

# Quality Evaluation Framework for Ethiopian Healthcare Websites

LAMI GAROMA ABAYA



A Thesis Submitted to  
Department of Computing  
School of Computing and Electrical Engineering

Presented in Partial Fulfillment of the Requirement for the Degree of Master of  
Science in Software Engineering

Office of Graduate Studies  
Adama Science and Technology University

Adama  
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## *Declaration*

I hereby declare that this MSc Thesis is my original work and has not been presented for a degree in any other university, and all sources of material used for this thesis have been duly acknowledged.

Name: \_\_\_\_\_

Signature: \_\_\_\_\_

This MSc Thesis has been submitted for examination with my approval as thesis advisor.

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Date of submission: \_\_\_\_\_

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## **List of Acronyms and Abbreviations**

2QCV3Q	Quis (Identity), Quid (Content), Cur (Services), Ubi(Individuation), (Feasibility).
ASTU	Adama Science and Technology University
E-commerce	Electronic Commerce
FAQ	Frequently Asked Question
FURPS	Functionality, Usability, Reliability, Performance and Supportability
ICT	Information and Communication Technology
IEC	International Electro-technical Commission
ISO	International Organizations for Standardization
IT	Information Technology
KGH	Kadisco General Hospital
LSP	Logic Scoring Preferences
MiLE	Milano Lugano Evaluation Method
MINERVA	Ministerial Network for Valorising Activities in Digitization
Q1 through Q53	Question 1 through Question 53
RQ	Research Question
SPHMMC	Saint Paulo's Hospital Millennium Medical College
W3C	World Wide Web Consortium
WAI	Web Application Interface
WDC	Wudassie Diagnostic Center
Web-QEM	Website Quality Evaluation Method
WEBUSE	Website Usability Evaluation

## *Abstract*

Website becomes an important tool for organizations to put their product online. Similarly, in healthcare organizations it allows to serve their patients online as well as to deliver information. In Ethiopia, healthcare providers have websites even though the usages of the website by end users are not become familiar due to their perception on quality of the existing website. The main objective of this study was to develop a website quality evaluation framework for Ethiopian healthcare organizations which is used as guidelines for developers of healthcare website in Ethiopia.

In order to develop the framework an extensive literature study was done on quality models, design guidelines, accessibility guidelines to identify characteristics, sub-characteristics and quality indicators. The proposed framework contains six characteristics (functional suitability, operability, reliability, content, service and performance efficiency) arranged hierarchically along with sub-characteristics and indicators.

The proposed framework was tested on three Ethiopian healthcare providers' website as case study using questionnaire prepared from the quality indicators identified in the proposed framework and proved as it is effective to measure Ethiopian healthcare website from patients' end users than the ISO/IEC 25010 quality evaluation model. Even though, the framework was proved as it is effective than other evaluation models the result of case study showed that further study required on easy of changing language, search and newsgroup quality indicators.

The result of case study showed that, the overall qualities of available Ethiopian healthcare provider's website are below moderate quality level.

**Keywords:** *Ethiopian Healthcare Website Evaluation, Health Website Quality Evaluation, Proposed Quality evaluation Framework, Proposed Framework*

## CHAPTER 1: INTRODUCTION

In this chapter the area of the study, inspiration to bring solution for the problem, the problem description, questions addressed by the study, application and significance of the solution, scope and limitation of the study, method used to bring the solution as well as evaluate the solution where discussed in next sections. Finally, the organizations of the entire document given in the last section of this chapter in a summarized format

### 1.1. Background of the study

Website has been used in different countries internationally which makes peoples can be access whatever they want at their home just by having computers and internet connections and the owner of the website to put their product or services online [1] [2] [3]. Website used to put the organization services and information online to be accessed by their customer/ User who gets benefit from the organization or owner of the website [2] [4].

There are many domains where websites are widely used as a literature showed. Those domains are like education, government, museum, business, entertainment and health [5] [2]. Therefore, instead of keeping silent in the world where website is used as a virtual world to represent each and every organization virtually is without doubt it is madness.

The previous study proved that the reliance of people increases from day to day on the website to online search information, shopping, communicating with people and performing different tasks [3] [4]. To increase the confidence of the users each owner of the website should provide what users are expected from the website and which in turn increase the usability of the website.

Healthcare related websites are owned by the healthcare providers [6]. The healthcare websites and its importance was proved by the researchers in the area and the healthcare websites quality addressed by different researchers are focused on the content, services as well as technical even though the technical part was not described well [7]. The aims of healthcare providers are to serve their patients using their website as an alternative service delivery ways. Obviously, websites are developed based on the organization (owners) requirements. But, in gathering the requirements the needs of end user or customer is difficult to address because of the requirements are not gathered directly from them. The quality of website can be addressed in different ways [8] [5] [9]. Those are developing the website based on international standards, accessibility guidelines, estimating what customer needs and evaluating the website with different target groups like end user, expert and managers [9] [10] [11].

Evaluation of website used for identifying which part of the website need improvement of quality and which part does not need. In this area many thing where done to cope up the quality of the website by the researchers.

Software quality evaluation models, quality evaluation standards, website quality evaluation models, human computer interaction techniques, general website quality evaluation frameworks or domain specific website quality evaluation frameworks was developed and made an improvement on the website quality. The concept of all previous work was similar which all of them are working on improvement of characteristics, sub-characteristics and quality metrics (quality indicators) [12] [13] [9].

Website evaluation framework used to evaluate the website quality by identifying the requirements of the different perspectives of users those interact with the website while it is in operational stage [2] [4]. Therefore, the central aim of the researchers who want to researched on the website quality evaluation framework are to consider all available literatures in the area and select relevant characteristics, sub-characteristics and quality indicators expected from the website which in turn used to evaluate the quality of the website.

Taking in to account the above discussed concepts and to have a high quality website in Ethiopian healthcare websites are the problem solved in this study entitled on quality evaluation framework for Ethiopian healthcare website. The framework identified and included relevant characteristics, sub-characteristics and quality indicators used to evaluate the quality of Ethiopian healthcare website based the expectation of end user or patients. In addition to solving the problem of the website quality the research also addressed quality evaluation characteristics, sub-characteristics and criteria those are highly relevant to the healthcare website than other website domains.

## **1.2.Motivation**

Country like United Kingdom, Germany, France, Italy and Spain are categorized in the world best users of website to deliver online to their customers in the area of healthcare [7]. “In the entire world the existence of more than 200,000 Web Sites entirely dedicated to health and that 60% of Internet users accessed it for health related issues” [7]. Accessing of health information over the internet are increased researchers was showed.

As discussed in the section 1.1 under chapter 1 of this report, the aims of the using website by healthcare providers are to deliver their services to patients as an alternative way to decrease the crowdedness at the healthcare providers. Using of ICT for healthcare deliveries are the newly revealed strategy of Ethiopian ministry of health and Ethiopian federal republic government in order to deliver the health related information for Ethiopian nation and nationalities without distance barrier by using Ethiopian telecommunication corporation facilities [14].

Using websites by healthcare industry are very familiar in other countries and ii is in infant stage in our country, Ethiopia. As different researchers showed, the first things to use the website are impression of end users’ have on the quality of the website. Users in their perception, if they find the website seems not good they leaves and go to search another website that represent their perception even by browsing the first page(home page) of the website [2].

To bring the tradition of using healthcare providers' website for getting services, to our country Ethiopia this study inspired to work on the quality components of the Ethiopian healthcare website. The result of the study used to improve the available Ethiopian healthcare website quality as well as a guideline to develop a high quality website for healthcare websites.

### **1.3. Statement of the problem**

Evaluation of software quality as well as website quality helps to improve the quality of the product to its high level quality level. Specifically, website quality evaluation starts from clearly following existing standards, models, guidelines and participation of customer who the website are intended or used by them. As stated in ISO 2504n quality evaluation division the evaluation of software product needs clearly specifying the requirements for evaluation. "ISO/IEC 25040 - Evaluation reference model and guide: Contains general requirements for specification and evaluation of software quality. Provides a framework for evaluating quality of software product and states the requirements for methods of software product measurement and evaluation".

Therefore, to evaluate the level of given website quality it starts from clearly identifying which quality factors should be considered and which viewpoint of users are taken in to account. Website evaluation requires set of quality factor that describes what is expected from the website's characteristics.

The problems are in the area where requirement gathering for evaluating quality of a website become greatest factor, existing characteristics are either wider which difficult to apply or narrow which does not cover all the requirements expected from the website by the targeted viewpoints [15]. Requirement gathered are in the concepts of software quality standards called characteristics, subcharacteristics and quality indicators [9].

There are different website domains as discussed under section 1.1 of this report in the first chapter and in order to identify requirements for the website it needs the specific expectation of the domain of the website specifically in information and services. Thus, it's also necessary to take in to account the domain of the website, while requirement gathering [3] [1] [16].

To evaluate healthcare website, it requires clearly specifying the requirements users, developers and managers expectation from the website [12] [17] [7]. It becomes difficult to use directly the existing software and website quality models and existing frameworks directly for healthcare websites, because, of the requirements are not enough to evaluate healthcare websites.

The questions asked to randomly selected Ethiopians in order to identify problems in the area of Ethiopian healthcare website. The asked participants education level are undergraduate and above. The answers to the question are summarized as follows:

- They know uses of healthcare website
- They expected health related information and services from the healthcare websites

- More than half of them know healthcare website in Ethiopia and commented on the quality of information and services because of it was not as they expected.
- Their message was the existing website should be improved and government should work on the hosting of new websites that deliver healthcare services and information

Therefore, it is possible to identify that in our country Ethiopia as it can be possible to understand from the peoples saying and from our daily life using of website for the healthcare delivery purposes are not as much familiar to our community and even if they are inspired to use the quality of the website also under question.

Therefore, the study aimed to solve the gap of healthcare website quality in Ethiopia and the difficulty of applying existing website quality models, guidelines, standards and frameworks by proposing the new quality evaluation framework for Ethiopian healthcare website quality by identifying relevant characteristics, sub-characteristics and quality indicators for healthcare websites.

The interview question used for problem identification attached to this report at the end in the **APPENDIX A** section.

#### **1.4. Research questions**

In order to achieve the objectives of study different questions have been researched and solved. Those questions are listed hereunder:

**RQ1:** What mean by website quality and what are the characteristics of existing software and website quality models as well as which quality characteristics reflect the quality of healthcare websites?

**RQ2:** Is website design guidelines are important for evaluating quality of healthcare websites?

**RQ3:** Currently what practices exist in Ethiopia on website quality evaluation?

**RQ4:** How much websites in Ethiopia satisfying the information and service needs of its patients?

The answer of RQ1 used to provide understanding on the area of the study as well as used to identify the relevant characteristics for healthcare website quality evaluation as well as used to identify the gap of existing work, RQ2 used to access the usefulness of existing website design guidelines or healthcare website design guidelines, RQ3 used to address the existing practices in website quality in general as well as specific to healthcare website and finally, the answer of RQ4 used to test the solution provided to fill the gap and at the same time to know level of quality of those website selected for case study.

### **1.5. Objective of the Study**

The main objective of this study is to construct quality evaluation framework for Ethiopian healthcare websites. In order to achieve this main objective, some sub-objectives can be formulated. The specific objectives of the study are:

- To develop a quality evaluation framework for Ethiopian healthcare websites from patients or end users viewpoints
- To prepare evaluation tool for the proposed framework(Questionnaire)
- To apply the proposed evaluation framework to case study websites
- To Test the usefulness of the proposed quality evaluation framework
- To provide suggestions for improving the proposed framework

### **1.6. Significance and Application of the study**

The quality evaluation framework for Ethiopian healthcare websites applicability and significance can be seen in different perspectives as listed below.

- **Healthcare provider (owner of the website)**

The central ideas of the proposed framework were to harmonize the least quality of the all available website in Ethiopian healthcare providers. Healthcare providers include hospitals, clinics and other related organization. Since, trust of customers increase on a quality of the website as well as services delivered by the website, its usability also increase. And then the healthcare providers familiarity also increased when customers frequency of using website increase.

- **Patients or users able to use website**

The patients who able to use website, this means to get services from the website at least the users should have knowhow on how to use the technology through which he or she can access the website. Even though, making the website accessible by the wide range of users are the central idea of website accessibility guidelines it becomes difficult to make uneducated (who can't read and write) users to use the website. Because of this, the study focuses on the patients who able to use the website. Patients or users able to use the website means those users at least know terms related to website such as link, navigate, search, home page, webpage and etc. Therefore, the users are benefits from the website by finding the information they are looking for, using daily news on the hot issues related to the disease they become to their own first aid provider, they can contact any doctor or specialist in the healthcare providers using the website, they can read testimonials of the healthcare providers from the website, they can register as well as receive an appointment from the hospital using the website and so on.

