35%
3	**8**	24%
4	**6**	18%
5	**4**	12%

8. Interface attractiveness - Similar fonts and colors are used throughout the website



1	**0**	0%
2	**0**	0%
3	**7**	21%
4	**20**	59%
5	**7**	21%

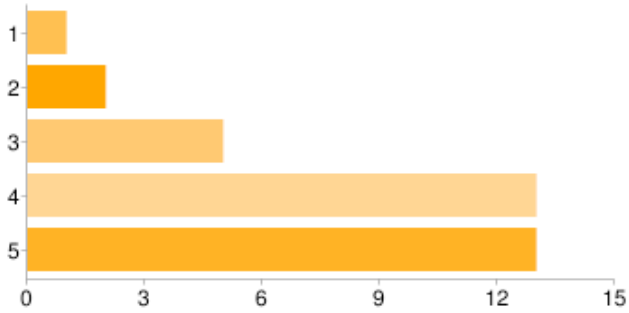
8. Interface attractiveness - I think the alignment of text and page elements is consistent throughout the website



1	**0**	0%
2	**3**	9%
3	**9**	26%
4	**16**	47%
5	**6**	18%

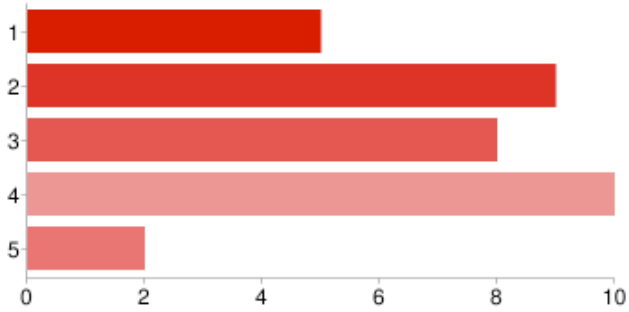
From questions 9 - 10 , please provide your opinion on the functionality of the website

9. Navigation - It is easy to go to the home page from any other page in the site



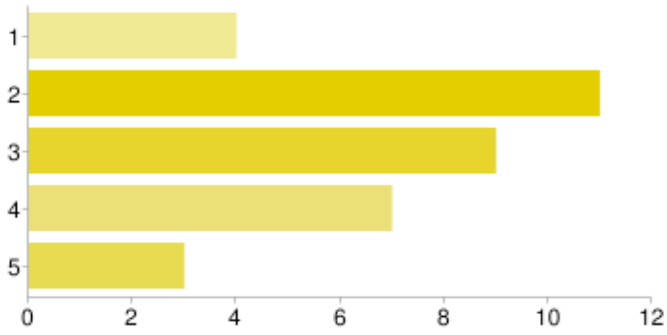
1	**1**	3%
2	**2**	6%
3	**5**	15%
4	**13**	38%
5	**13**	38%

9. Navigation - While navigating, I can immediately tell where I am in the website



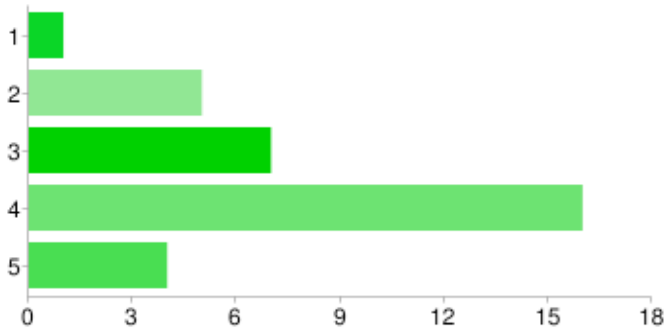
1	**5**	15%
2	**9**	26%
3	**8**	24%
4	**10**	29%
5	**2**	6%