- **Employees of the organization**

The website developed using the framework have the expected quality level of the healthcare website which satisfies its users. Employees of the healthcare provider can provide services to their patients and can follow the health condition of the patients treated in their hospitals. The testimonial of the patients on the website can be browsed different users and attract the customer to the healthcare providers. Therefore, employees in the healthcare providers become profitable and famous on the area, especially for those are healthcare professionals.

- **Ethiopian ministry of health**

The aims of Ethiopian ministry of health are every people in Ethiopia without any barrier to get health related facilities at the place nearest to them and providing another alternatives for delivering healthcare for people through mobiles, internets, websites etc.. The framework used to develop the high quality website for healthcare provider which in turn used to deliver health related information and services. Therefore, the aim of Ethiopian ministry of health addressed using the website, this show the advantage of the framework. Ministry of health certify the healthcare providers, therefore they can consider website as one criterion.

- **Website developers**

The proposed framework used as guidelines to develop a high quality website in the perspectives of patients. To develop the website for healthcare website it is not enough to develop the website just only by collecting the requirements of the organization as well as using the assumptions of the website developers, because of the consideration of who are going to use the website should be addressed. Therefore, to address the issue related to patients the proposed framework proved as valuable tools. So, website developer can use the framework as a guideline and develop the high quality website for the healthcare providers.

- **Researchers**

The researchers in the area, if they want to conduct study on the quality of healthcare website from other perspectives of users they can consider this framework as it is for the patients' perspectives. The researchers on the area also research and modify this proposed framework by combining different evaluation methods, models and techniques not applied in this study.

### **1.7. Scope and Limitation of the study**

Even though, evaluating overall quality of website should be from end users' and developers' perspectives, this research only addressed end users or patient's perspectives. The characteristics, sub-characteristics and metrics considered are only used to evaluate the website from end users perspectives.

The study addressed the quality evaluation for Ethiopian healthcare website by developing a theoretical evaluation framework that contains quality characteristics, sub-characteristics and quality indicators relevant to healthcare websites

However, the result provided by the study in the viewpoint of end users are based on the direct participation of end users which considered as satisfied solution as a literature in the areas, but the expert viewpoint and managers viewpoints was not considered for the study. The study accomplished in six months which needs to limit the scope and provide solution with in the set time.

Increasing number of the respondents has its advantage on getting accurate result even though they willing to participate in evaluation were another difficulty. Many respondents were refused to participate in the evaluation without telling their reason. To decrease the difficulty to reflect their needs from the website and to make the response accurate the respondent participates in the evaluation are limited to those at least know the term used in the website.

## **1.8. Methodology**

In order to successfully accomplish the intended solution for the identified problem in this study there are number of methods employed. Those methods are briefly discussed in the next section, but, the detail description and why the method selected for the study are discussed in the chapter 3 of this report.

### **1.8.1. Literature Review**

The extensive literature review conducted on the area of software quality, website quality, and healthcare websites as well as Ethiopian healthcare related website qualities. The literatures are used to identify which quality characteristics are relevant to website quality evaluation while users' viewpoints are considered for website quality evaluations. The detail descriptions of the literatures on the area are discussed in the chapter 2 of this report. The related work on this study deliberately discussed in the 4<sup>th</sup> chapter of this report, because of the components of the proposed framework are selected and included based on it, therefore reader of the report can easily understand the framework.

### **1.8.2. Data Collection**

It is obvious that, in general description any researchers' first starts from identifications of problem, propose solution and carried out the study using selected methods to provide proposed solution. During this process the researcher's uses different ways of collecting data from different places, persons and others. Similarly, to provide quality evaluation for Ethiopian healthcare website solution for the quality problem of Ethiopian healthcare website providers various data collection methods was used.

In order to identify the problem the interview was used, to identify available healthcare website Ethiopian website directory was searched as well as physically ministry of health and healthcare providers asked, phone call was made to healthcare providers to identify whether they have website or not, questionnaire was used to collect data to get perception of sample participants on the selected website as a case study. Online implemented questionnaire was used to collect perception of the patients on the case study website. Detail discussion of data collection method and why it selected for this study given in the chapter 3 of this document.

### **1.8.3. Evaluation and Testing**

The data collected from the patients are converted to the Excel and R software for the analysis. The data collected from the patients were used for dual purposes: first to evaluate the level of the quality of the websites selected for case study and second for testing the proposed quality evaluation framework for Ethiopian healthcare website. The detail of this section also discussed in the chapter 3 of this report.

## **1.9. Thesis Organization**

The overall content of this thesis study contains six chapters and each chapter organized to address following concepts.

**Chapter 1** gives the research background, motivation to do the research, problems solved by study, questions answered by the study, limitation of the study and significance of the research discussed.

**Chapter 2** introduces the detail literature description on the area of the study such as definition of quality, perspectives of quality, software quality, website quality and the evaluation models for software quality as well as website quality and finally comparison of existing models.

**Chapter 3** discusses the methods employed to solve the problem identified in this research and reason why the particular method and tool selected.

**Chapter 4** elaborates detail development of the proposed framework, existing quality evaluation related works, selecting of quality characteristics, sub-characteristics and indicators of the proposed framework.

**Chapter 5** presents the testing and validation of the proposed framework using the methodologies selected

**Chapter 6** provides conclusion and recommendation for future work of the thesis.

## CHAPTER 2: REVIEW OF LITERATURE

In this chapter, literatures in the area of software quality discussed as follows. In the beginning definition, viewpoints in the software quality evaluation are explained. Next to that, the existing software and website quality evaluation models are discussed. Finally, the summary of characteristics addressed in each software and website quality evaluation models are given in tabular format.

### **2.1.What is quality, software quality and website quality?**

Generally speaking quality means for anything it is the level of satisfaction on given product, service, information and system. Quality means the absence of deficiencies and high level fitness for use. Quality also defined as those products that meet need of customer who use the product and inspire the customer to use again [15]. According to [18] quality can be defined as the function of a product that changes the world for the better.

Software quality is defined as the degree to which software fulfills a required combination of attributes [19]. Based on stakeholders need quality requirements to build software architecture commonly divided in two main groups based on the quality they are requesting those are development and operational qualities. A development quality requirement is a requirement that is important for developers like maintainability, understandability and flexibility. Operational quality requirements are requirements that make the system better from the user's point of view, e.g. performance and usability. Depending on the domain and priorities of the users and developers, quality requirements can become both development and operational, such as performance in a real-time system [20].

In the context of software engineering, software quality defined as software functional quality and software structural quality. Software functional quality reflects how well it conforms to functional requirements or specifications. That attribute can also be described as the fitness for purpose of a piece of software. Software structural quality refers to how it meets nonfunctional requirements that support the delivery of the functional requirements, such as robustness or maintainability, the degree to which the software was produced correctly [21].

Website quality is similar with software quality it defined as how well a website is designed and how well the design meets with the user's satisfaction [18]. As researched by different researchers in different studies different studies it is shown that as website quality is dependent on software quality [18] [22] . Website quality can be defined as the degree of customer satisfied while interacting with the particular website [23]. Therefore, to evaluate quality of website it starts from customizing quality factors available in software quality models and identifying which components to be included in website quality evaluation. Quality factors are quality characteristics used to represent the properties of website while users are interacting with the website or software [9].

### **2.2.Different perspectives of website quality evaluation**

Quality of website could be evaluated from two perspectives; those are programmers' perspectives (internal quality characteristics such as maintainability, security and functionality

and so on) and end-users' perspectives (external quality characteristics such as Usability, Efficiency, Creditability and so on) [18]. In other study researchers define software or website quality evaluation from three perspectives which includes developer, manager and end-user [5]. End-user mainly focused on quality in use characteristics which is referred in different literatures as external quality characteristics while developer and manager focuses on internal quality characteristics.

As elaborated in [24] there are broad approaches towards software quality which to be considered by researcher in the area of software quality in order to investigate the quality of software products. Those are:

- User based: The software quality can be investigated evaluating by end users of the software product under investigation.
- Product delivery based: The software quality can be investigated evaluating by designer of the software product under investigation.
- Manufacturer based: The software quality can be investigated by evaluating the development process and process quality control of the software product under investigation.
- Organization based: The software quality can be investigated by evaluating the project costs, resources and production time of the software product under investigation.

### **2.3.Existing software and website quality models**

The researchers proved that website quality models discussed under this section are derived from the software quality models discussed hereunder by selecting the relevant quality characteristics in the website domain from the perspectives of website quality discussed above.

#### **2.3.1. Software evaluation models**

Quality models was developed and used by different companies in order to improve the quality of software [9]. Software quality models are used to define relationship between characteristics of software quality. A quality evaluation model contains characteristics, sub-characteristics and indicators. Finally hierarchy indicators or metrics are used for real evaluation. Software quality characteristics are also known as software quality factors or high level quality factors, sub-characteristics and quality indicators are called low level quality factors [9] [18]. Models are derived from software quality standards developed by international standards like ISO/IEC 9126, ISO/IEC 25010. Qualities of software are improved at different stages like quality of software product which focuses on final product and quality improvement of software processes when software is under construction. Quality evaluation model categorized in to three those are basic model, tailored model and open source quality model. Basic model is more comprehensive quality evaluation model and applied to wide range of software while the other two are derived from basic model and applied to specific range of software [9]. The generality of basic model also adds to researcher in the arena another work load which need customizing of the quality model to their own software product by selecting appropriate quality characteristics.

In many study researchers proved that representing quality in hierarchical way is easy to understand and measure software quality. The hierarchical representation of quality factors with

their relationship is called quality model. Using the model it is possible to access quality of any software at any stage (operational, under development). In this section some main software quality models are concisely described with their hierarchical representation of quality characteristics.

### 1. Mc Call Model

Mc Call’s model was known as the first software quality evaluation model and allows evaluation of software quality from three different angles such as product review (contains characteristics those indicate basic functionalities of the software), product operation (characteristics those indicate capability to change) and product transition(characteristics those indicate capability to adopt new environment) [9] [2]. However, Mc call model gave weakness in the accuracy of measurement of quality as it depends on responses “Yes” and “No” the model contributes the relationship between quality characteristics and metrics [9].

The model as showed in the Figure 1 [2] bellow it contains quality factors as higher characteristics, decomposition of the quality factor into quality criteria known as sub-characteristics and quality metrics that measured directly in real world. The metrics available on the last column in the figure 1 bellow directly measure by answering question in “Yes” or “No” format and it is in turn used to calculate the global value of software quality factor from range of low(0) to high(100) and the measurement is subjective [2].

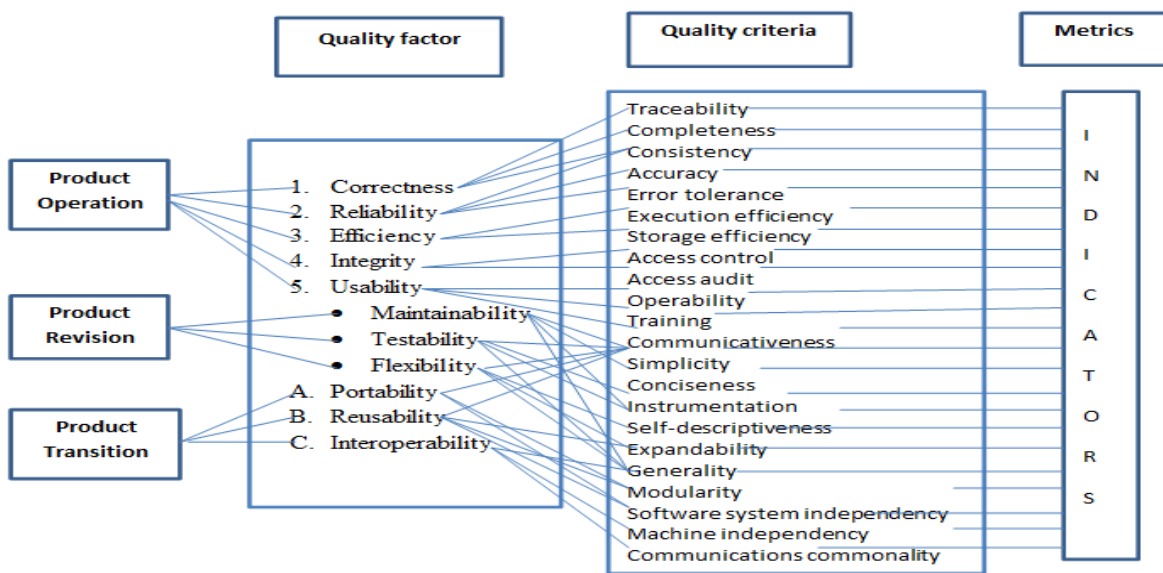


Figure 1: Mc Call quality model

### 2. Boehm Model

Boehm model is the improvement of Mc Call model that consists of large-scale characteristics. The high-level factors are utility, maintainability and portability [9]. This model represents

quality factors in hierarchical list of quality characteristics categorized as high-level characteristics, intermediate characteristics and primitive characteristics. According to [2] the high level characteristics demonstrate the overall behavior of the software product. The high levels of the Boehm model are:

- Portability: indicates degree of software product can work in other environment
- Maintainability: indicates degree of modifying the software product
- As-in utility- easiness of using the software product

The intermediate characteristics consist of 7 quality characteristics shown in the middle of the model in Figure 2 below. The primitive characteristics at the lowest level of the hierarchy indicate a foundation for defining the upper quality characteristics in the model. The difference of Mc Call Model and Boehm model are in Boehm model the Testability factor in the Boehm model is a criterion for the Maintainability factor but in McCall’s model; both factors are taken as separate factors [2].

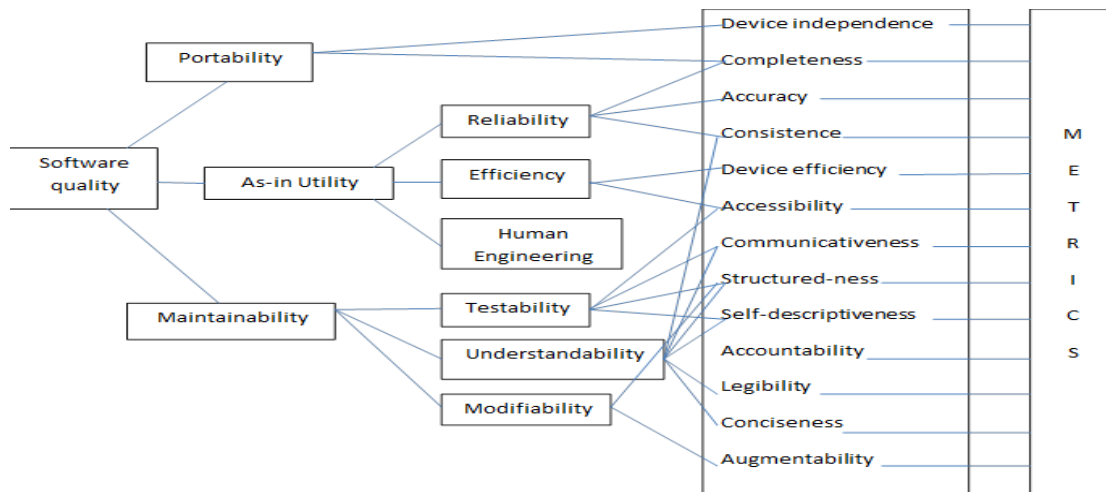


Figure 2: Boehm quality evaluation model

### 3. ISO 9126 standard quality model

The ISO 9126 quality model was proposed by 1992’s for identifying software quality evaluation characteristics and guidelines [25] [18]. The standard contains six quality factors: functionality, maintainability, efficiency, portability, usability and reliability with 21 sub-characteristics (attributes). The model was very general and can be applied to any type of software product measurements even if there are difficulties in applying the model [2] [25]. There are two series of the standard have been established those are: series ISO 9126 defined the quality model that used to define quality factor, quality criteria as well as metrics and series ISO 14598 described the quality evaluation process [18].

In ISO model characteristics are broken into sub-characteristics and again sub-characteristics further broken down into indicators for direct measurement. In evaluating quality of website the choices of indicators are based on the choice of indicators is based on a set of web quality guidelines [26], W3C standards [27] and the analysis of the existing websites [18]. Every tailored software quality evaluation models use ISO 9126 as a base model [9]. Both figure below taken from the literature [9].

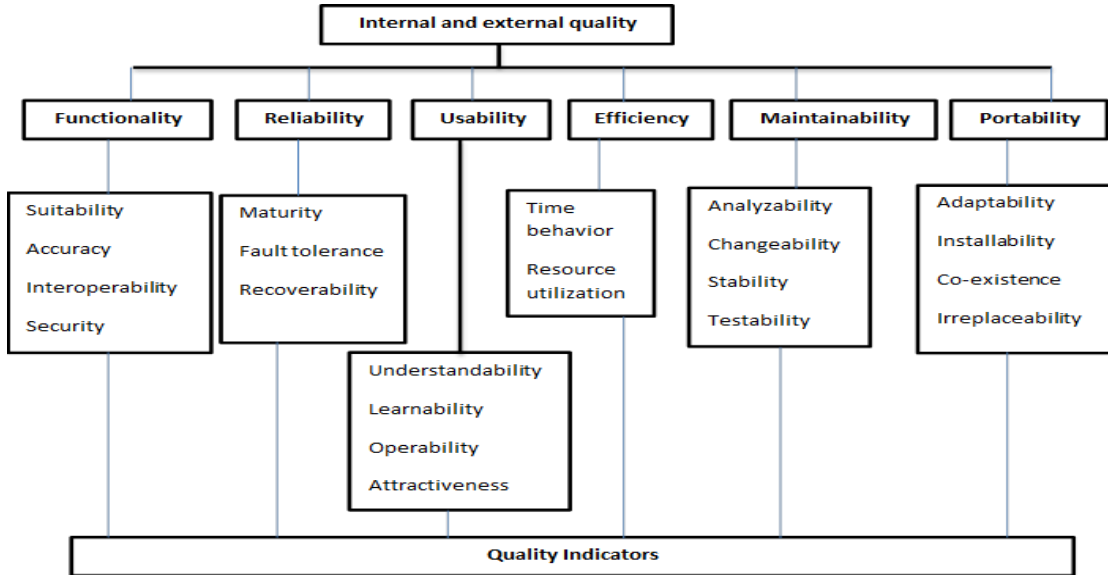


Figure 3: ISO 9126 Quality Model for external and internal quality

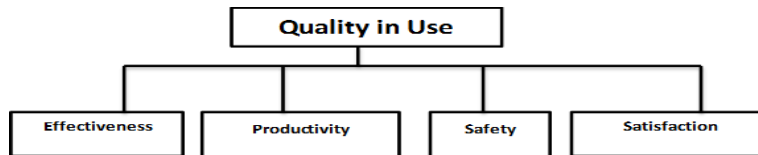


Figure 4: ISO 9126 Quality in use

Internal and external attributes and quality in use attributes are two different types of attributes in ISO 9126 quality model that used to represent different stages of software systems. Internal quality attributes are attributes or properties of the software assessed without execution while external quality attributes are properties of software assessed during execution. ISO 9126-1 has four parts:

- Part-I: Quality model: define quality characteristics and sub-characteristics for a software product.
- Part-II: External metrics: define metrics for external quality characteristics of a software product.
- Part-III: Internal metrics: define metrics for internal quality characteristics of software product

- Part-IV: Quality in use model: define the characteristics of given software product while the product directly used by the target users.

The ISO 9126 quality model shares similar quality characteristics and sub-characteristics with Mc Call and Boehm's models. ISO 9126 model provides quality characteristics, sub-characteristics and measures, however the model is not complete and fixed. Therefore, in this model depending on the type of software under evaluation and the reason that software evaluated, the quality characteristics can be added [2]. The structure ISO 9126 and ISO 25010 are similar even though the ISO 25010 is the modified version and comprehensive than the previous one.

#### **4. Dromey's quality model**

According to [25] in this model the measurement of tangible quality properties are used to build quality evaluation framework that analyzes the quality of software components. In the framework, tangible quality properties are matched with quality components to make the measurements of software systems easy using the model. The model central idea is that, each object or the artifact generated during software lifecycle are matched or associated with quality evaluation model for making the measurement of software quality simple and easy. The example of software components in Dromey's model discussed below:

- Variables, functions, statements, etc. can be considered components of the Implementation model;
- A requirement can be considered a component of the requirements model;
- A module can be considered a component of the design model;

As shown in the example above the components in the software lifecycle are used to measure the quality of software. The tangible properties of software components in the model assumed to possess the following basic properties [25] [2]. Those are: [2]

- 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?)

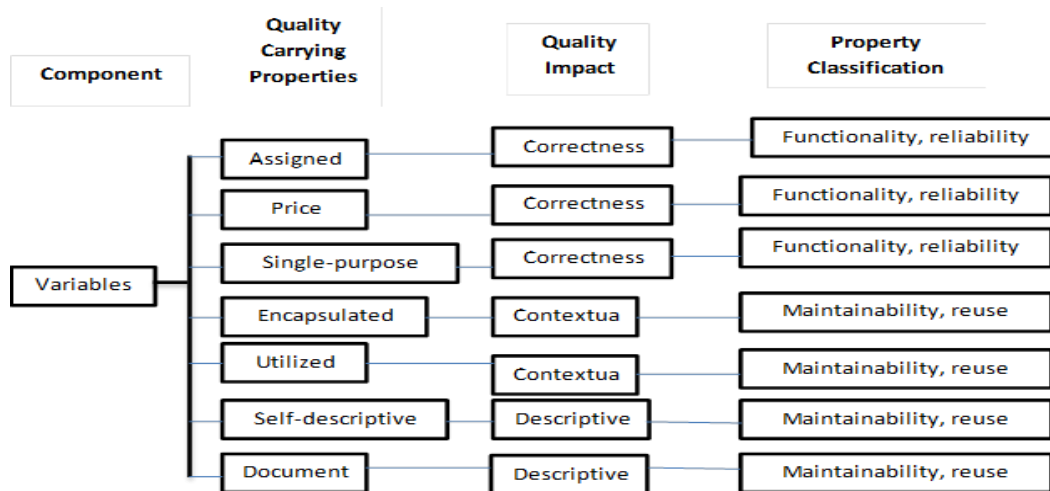


Figure 5: Dromey's Evaluation model

The model was attempts to connect quality attributes and sub-attributes as well as software product property with software quality attributes. As shown in the figure 5 [2] above the main steps performed in Dromey's model are: choosing high quality attributes necessary for evaluation, listing components or modules of the software system, identifying quality-carrying properties for the components or modules, determine how each property affects the quality attributes and evaluate the model [25].

## 5. The FURPS Model

The model categorizes the characteristics as Functional Requirements (FR) and non-functional (NF). The FR are defined by the inputs and outputs expected or Functionality(F) while the NF are grouped as Usability (U), Reliability (R), Performance (P) and product support (S) [9]. Figure 6 bellow depicts the characteristics and sub-characteristics shows FURPS model [9]. Its main problem is that some main features, like portability, are not considered. The model contains two level of hierarchy [9].