9. Navigation - I am able to move from one page to another page without getting lost



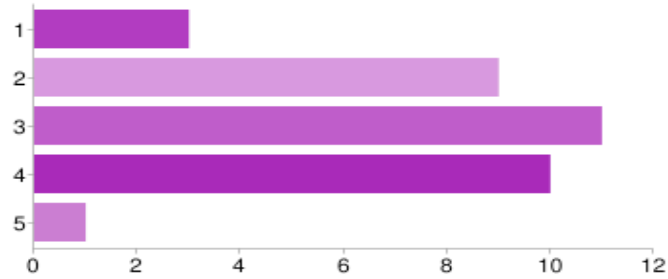
1	**4**	12%
2	**11**	32%
3	**9**	26%
4	**7**	21%
5	**3**	9%

9. Navigation - I can easily navigate backwards through previously visited pages



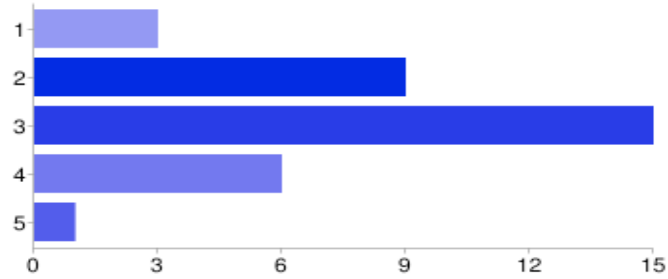
1	**1**	3%
2	**5**	15%
3	**7**	21%
4	**16**	47%
5	**4**	12%

10. Search & suitability - I am satisfied with the functionalities of the website



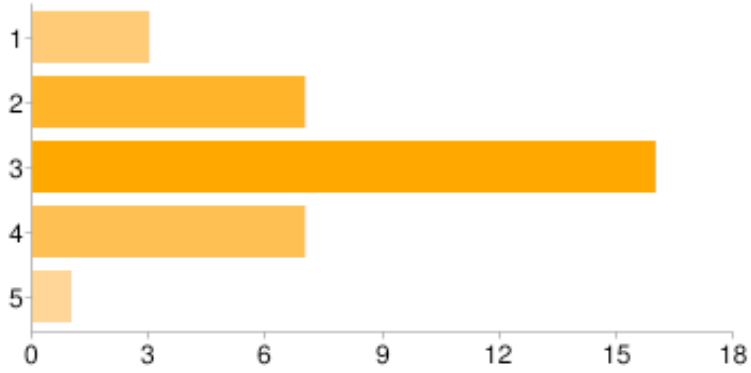
1	**3**	9%
2	**9**	26%
3	**11**	32%
4	**10**	29%
5	**1**	3%

10. Search & suitability - Search hints are provided when wrong keywords are used



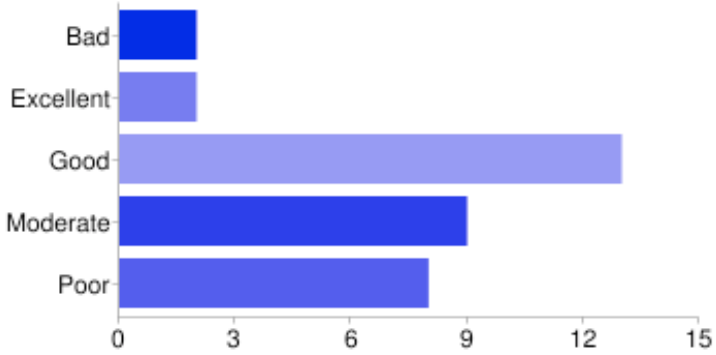
1	**3**	9%
2	**9**	26%
3	**15**	44%
4	**6**	18%
5	**1**	3%

10. Search & suitability - The website provides varied search options (e.g. by faculty, employees, courses, programs, etc)



1	**3**	9%
2	**7**	21%
3	**16**	47%
4	**7**	21%
5	**1**	3%

11. What overall rating would you give to the quality of the TU-Delft website?



Bad	**2**	6%
Excellent	**2**	6%
Good	**13**	38%
Moderate	**9**	26%
Poor	**8**	24%