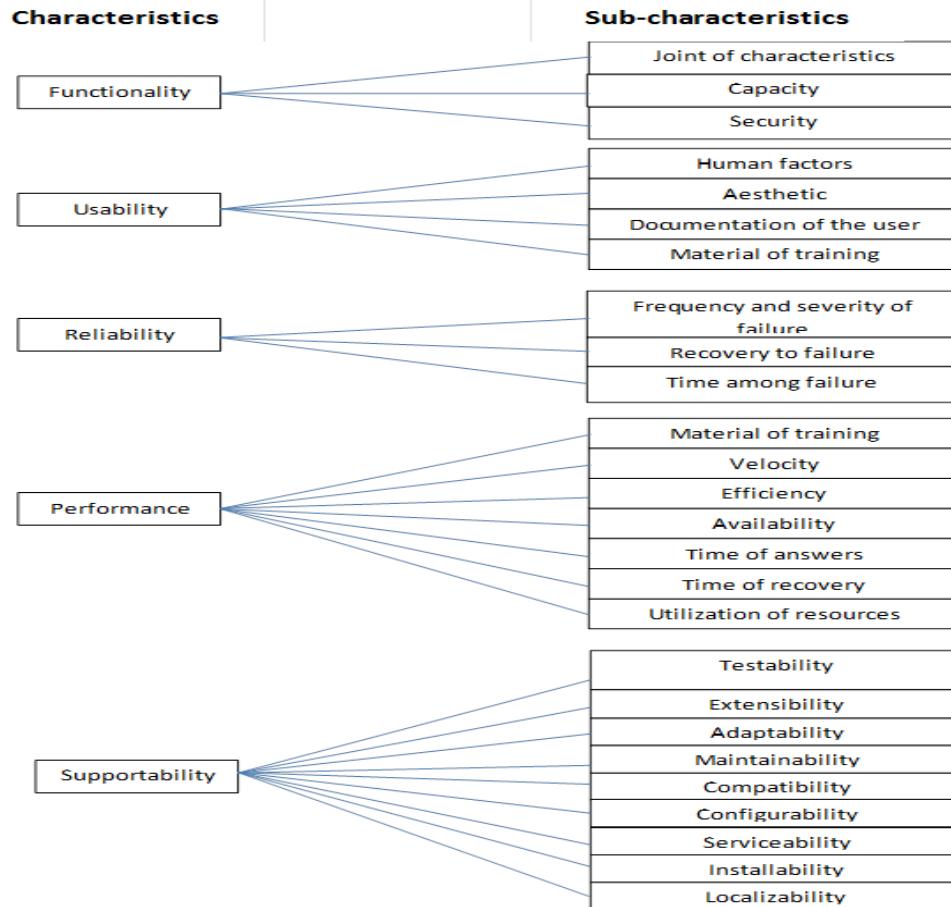


Figure 6: FURPS Model

## 6. ISO 25010 Model

The standard is the successor of ISO 9126 model and it contains two extra characteristics. In the ISO 9126 there are 6 quality characteristics and there are 8 quality characteristics in ISO 25010. In ISO 9126 the higher-level quality characteristics are: functionality, reliability, usability, efficiency, maintainability and portability whereas the higher-level quality characteristics in ISO 25010 models are: functional suitability, reliability, performance efficiency, operability, security, compatibility, maintainability and transferability. The figure 7 and 8 below shows the hierarchical representation of quality characteristics, sub-characteristics and indicators in the ISO 25010 software quality model. The model also maintains the three different views in the study of the quality of a product like in ISO 9126. Both category of the model shown in the figure below [9].

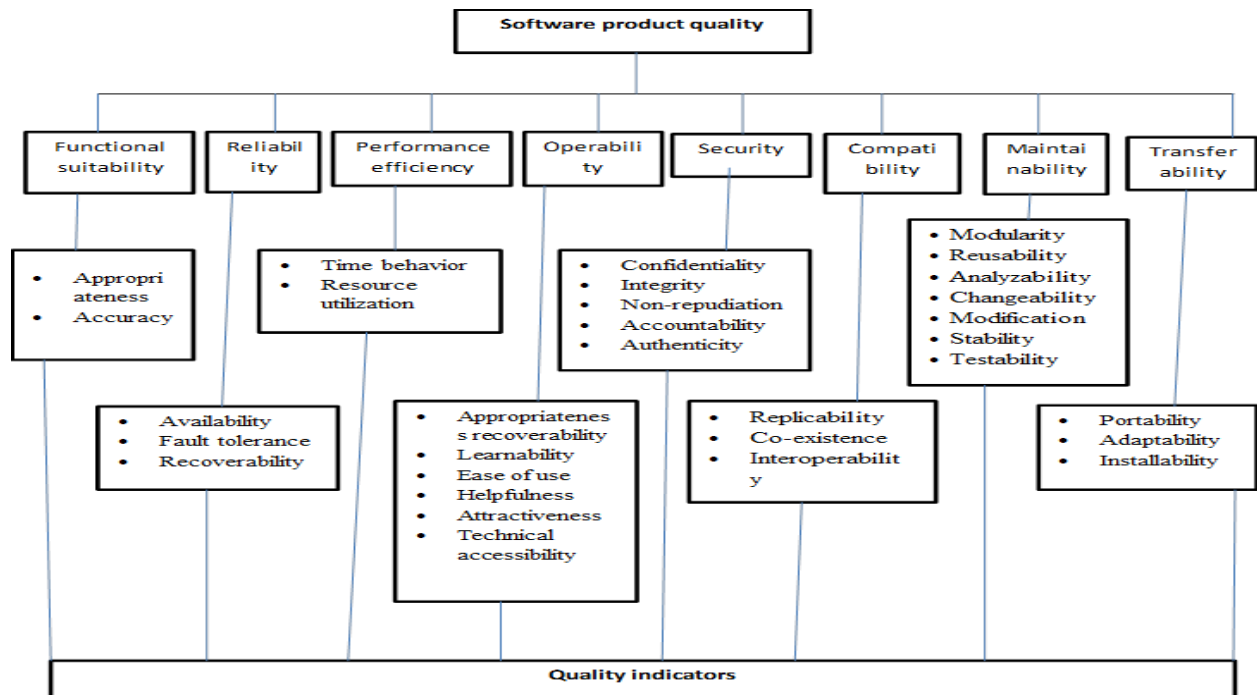


Figure 7: ISO 25010 Quality evaluation model

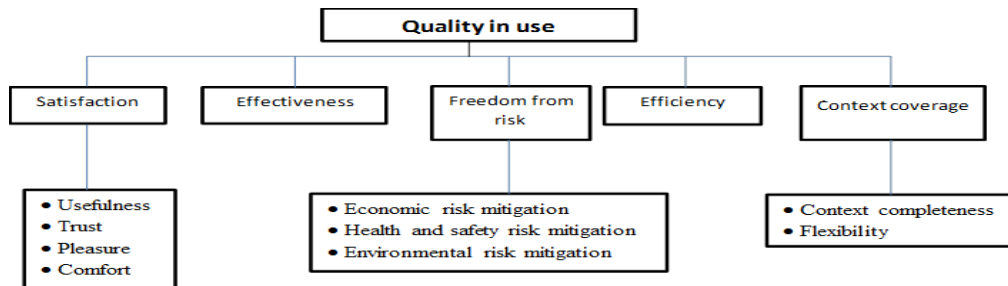


Figure 8: Quality in use model of ISO/IEC 25010

According to [28] the ISO 25010 is mainly used to define quality, metric-based approaches are used to assess the quality of a given system and reliability growth models are used to predict quality.

### 2.3.2. Website evaluation models

In this section, different website quality evaluation models are reviewed and discussed to show what was done in the area of the website quality evaluation, in order to identify what to do to fill the gap in the area. Then after discussion of available website quality models, the gap to be filled by this thesis and the necessity to research in the area described. As different study shows, the website quality models developed and used was customized from the basic software quality models [2] [18] [9] [5] [29] discussed in section 2.3.1 of this chapter similar activities are followed in this thesis to design evaluation framework for Ethiopian healthcare websites.

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

In this model website quality characteristic, sub-characteristics and indicators are described in quality requirement tree. In this model quality indicators can be measured directly or indirectly and the model evaluate website quality objectively [30]. The model derived from ISO 9126-1 quality model and addresses functionality, reliability, efficiency and usability quality characteristics and applied to museums domains as case study after that it was applied to other domains [2] [30] [29]. Even though, the model used objective evaluation of website quality weighting attributes are completely depends on experts' judgement [30]. In applying WebQEM in evaluation of website quality the processes should be followed are [2] [18]:

- Selecting a website or sets of websites to compare or evaluate: evaluator select a single website or set of websites for evaluation and comparison.
- Specifying evaluation goals and intended user's view point: in this step evaluator specify requirement from intended user and define goal for why evaluation take place [18] [2].
- Defining the quality characteristics and sub-characteristic attributes requirement tree: depending the specified quality requirements evaluator define quality requirement tree that contain characteristics, sub-characteristics and attributes. Characteristics can be selected and added to quality requirement tree based on ISO prescribed characteristics in addition to attribute customized to web domain [29].
- 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

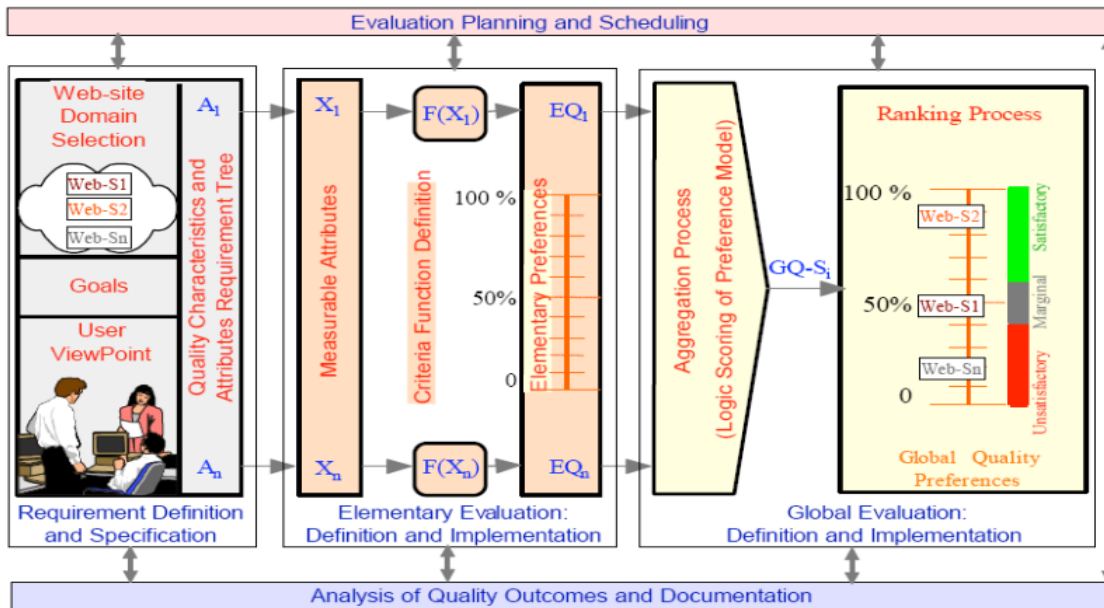


Figure 9: Web-QEM

In this model the central evaluation method used was Logic Scoring Preference (LSP) approach and LSP is a method used to quantitatively measure attributes of a product through logic scoring [29]. In the evaluation processes end user participates only for requirement specification which used to build quality requirement tree other steps are done by experts' evaluator.

## **2. MINERVA (Ministerial Network for Valorising Activities in Digitization)**

The model proposed to evaluate quality of cultural website (seminaries, archives, libraries, and other cultural institutions) and the model defines quality from accessibility as well as usability point of view [12]. The central concept of MINERVA model is that it defines the quality characteristics that reflect cultural website properties. The models used for evaluating of cultural website and support the design as well as the development of cultural website [12] [2]. The quality components that contribute to an evaluation of cultural website provided by MINERVA model consists of ten quality components: transparent, effective, maintained, accessible, user-centered, responsive, multi-lingual, interoperable, managed and preserved and their detail are discussed as below [12].

- Clarity: putting clearly for users about websites' objectives, mission, and the identity.
- Effectiveness: addresses the content of website which means the content of website must provide valid and relevant information for the user of website.
- Maintenance: addresses technical and content support as well as providing on improvement of function of the website.
- Accessibility: addresses easy access of the website to all users (access for blind users, those with relative vision, or users with hearing problems), the possibility of using a variety of technologies to present information to users, and the functionality with a variety of explorers, operating systems, and devices.
- User-centeredness: the user should be satisfied in all aspects of website such as easy to use, attractive and usefulness of the website for users.
- Responsibility: covers the ability of the website owners in responding to the questions of users, helping users to participate in generating content and answering the questions posed in a forum.
- Multilingualism: website should support multiple languages in case of users interested to access the website, and they do not know the language by which the website developed then they can choose the language they want. Language may be an important barrier to website access, so there is a strictly need to consider this characteristic
- Interoperable: It refers to the interaction of a website with other websites. If a website has been based on standard technologies, techniques, and models, interaction and adaption with other websites would be easy to increase the use of the website.
- Managed: It denotes the legal issues related to protecting copyright and privacy
- Preserved: addresses the long-term protection of the website and the ways to facilitate protecting the contents of the website.

The model designed for cultural domain which contain characteristics relevant to that particular domain and if this model wants to adopted in another domain it needs modification in order to include relevant characteristics and subcharacteristics. Therefore, Minerva model is an appropriate model for website evaluation in cultural domain while it is impossible for evaluation of website in another domain directly without making modification to characteristics in the model.

### **3. MiLE (Milano-Lugano)**

This model address the quality of website which are resulted to increase the satisfaction of stakeholders related to usability of the website. The model can be used to measures the quality of website either as evaluator based or end user based or by combining both an evaluator and users [12] [2]. The model specified different criteria's to measure quality of website as discussed below:

- **Content:** Assess the level of quality of information on the pages of website.
- **Services:** Used to assess either the website provides all functionalities that its user need to do or not.
- **Navigation:** Used to assess means of user access certain part of information in the part of website and logical structure of information to move across information available in the website.
- **Cognitive features of the interface:** It deals with how the website designed by considering the perception and feeling of end user into consideration and how the end users can easily memorize the structure of the website.
- **Aesthetics:** This criterion assesses the graphic design and template of the website, the type of font, color, size, images, and other graphic features in a website.
- **Technology:** Deals with how website functions or compatible in variety of explorers, the security level of the host server, and the interaction between the website and remote database

MiLE model is a usability focused evaluation method based on the combination of expert evaluators and user's empirical testing. The model bases its evaluation on two heuristics: abstract and concrete evaluation heuristics [2]. The characteristics discussed above in MiLE model are more of used to address the usability of the website. Content, service, navigation, cognitive features of interface and aesthetics are criteria's used to measure usability of website another models designed for website quality evaluation while technology used to measure compatibility of the website characteristics. Without any doubt the MiLE model is very less comprehensive while compared to other website quality evaluation models [2].

#### 4. 2QCV3Q model

This is a conceptual model that contains 7 dimensions (7-loci) used to evaluate the quality of the website. The model developed to help site owners and developers to evaluate Web site quality and incorporate these findings into site design. The model takes its name from the rhetorical principles of Cicerone loci, which begin with Quis (identity), Quid (content), Cur (services), Ubi (location), Quando (management), Quomodo (usability) and Quibus Auxiliis (feasibility) [2] [8].

The 7 dimension with their definition in the model are: Identity (Who: the image that the organization projects), Content (What: available information for the users), Services (Why: services available for the users), Location (Where: visibility of a site and ability of the site to offer a space where users can communicate with each other and with the organization), Management (When: Web site management involves updating the information it provides), Usability (How: it determines how efficiently and effectively the site's content and services are made available to the user), Feasibility (With what means and devices : includes all aspects related to project management) [8]. The characteristics and subcharacteristics in this model are listed out in the table below. The detail of the model given in the table below [8].

**Table 1: The 2QCV3Q model**

<b>Ciceronian Loci</b>	<b>Sub-characteristics and indicators</b>
<p><b>Quis</b> (Persona: Who?) <b>Identity</b></p>	<p><b>Identification</b> Brand (organization or company) Image <b>Characterization</b> Design Personalization</p>
<p><b>Quid</b> (Factum: What?) <b>Content</b></p>	<p><b>Coverage</b> Domain referred to owner's and user's goal Value of information and links <b>Accuracy</b> Quality of information Source, authors</p>
<p><b>Cur</b> (Causa: Why?) <b>Services</b></p>	<p><b>Functionalities</b> Adequacy to owner's goals Adequacy to user's goals' <b>Control</b> Correctness Security, ethics and privacy</p>
<p><b>Ubi</b> (Locus: Where?) <b>Location</b></p>	<p><b>Reachability</b> Intuitive URL Retrieval <b>Intractability</b> Contact information</p>

	Community building
<b>Quando</b> (Quando: When?) <b>Management</b>	<b>Correctness</b> Updates and revisions Dates <b>Maintenance</b> Check-up Tools
<b>Quomodo</b> (Modus: How?) <b>Usability</b>	<b>Accessibility</b> Hardware and software requirements People with disabilities <b>Navigability</b> Structure, orientation Download times <b>Understandability</b> Languages Level of terminology
<b>Quibus Auxiliis</b> (Facultas: With what means and devices?) <b>Feasibility</b>	<b>Resources</b> Financial and human resources Time <b>Information and Communication Technology</b> Software(implementation, integration)

#### 2.4. Comparison of existing website and software quality evaluation models

The aim of researchers in the area of website and software quality evaluation is to provide a comprehensive model used for evaluation of software product in a specific domain of the software in different viewpoints (perspectives) [9] [2] [31] [5] [24]. Comprehensive quality model is a quality model that encompasses all expected quality characteristics to evaluate a software product [2]. Therefore, comparison of quality evaluation models are done in the table below based on the characteristics included in the model which in turn used to evaluate the software product quality [9].

Hereunder all software and website quality models discussed above are compared based on based on the sub-characteristics covered in each quality evaluation models. The model that covers more sub-characteristics, however it is difficult to implement for evaluation in different software domains because it needs modifications, and the model is considered as a comprehensive model. The high level in one quality evaluation model used as subcharacteristics in other quality model as discussed above.

Here while comparing ISO 25010 it addresses more quality characteristics than others which indicates the model is contain more quality sub-characteristics to measure given software quality.

Table 2: Comparison of existing models

Characteristics	Website Quality Models				Software Quality Models					
	Web-QEM	MINERVA	MiLE	2QCV3Q	Mc Call	Boehm	ISO-9126	Dromey's	FURPS	ISO-25010
Correctness				X	X					X
Reliability	X				X	X	X	X	X	X
Efficiency	X	X			X	X	X			X
Integrity					X					X
Usability	X	X	X	X	X		X		X	X
Maintainability		X		X	X		X	X		X
Testability					X	X				X
Flexibility				X	X					X
Portability			X		X	X	X			X
Reusability					X			X		X
Interoperability		X			X					X
Human Engineering						X				
Understandability		X		X		X				X
Modifiability						X				X
Functionality	X	X		X			X	X	X	X
Performance									X	X
Supportability									X	
Content		X	X	X						
Transparency		X								
Navigation		X	X	X						
Presentation		X								
Service			X							

### 2.5. Drawback of existing website and software quality evaluation models

In different software as well as website domain researchers are developed tailored software and website quality models which contains appropriate characteristics for their software product. Especially, in the area of website quality evaluation, available models are impossible to apply in different website in different domains like e-commerce, education, health and etc. because of the need of users from website are varied from website domain to another website domain. The Available website quality evaluations are designed by taking into account the domains of the website which makes the model either cannot be applicable in other domain or need modification to use it. Therefore, generality of website quality models are resulted in difficulty to apply in different website domains without modification and the specificity of the website quality models resulted in incomprehensiveness of characteristics for all domain. In order to overcome the drawbacks of existing software and website quality models, the researchers in the area follows different approaches like developing quality evaluation framework for the domain of website or software that contains all relevant characteristics and sub-characteristics for evaluating the software products.

## *Summary*

In this chapter definitions for quality, software quality and website quality were discussed. In order to evaluate the quality of given website it requires clearly defining of viewpoints or perspectives. Website quality evaluation can be done by using existing website quality evaluation models or by developing customized models or frameworks which contains relevant characteristics, sub-characteristics and metrics. The comparison of existing software quality models was made in this chapter and ISO/IEC quality models are selected as comprehensive model for evaluating software quality. Therefore, the detail discussion for existing software and website quality evaluation models was discussed in this chapter along with comparison and in the next chapter the detail methods used for the developing and testing the proposed framework, evaluation tool for the proposed framework and more will be discussed.

## CHAPTER 3: METHODOLOGY

In this chapter approaches used to develop the proposed healthcare website quality evaluation framework are discussed. The method used for testing the proposed evaluation framework also elaborated along with the background theory which makes the method is usable to evaluate the proposed framework. In the following section a brief discussions on the area of the study, design of the proposed framework, sampling of participants, data collection, ethical consideration of participants, and testing and validation of the proposed framework.

### 3.1. Description of the study area

The study focused to solve the problem in the area of website quality in Ethiopian healthcare. There are limited numbers of health related website in Ethiopia which provides services for their patients as well as information are available for users on their website. The available websites in Ethiopia shows they give delivering of information and services using their website at below than expected quality of the website. Among available government and private healthcare providers in Ethiopia, the private hospitals have website than government hospitals and personal information gathered from IT workers of ministry of health of Ethiopian federal republic government shows Ethiopian government gave no emphasis on delivering services and information to patients or nation and nationalities of Ethiopia using website.

The healthcare related websites available in Ethiopia and currently working are attached to this thesis in **APPENDIX B**.

### 3.2. Design of the proposed evaluation framework

The proposed healthcare Ethiopian healthcare website were constructed from literature on the area of website quality [32], literature on the area of software quality evaluation [9] [24] [10], related works [2] [12] [17] [11] [33], website design guidelines, healthcare website design guidelines, uses of Ethiopian healthcare websites, website accessibility guidelines, software evaluation standards.

The literatures on the area discussed above are used for selecting high level characteristics, sub-characteristics relevant to healthcare websites evaluation. Guidelines on the area of healthcare website quality evaluation used for selecting appropriate metrics or indicators for characteristics and sub-characteristics selected as relevant for Ethiopian healthcare website quality. The metrics are categorized under the sub-characteristics that they are aimed to evaluate on the page of the website. Related work in this research used to represent both health website quality evaluation frameworks and website quality evaluation frameworks. The general approach used in the research depicted in the figure below.

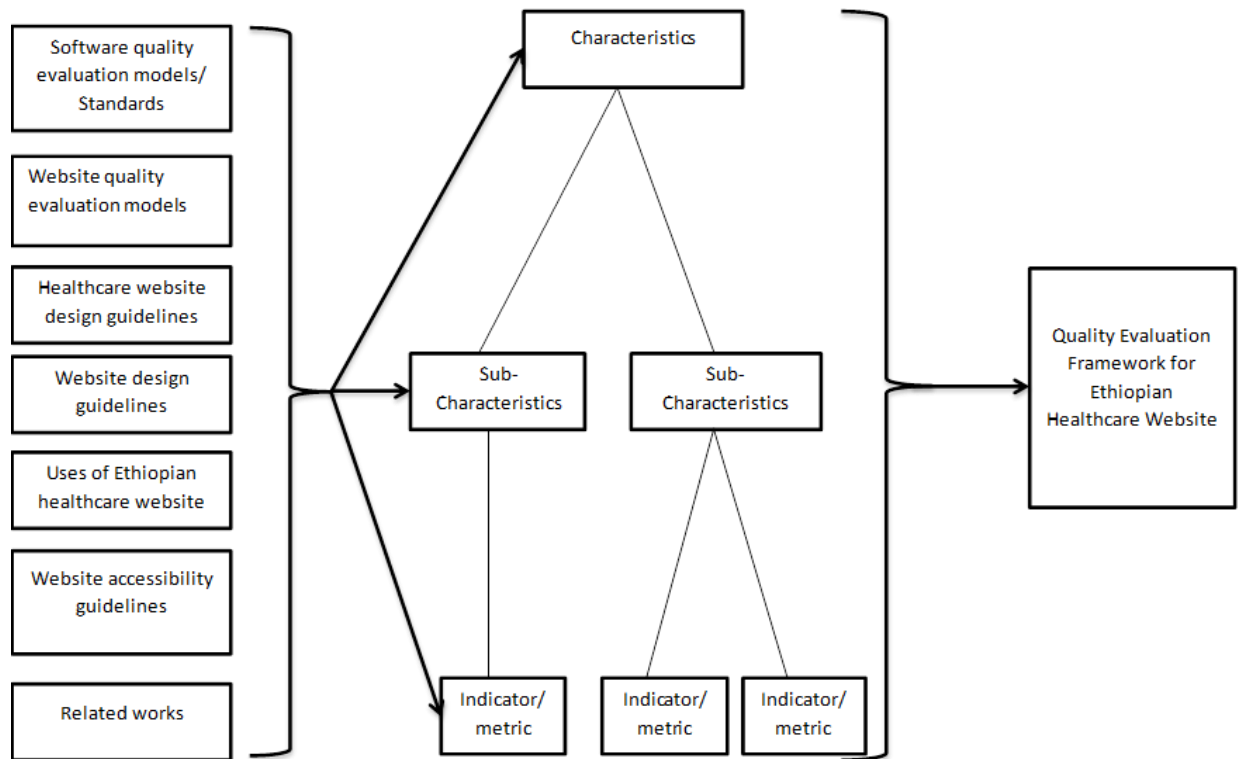


Figure 10: Methodology for developing the proposed framework

### 3.3. Test and validate the proposed evaluation framework

The developed framework for Ethiopian healthcare website quality evaluation was tested and validated using questionnaire. The questionnaire constructed from the metrics or indicators selected under sub-characteristics of framework. Each question was designed to address quality metrics directly measured from the website page.

Cronbach's alpha and item-total correlation were used to analyze the consistency of responses gathered from end users. Cronbach's alpha is a reliability analysis method that is used to analyses 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].

The questionnaire applied to Kadisco general hospital, St. Paul's hospital millennium medical college, Wudassie diagnostic center websites as a case study and the result of questionnaire analyzed for validations and testing of the proposed framework. Internal consistency of the questions in a questionnaire analyzed using statistical analysis method called Cronbach's alpha which is suitable for analyzing multiple Likert scale questionnaire used for data collection [34]. Cronbach's alpha used to measure the reliability (internal consistency) of the questions (items) in the questionnaire. Items in a questionnaire are reliable means it is possible to analyze the data

collected by the items or questions and can be possible to interpret the data. The formula for Cronbach's alpha is given below with detail description [34].

$$\alpha = \frac{N \cdot \bar{c}}{\bar{v} + (N-1) \cdot \bar{c}}$$

Where:

N = the number of items,

$\bar{c}$  = average covariance between item-pairs, and

$\bar{v}$  = average variance.

The value of Cronbach's alpha is starts from 0 and up to 1 [2].After data collected using question prepared in the questionnaire then interpretation given for Cronbach's alpha are as a follow [2] [35] [34]:

**Table 3: Intervals of Cronbach's alpha**

<b>Cronbach's alpha</b>	<b>Internal consistency or reliability of items</b>
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

WEBUSE analysis calculated from the collected data and the final result of high level characteristics in a proposed Ethiopian healthcare website quality evaluation framework interpreted as follows which is called merit value of the responses [36]:

**Table 4: Option of responses for questions and their Merit values**

<b><i>Response options</i></b>	<b><i>Merit points</i></b>
Strongly Disagree	0
Disagree	0.25
Neutral	0.50
Agree	0.75
Strongly Agree	1.00

In WEBUSE analysis method questions are grouped in such a way that, which quality characteristics they are intended to address. WEBUSE analysis method was selected as best analysis method when researchers are using Likert scale questions for data collection in usability evaluation of websites [36] [35]. The WEBUSE analysis was adopted from the previous works on this study [36]. The merit value of high-level quality characteristics calculated as follows:

$$X = \frac{\sum \text{Merit point of each question of quality metrics}}{\text{Total number of questions for the quality metrics}}$$

Finally, the overall quality of the website high level characteristics calculated and interpreted as follows:

$$Q = \sum_{i=0}^n X_i/n$$

Where

- ✓ X, is the average merit point of a high-level quality characteristics
- ✓ Q, is the mean average of the overall quality of the website
- ✓ n, is the total number of items in the questionnaire

The average merit points of high level quality characteristics and sub-characteristics as well as metrics in WEBUSE analysis method are starts from 0 up to 1 with their own interpretation of overall quality level of the website [2] [35] [36]. The interpretations for the WEBUSE analysis tool are given in the table below which tells level of quality of the evaluated website [2] [36].

**Table 5: Point intervals and overall quality levels**

<b>Merit points, X</b>	$0 \leq x \leq 0.2$	$0.2 < x \leq 0.4$	$0.4 < x \leq 0.6$	$0.6 < x \leq 0.8$	$0.8 < x \leq 1.0$
<b>Overall quality level of website</b>	Bad	Poor	Moderate	Good	Excellent

### 3.4. Sample selection

Number of participants was selected based on the previous scientific researches done on the area of website quality evaluation. In order to validate the frameworks developed in the area of the website quality evaluation at least 30 participants (only from patients'/end user category) should be successfully evaluate the website considered for a case study [2] [36]. Therefore, based on the above concepts 70 participants are selected for each case study websites. The questionnaire made available for the evaluators for 3 weeks (22/07/2017 up to 11/08/2017) and each website was evaluated for one week to two week.

The researchers in the area discussed that in order to test the quality evaluation framework on the area of website quality, applying the proposed framework as a case study on single or multiple website and analyzing the response result can be possible to test or validate the proposed framework [2] [35] [33] [19]. Therefore, since it is possible to test the proposed framework by applying on single website, taking into consideration duration of research and participants (personnel) in the research, the method selected for testing the proposed quality evaluation framework for Ethiopian healthcare website.

The Kadisco general hospital (KGH), St. Paul's hospital millennium medical college (SPHMMC), Wudassie diagnostic center (WDC) websites are selected for case study based on the objective of

the study which was aimed to develop website quality evaluation framework in a perspective of end user or patients. This means, the evaluated website are focused on their patients. The metrics considered in a framework were on the patients' perspective. Therefore, the website selected must be website which focused directly on patients. Available websites in Ethiopia on the area of healthcare are attached as **APPENDIX B** on this report.

### **3.5.Data collection and analysis**

To gather data from end user of Ethiopian healthcare website, questionnaires were derived from the metrics of the proposed quality evaluation framework for Ethiopian healthcare website. The questions in a questionnaire designed in such a way that the question should measure at least one metrics directly from the website. Additionally, questions should be easy or understandable in similar manner for user (patients) to gather perception of users on a metrics.

The question derived from the metrics in the proposed framework in order to collect the perception of users on the selected website for case study. To make the questionnaire understandable and convey relevant data the following methods was used in questionnaire preparation. Those are:

- A pre-test or pilot test was conducted using ten participants. The feedback of the respondents are collected and used to improve the questions.
- A question check list was used to make sure whether the questions in the questionnaire address at least one metrics in the proposed [2]. As well as the checklist also used to measure whether the question are easily understandable or not. The detail steps followed in a question checklist attached to **APPENDIX C** of this document.

Proposed quality evaluation framework of Ethiopian healthcare website applied to the Kadisco general hospital, St. Paul's hospital millennium medical college, Wudassie diagnostic center websites as a case study using a questionnaire and analysis are done on the responses of patients or users. Firstly, responses of end user or patients are collected and converted to R software and excel software [34]. Secondly, the internal consistency(Reliability) of responses are analyzed whether the data can be used for further analysis or not using statistical analysis method called Cronbach's alpha [2] [35] [37]. The intervals of Cronbach's alpha used for analysis are discussed above. Thirdly, using WEBUSE analysis method the gathered data on case study websites was calculated [36]. Finally, the perception of patients on overall quality of case study websites gathered by single question in a questionnaire compared with the result of WEBUSE analysis and the result are discussed [36].

### **3.6.Ethical consideration**

To increase the confidence of the respondents for conducting the survey, no personal information was asked for privacy purpose. The only information asked was their demographic information and the responses gathered were analyzed anonymously. Having the concept that, if there is no

contact information asked in the survey from participants they freely forwards their perception on the website.

***Summary:***

Ethiopian healthcare is an organization used to deliver health related services and information for patients. Website of healthcare providers used to deliver healthcare activities online to users. In this chapter the detail description of developing the proposed healthcare website quality evaluation, methods for data collection and analysis in order to test the effectiveness of the proposed framework was discussed and the rationale behind the selection of websites for case study as well as respondents were discussed, followed by ethical consideration of respondents and in the next chapter the detail activities for selection of characteristics, sub-characteristics and metrics in the proposed framework will be discussed.

## CHAPTER 4:

### GENERATING THE PROPOSED EVALUATION FRAMEWORK

The main aim of this chapter is to construct the quality evaluation framework for Ethiopian healthcare website. The evaluation framework generated from software quality models and website design guidelines by considering different users of Ethiopian healthcare websites. The framework generated contains characteristics, sub-characteristics and quality indicators. Characteristics are general quality factors for evaluating website while it is decomposed into sub-characteristics which are more specific than characteristics. Sub-characteristics in turn decomposed in to one or more quality indicators which can be directly measured from website.

As discussed in the chapter 2 of this document there are many software as well as website quality models that used to measure quality of software or website, but the problem of the existing software quality models is: general- that difficult to apply in specific domain of website to be evaluated and specific- designed for evaluating website in single domain.

Therefore, this chapter discusses how the proposed Ethiopian healthcare institution website quality evaluation framework constructed by using existing quality models discussed in chapter 2 and website design guidelines in general as well as specific to healthcare institution.

#### **4.1.Uses of Ethiopian Healthcare institutions websites**

Internationally, the uses of any healthcare website are to put information regarding the healthcare providers or owners, to facilitate the communication between health professional and other health professionals, to facilitate the communication between health professional and patients, help the owners to deliver their services online to their customers, help patients to make appointment for the treatment [7] [38]. The contents and services on the website are accessible and visible to anyone whose are interested in [38], which increases the advantage of getting health information at anytime and anywhere. In our country Ethiopia, the use of healthcare website has no difference when compared with the international one. Therefore, the uses of Ethiopian healthcare website are delivering information and services online. Thus, if website allows Ethiopian nation and nationalities to communicate with healthcare professionals and get health information online at their home then the quality of information and service provided by the website online is under question.

The main participants of Ethiopian healthcare websites are:

- Patients
- Health professionals
- Healthcare provider or owners
- Managers
- Health students
- Researchers

## 4.2. Website quality evaluation model

In the area of website quality evaluation many models are tailored from the software quality models and used to evaluate the quality of website in different areas like academic, museum, etc. as well as many evaluation framework also customized from available website or software quality evaluation models. Having this concept in mind, the proposed quality evaluation framework for Ethiopian healthcare website evaluation were constructed based on ISO/IEC 25010 prescribed characteristics and sub-characteristics considering patients as end user of the website.

### 4.2.1. ISO/IEC 25010 characteristics and sub-characteristics

This standard emerged in 2007 which is known as the updated model of ISO 9126 model [9]. Basically, evaluating any types of software requires eliciting, grouping and assigning quality criteria for each and every characteristic expected from that particular software [2]. This concept is also the base in different International software quality evaluation standards and frameworks [28]. Every researcher in the software quality evaluation area uses this concept and before evaluation takes place they work on identification of characteristics, sub-characteristics and indicators relevant to the software under evaluation. ISO/IEC 25010 quality model contains eight high level characteristics and several sub-characteristics as shown in the table 6 below. ISO/IEC 25010 follows the hierarchical structure to group properties of software under appropriate characteristics, sub-characteristics and indicators which break down product quality into smaller and manageable components called indicator(quality indicator) [10] [28]. Indicators are made easy measurement of the whole quality of software quality want to measure.

The researcher proved that ISO/IEC 25010 quality model contains more quality characteristics and sub-characteristics than others to represent the properties of software in assessing the quality of software. Therefore, it is called complete quality model among available software quality models [9]. In the table 6 below the characteristics of ISO/IEC product quality model shows sub-characteristics classified under which characteristic [28] [9]. The detail of the model used to construct the proposed framework discussed in table 6 below [28].

**Table 6: ISO/IEC 25010 characteristics and sub-characteristics**

S.No	Characteristics	Sub-characteristics
1	Functional suitability	Functional completeness, Functional correctness, Functional appropriateness
2	Reliability	Maturity, Availability, Fault tolerance, Recoverability
3	Performance efficiency	Time behavior, Resource utilization, Capacity
4	Operability	Appropriateness recognisability, Learnability, User error protection, User interface aesthetics, Accessibility

5	Maintainability	Modularity, Reusability, Analyzability, Modifiability, Testability
6	Security	Confidentiality, Integrity, Non-repudiation, Accountability, Authenticity
7	Compatibility	Co-existence, Interoperability
8	Portability	Adaptability, Installability, Replicability

The detail descriptions of characteristics and sub-characteristics available in ISO/IEC 25010 quality model are given hereunder.

### **1. Functional suitability**

According to ISO/IEC 25010 functional suitability defined as “the degree to which the software product provides functions that meet stated and implied needs when the software is used under specified conditions” [10]. It is decomposed into three sub-characteristics; those are: functional completeness defined as the degree of function of software are enough for user to perform what they want, functional correctness is defined as how the function of software product is aligned with what user expect from it, and functional appropriateness are defined as how functions of software appropriate for specific tasks and user objectives [9].

### **2. Reliability**

According to ISO/IEC 25010 reliability defined as “the degree to which the software product can maintain a specified level of performance when used under specified conditions” [10] [9]. It is decomposed into four sub-characteristics: maturity is defined as how the component is enough to do what is expected from, availability is about the product is in operational and ready to use always when user required, fault tolerance is about software product can maintain a specified level of performance in cases of software faults to its specified interface and recoverability defined as the software product re-establish a specified level of performance and recover the data directly affected in the case of a failure [9].

### **3. Performance efficiency**

According to ISO/IEC 25010 performance efficiency defined as “the degree to which the software product provides appropriate performance, relative to the amount of resources used, under stated conditions” [10] [9]. It consists of two sub-characteristics: time behavior indicates that how software product provides appropriate response and processing times and throughput rates when performing its function under stated conditions, resource utilization indicates the appropriate amount of resource needed by the software product while performing its function under specific condition and capacity defined as maximum limits of the product or system, parameter meet requirements [9].

### **4. Operability**

According to ISO/IEC 25010 operability defined as “the degree to which the software product can be understood, learned, used and attractive to the user, when used under specified conditions” [10]. It is decomposed into five sub-characteristics: appropriateness recognize-ability defined as how much the software product tells to the user how they recognize whether the software appropriate for their needs or not, learnability defined as how much effort does user put to learn its application, user error protection defined as how much the system or software product protect user from making error, user interface aesthetics defined as how much user pleased and satisfied in using the interface of the software product and accessibility defined as how much the system used by different types of users (like users with disabilities, users who don’t know language of the website etc....) [10] [9].

## **5. Maintainability**

According to ISO/IEC 25010 maintainability defined as “the degree to which the software product can be modified, and it include corrections, improvements or adaptation of the software to changes in environment, and in requirements and functional specifications” [10]. Maintainability characteristics also decomposed into five sub-characteristics: modularity defined as how much system components or computer program components are interdependent on each other such that change on one component do not affect other, reusability defined as how much system components re-used in another components of software system, analyzability defined as how much the components are easy to identify if failure in the software product happen as well as how much easy to solve the problem, modifiability defined as how much easy to modify the software products and testability defined as the easiness to validate the modified software product during modification [10].

## **6. Security**

According to ISO/IEC 25010 maintainability defined as “the protection of system items from accidental or malicious access, use, modification, destruction, or disclosure” [9] [10]. Security characteristics decomposed into five sub-characteristics: confidentiality defined as how much the software product protects data or information from unauthorized access whether accidentally or deliberately, integrity defined as how much software product protects unauthorized access or modification from data, non-repudiation defined as how much the software product identify whether the action or event takes place or not to ignore action or event repudiated later, accountability defined as how much action takes place by entity traced to that entity for the security purpose and authenticity defined as how much the software product provides an identity to subject or resources [9] [10].

## **7. Compatibility**

According to ISO/IEC 25010 compatibility defined as “the ability of two or more software components to exchange information or to perform their required functions while sharing the same hardware or software environment” [10]. Compatibility characteristics decomposed into

two sub-characteristics: co-existence defined as how much two or more software products that share the same environment as well as resources co-exist independently without any impact on each other and interoperability defined as how much the software product cooperatively operate with one or more software components to perform its functions [10].

## **8. Portability**

According to ISO/IEC 25010 compatibility defined as “the ease with which a system or component can be transferred from one hardware or software environment to another” [10]. Portability characteristics decomposed into three sub-characteristics: adaptability defined as how much the software product can be adapted for different specified environments without applying actions or means other than those provided for this purpose for the software considered, installability defined as how much the software product can be successfully installed as well as uninstalled in a specified environment and replicability defined as how much software product can be used in place of another specified software product for the same purpose in the same environment [10] [9].

### **4.3. Website design guidelines**

According to [39] from visitor point of view the good website quality can be defined as a site that usable, has something they wants, doesn't waste their time and not frustrating. In the guidelines the implementation detail of components that satisfy the required website quality are listed with detail description which makes easy to put into work. The detail descriptions of the good website quality proved by researcher are [39]:

- Website can be accessible by everyone
- Website can be as fast as possible
- Make website easy to use
- Make website useful
- Maintain integrity: being professional
- Make website friendly and fun to use

### **4.4. Healthcare institution website design guidelines**

Website design for hospital and medical organizations become challenging because of information kept on it and satisfaction of visitors. In addition to that, it does not conform to today's design standards, which make them incompatible or difficult to browse on mobile devices and smartphones [40]. According to [41] following best design guidelines for healthcare organization can help the website to attract more visitors. If the way of patients and community interact with healthcare organization changed to website, try to connect effectively with them and make the website that that holds current design concepts. In addition, it needs to be functional, intuitive, easy to navigate, and boast impressive load times [42].

Designer of healthcare providers’ website should follow the following concepts summarized in the table below while developing the website for healthcare providers.

**Table 7: Healthcare providers website design guidelines**

<b>Way to design healthcare providers website</b>	<b>Reference</b>
Simple and clear navigation, Responsive and mobile-friendly design, Mobile optimization, Clear hour, location and content information, Accurate, welcoming photography and videos, Showcase healthcare providers brand, Highlight healthcare providers staff and treatment plans, Easy accessible and patient information	[40]
Make simple and easy, Include social media, Include patient forms (register, find staff etc. ), Display contact information clearly, Create information portal with patients and staff, Style points (use neutral colors)	[41]
Reflects providers’ brand online by showing what makes it unique, Improves providers, bottom line by attracting visitors, filling your waiting rooms and physician schedules, Helps visitors complete their top tasks with an outstanding user experience and a responsive design that works across all devices	[42]

Even though, characteristics used to evaluate website quality are the same for all website domains, the relative importance of characteristics are different from one website domain to another website domain [31]. Consequently, the evaluation model or framework in one website domain is impossible to use in another website domain as it is without modification. This means, for example currency of information highly required in the healthcare domain website while security is highly required in financial domain of websites.

#### **4.5. Healthcare website evaluation previous related work**

In the area of healthcare website evaluation many works were done even if researchers in the area are not satisfied on the quality level of website in the domain [17]. According to [17] the highly relevant characteristics which end users of the website expected from hospital website are technical content, hospital information and facilities, admission and medical services, and external activities. The researcher measures the quality of hospital website from above listed five characteristics and the indicator used to measure or validate the listed characteristics of the hospital website are described as follows [17]:

- Technical content measured from websites in terms of site map, internal search engine as well as compliance to the following guidelines such as WAI (web accessibility initiatives for disabilities), W3C-CSS and W3C.
- Hospital information and facilities measured from availability of hospital age, location of hospital, way to reaching the hospital and content detail of public relation office.

- Admission and medical services measured in terms of hospital admission, discharge and every life during stay in the hospital, information of doctors employed in the hospital.
- Iterative and online services measured in terms of online reservation, availability of communication with email or internet to hospital and availability of health related forum.
- External activities measured in terms of users able to obtain health information, job opportunities, and list of conference organized by hospital website.

The researchers proposed a dimension for evaluating website quality of worldwide health which applied to wide range of website through world [7]. The researchers consider the concept that” Due to the sensitiveness of their content and impact on users, health related sites should be evaluated” they proposed the health website evaluation methodologies components such as content, services and technical. The proposed quality evaluation for health websites in [7] are worked to develop an evaluation, comparison and improvement methodology for healthcare institution specifically focused on healthcare providers’ (like Hospital, HealthCare centers etc.)

Three dimensions used by the researcher to evaluate health websites in [7] are discussed as follows with sub-dimension or sub-characteristics of the high-level dimensions. The dimension and sub-dimensions in this research matched with characteristics and sub-characteristics in ISO/IEC 25010 software quality standards.

#### **A. Content**

The content dimension of the health websites are the never compensated component of the website existence. Under content dimension the attributes like accuracy, completeness, opportunity, consistence, coherence, update and syntax categorized as well as evaluated.

#### **B. Services**

The service dimension of health websites, in the research given similar definition with content dimension of health website defined above. Under services dimension researchers categorizes attributes like security, reliability, privacy, performance, efficiency, accuracy, opportunity, availability, response time, time saving, empathy, reputation and personalization evaluated.

#### **C. Technical**

Technical dimension of health website quality defined as the quality dimension that measures the attributes available in software quality models such as ISO/IEC 25010 and ISO/IEC 9126. The website quality attributes categorized under technical dimension of health website quality are attributes like navigation map, path. Search engine, downloads time of pages, browser compatibility, broken links and accessibility are evaluated.

According to [31] the quality evaluation of website characteristics was identified and listed as well as the importance of characteristics discussed in detail. The researcher identified six website domains and five design features (characteristics). The website domains are financial, e-commerce, entertainment, education, government and medical whereas the high level characteristics identified was ranked up to top 5 for each and every selected website domain which did not include characteristics ranked below five. The summarized version of the research

work is tabulated in Table 8. The number listed in the table below under each website domain shows that the rank order for design features listed in the table. 1 means it is highly important than others whereas 5 means the lower important than others.

**Table 8: Importance of design features from highest to lowest**

Sno.	Design Features	Website Domain ( <i>Part 1</i> )		
		<i>Medical</i>	<i>Financial</i>	<i>e-Commerce</i>
1	Accuracy of information	1	2	
2	Easy to navigate	2	4	2
3	Search tool	3		4
4	Up-to-date information	4	1	
5	Comprehensiveness of information	5		
6	Multiple information sources		3	
7	Timely information		5	
8	Security of data			1
9	Appropriate explanatory text			3
10	Product and service price concerns			5
Sno.	Design Features	Website Domain( <i>Part 2</i> )		
		<i>Educatio n</i>	<i>Government</i>	<i>Entertai nment</i>
1	Accuracy of information	3	5	
2	Easy to navigate	1	1	2
3	Search tool	2	4	
4	Up-to-date information		3	5
5	Comprehensiveness of information	4		
6	Multimedia			4
7	Visual design			1
8	Site responsiveness			3
9	Clear layout of information	5	2	

According to [33] the authors performed a broad study on the existing website evaluation methods to identify quality characteristics included in their framework and developed a framework that used to evaluate hospital website qualitatively. The framework developed contains the perception of patients/users, researcher own experience as well as perception of doctor's, physician's etc. on hospital or medical websites. The framework contained seven (7) main categories with each of them have sub-categories used to measure the properties of hospital website. And the metrics proposed in this research work used to access quality of hospital

websites. The seven categories proposed by the researchers are quality of content, design, organization, user friendly, performance, service and technical. The detail of categories and sub-categories in the work are summarized in the table below.

**Table 9: Categories and sub-categories to measure hospital quality**

Sno.	Quality categories	Quality metrics
1	Content quality	Relevancy, accuracy, comprehensive content, usefulness, timely, impartiality, multilanguage/culture, variety of presentation, editing quality, and authority
2	Design quality	Attractiveness, appropriateness, colors, image/sound/video, text, and advertisements and banners
3	Organization quality	Logical structure, organization, site map, scope, links, navigation, and logo
4	User friendly quality	Ease of use, user interface, interactive features, satisfaction, privacy, customization, and personalization
5	Performance quality	Speed, usability, responsiveness, accessibility, availability, novelty, security, reputation, reliability, integrity, changeability, dynamism, consistency, sufficiency, and completeness
6	Service quality	Internet reception, internet settlement, medical consult, medical information, exclusive hospital/medical center's information, E-Radiology and E-Sonography and E-Laboratory, E-Library, E-Medicinal data base, calendar of hospital events, updating lists, frequently asked questions, communications, helping functions, news groups, search, and service quality
7	Technical quality	Programming languages, size and volume of website, page structure, mechanism of information retrieving, website ranking in search engines, extendibility, and solving technical problems

The categories in this research represents high level characteristics in software quality model, sub-categories represent sub-characteristics and the same definition for metric where given. Additionally, the researcher proposed the operational level evaluation criteria's in detail. However, the solution for hospital website quality evaluation proposed by researcher was comprehensive than other solution in the arena, it needs some clarification on high level characteristics of the framework components and better to convert evaluation from qualitative to quantitative [29].

The high level quality characteristics addressed in previous researches in the area of healthcare website quality are listed in the table below. The characteristics considered in one study treated

as a sub-characteristic in another study which indicates that, quality characteristics need grouping and decomposing. For example, accuracy of information categorized as quality characteristics by one researcher and as quality sub-characteristics by another researcher.

**Table 10: Characteristics addressed in the previous study**

<b>Previous related work healthcare website evaluation</b>	<b>Characteristics addressed in the study</b>
[17]	Technical content, hospital information and facilities, admission and medical services, and external activities
[7]	Content, service and technical
[33]	Accuracy of information, easy to navigate, search tool, up-to-date information, comprehensive information
[31]	Content quality, design quality, organization quality, user-friendly quality ,performance quality, service quality and technical quality

The result of study in the area of health website or frameworks developed by different researchers in the area of healthcare website quality evaluation give high emphasis to the similar high level characteristics [31] [17] [33] [7] as shown in the table above. The high level quality factors got more focus by researchers in the area of healthcare website evaluation are:

- Content
- Information
- Service
- Technical

Researchers used the characteristics named technical to represent the quality characteristics listed in the international standards like ISO/IEC 25010, ISO/IEC 916 those are; functionality suitability, reliability, performance efficiency, operability, maintainability, security, compatibility and portability [7]. In many studies the content characteristics used to evaluate the information that the website hold by setting different metrics [31] [17]. Therefore, taking this into account, a quality evaluation for Ethiopian healthcare websites are designed by encompassing all important quality evaluation characteristics, sub-characteristics and metrics as given in the next section.

#### 4.6. The proposed healthcare quality evaluation framework

The framework generated after comprehensive study on the area of website quality generally as well as specific to healthcare. The proposed quality evaluation framework for healthcare website constructed from existing website and software quality models, quality evaluation framework for website and software, website design guidelines as well as healthcare website design guidelines. The uses of Ethiopian healthcare website also considered for development of the framework.

The proposed framework contains high level characteristics, sub-characteristics grouped under high level characteristics and quality metrics used to measure the level of quality of sub-characteristics directly from the webpages of the website. As shown in table below the high level characteristics are taken from ISO/IEC 25010 quality model division and other related studies on the healthcare website evaluation.

**Table 11: Characteristics and sub-characteristics in proposed evaluation framework**

<i>Description</i>	<i>Characteristic</i>	<i>Sub-characteristics</i>	<i>Reference</i>
<ul style="list-style-type: none"> <li>❖ Searching and retrieving issue/ searching mechanism(Global and scoped search supported)</li> <li>❖ Navigation and browsing issue( scrolling, current location, path indicator available)</li> <li>❖ Navigation prediction(link title)</li> <li>❖ Functionalities of website are as users expect it to be.</li> </ul>	Functional suitability	<ul style="list-style-type: none"> <li>✓ Search</li> <li>✓ Navigation</li> <li>✓ Suitability</li> </ul>	[2], [10], [43], [44].
<ul style="list-style-type: none"> <li>❖ Table of contents, site map, global index available</li> <li>❖ User friendly interface</li> <li>❖ Personalization</li> <li>❖ Provide services which user demands</li> <li>❖ Help feature available for first time user</li> <li>❖ Support multiple language</li> <li>❖ Interfaces are attractive and artistic</li> <li>❖ User supported by the staff</li> </ul>	Operability	<ul style="list-style-type: none"> <li>✓ Understandability</li> <li>✓ Interactivity</li> <li>✓ Customization</li> <li>✓ Learnability</li> <li>✓ Multiple-lingual</li> <li>✓ Aesthetics</li> </ul>	[2], [10], [16], [13], [8], [29], [11].
<ul style="list-style-type: none"> <li>❖ Web technology used</li> <li>❖ Navigation and link used maturity</li> <li>❖ Use of valid links</li> <li>❖ Absent of features due to different browser</li> </ul>	Reliability	<ul style="list-style-type: none"> <li>✓ Availability</li> <li>✓ Fault tolerance</li> <li>✓ Recoverability</li> </ul>	[2], [29], [10].
<ul style="list-style-type: none"> <li>❖ Support for website text-only version</li> <li>❖ Readability by ignoring/deactivating</li> </ul>	Performance efficiency	<ul style="list-style-type: none"> <li>✓ Accessibility</li> </ul>	[2], [43].

<ul style="list-style-type: none"> <li>browser image feature</li> <li>❖ Quick static pages</li> <li>❖ Lower website size ( page size small)</li> </ul>		<ul style="list-style-type: none"> <li>✓ Time behavior</li> <li>✓ Resource utilization</li> </ul>	[11]
<ul style="list-style-type: none"> <li>❖ Availability of health information and its understandability</li> <li>❖ Website purpose</li> <li>❖ Usefulness of information</li> <li>❖ Branding</li> <li>❖ Authority</li> <li>❖ Readability or available in multiple format</li> <li>❖ Up-to-datedness or currency of information</li> <li>❖ Comprehensiveness of information</li> <li>❖ Information available are objective</li> <li>❖ No error of sentence and words</li> <li>❖ Information are in structured format( number of sub-headed per heading, number of paragraph, number of sentences per paragraph)</li> <li>❖ Distinction between author and webmaster</li> <li>❖ Information on the site are reliable and error-free</li> <li>❖ Availability of hospital age, location and clear contact information</li> </ul>	Content	<ul style="list-style-type: none"> <li>✓ Relevancy</li> <li>✓ Up-to-datedness</li> <li>✓ Authority</li> <li>✓ Variety of presentation</li> <li>✓ Impartiality</li> <li>✓ Comprehensiveness</li> <li>✓ Identity</li> <li>✓ Accuracy</li> <li>✓ Contact</li> </ul>	[2], [13], [8], [11], [44], [43], [35], [32]. [17]
<ul style="list-style-type: none"> <li>❖ Inpatients and outpatients complete reception using the site</li> <li>❖ Online payment are possible</li> <li>❖ Medical help are available by staff</li> <li>❖ Exclusive medical information available</li> <li>❖ Communication between staff and patients are allowed</li> <li>❖ News available</li> <li>❖ Extra services allowed by website</li> <li>❖ Calendars available</li> <li>❖ New events are available separately on homepage</li> </ul>	Services	<ul style="list-style-type: none"> <li>✓ Reception</li> <li>✓ Settlement</li> <li>✓ Medical consult</li> <li>✓ Medical information</li> <li>✓ Communication</li> <li>✓ Newsgroup</li> <li>✓ Updating list</li> </ul>	[44], [43], [33], [7].

The proposed framework contained of six quality characteristics, thirty one sub-characteristics and quality indicators or metrics for each and every sub-characteristics. Functional suitability, operability, reliability and performance efficiency characteristics are included from the base model while content and service are described in WebQEM as domain specific functionality [29] [10]. Domain specific functionality changed for website evaluation based on the domain of the website to be evaluated [29]. The hierarchical representation of the proposed framework is given in the figure below, which intended to simplify the understandability of the framework.

The proposed framework uses bottom up approach for calculation of the overall quality of Ethiopian healthcare website quality selected for evaluation. Quality metrics or indicators defined are used to calculate the level of quality of each sub-characteristics of the website. The summation of the level of quality of each sub-characteristics grouped under the same high level characteristics are used to obtain the quality level of the high level characteristics of the website. Finally, summation of the value obtained for each high level characteristics result in the overall quality of healthcare website quality selected for evaluation.

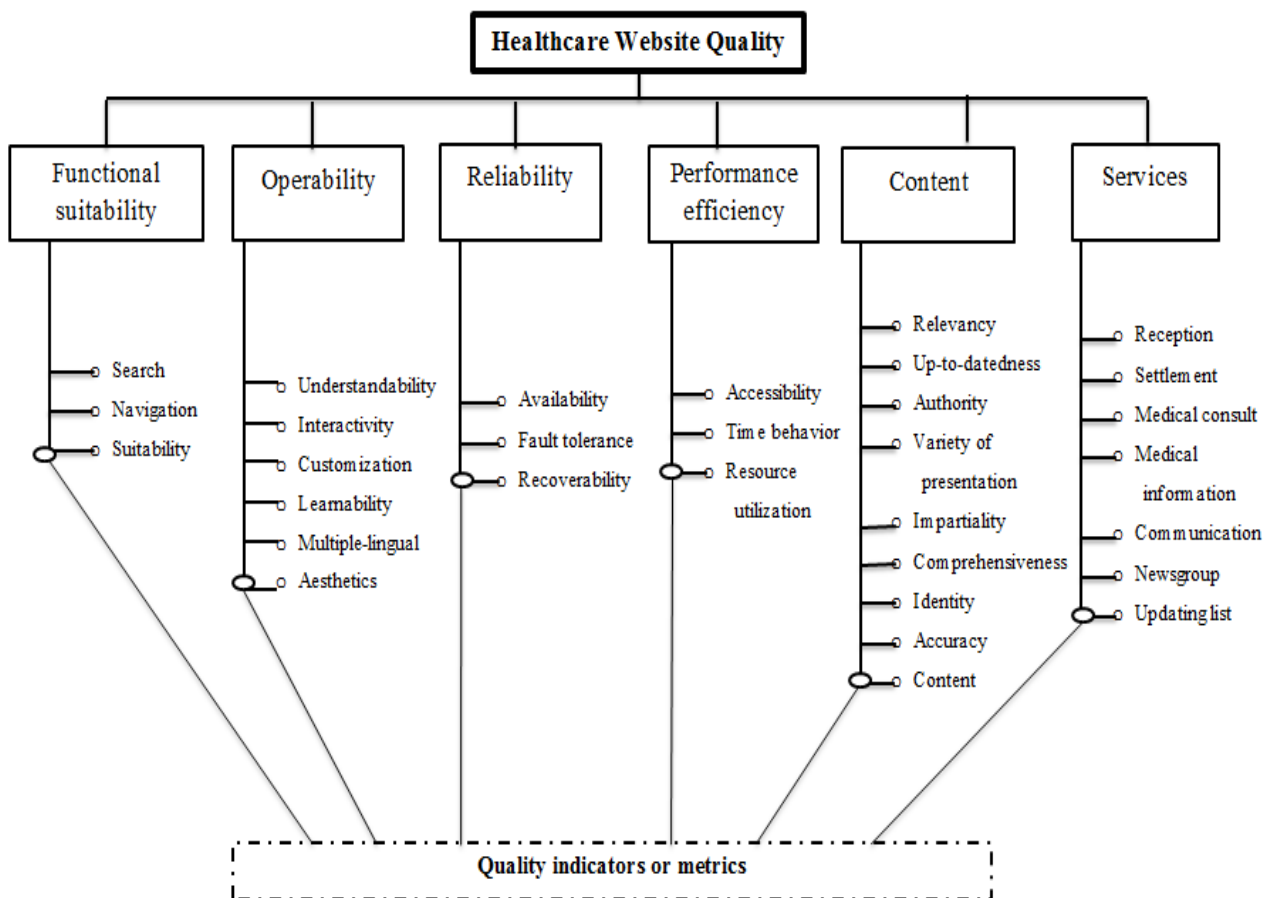


Figure 11: Proposed quality evaluation framework for Ethiopian healthcare website

## **4.7.High level characteristics and sub-characteristics of the proposed framework**

### **4.7.1. Functional suitability**

The name of characteristic called functionality in ISO/IEC 9126 changed to functional suitability in ISO/IEC 25010 because of this name was more preferable to represent the subcharacteristics encompassed in. Functional suitability focuses on the analysis of the website based on whether the website has all functionalities or not and the degree of functionalities of the website are implemented as users expect it or not while using the website [45]. Functional suitability decomposed into functional appropriateness and functional accuracy in ISO/IEC 25010 quality model division. In the proposed framework accuracy added under the content characteristics and functional suitability characteristics named as suitability. Search and navigation are encompassed under functionality characteristics in Web-QEM discussed under chapter 2 of this report. Navigation also included in MiLE website evaluation model as high level characteristics.

The functionalities of website are divided in to two; those are functionality common to all website domains and functionality specific to a particular website domain [29] [44]. In the proposed evaluation framework common functionalities of healthcare website are addressed under functional suitability characteristics and domain specific functionalities of the healthcare website are addressed under content and service characteristics. In the proposed evaluation framework the quality of functional suitability characteristics are computed by summing up the individual quality level of sub-characteristics listed under functional suitability. Those are: Search, Navigation and Suitability.

#### **i. Search**

Search characteristic is a website functionality used to support users in order to retrieve the information they want from the website by providing different mechanism of search. The search sub-characteristics are treated as navigation even if separating the search functionality help to easily assess the quality of website [2]. Search functionalities also include website search mechanism (like global search and scoped search in the domain) and retrieve mechanism (level of retrieve customization and level of retrieve feedback) [29].

#### **ii. Navigation**

Navigation used to assess means of user access certain part of information in the part of website and logical structure of information to move across information available in the website [12]. Website is a collection of information organized and accessed through an interface used to take user to information provided by an organization owned the website. Therefore, to go through the pages of website as well as external to the website, navigation is implemented and used. Navigation and browsing issues like indicators of path, label of current position, links per page, scrolling, explanatory link title, quality of link phrase, sitemaps, and table of contents are used to simplify the use of the website [29].

### **iii. Suitability**

Suitability named as functional appropriateness in ISO 25010 quality models and defined as “degree to which functions facilitate the accomplishment of specified tasks and objectives” [10]. Measures the functionalities of website whether it accomplish task as user expect it or not. Users while using the website if they are satisfied in the functionalities made available by the website, then the website functionalities are suitable. Finally, every functionalities of website are suitable means users satisfaction are high to use the website.

#### **4.7.2. Operability**

Operability characteristic in ISO 25010 models previously named as usability in ISO 9126 and other website quality evaluation models discussed in the chapter 2 of this report. Usability experts concluded that if users are satisfied to the website while they are using there are many advantages for users like satisfied in using the web site, interaction with the web site is enjoyable for them, attain their objectives efficiently and effectively, trust in the web site, become loyal and help to recommend the product or service to others [6].

Usability considered as high level characteristics in Web-QEM but not in other website quality evaluation models. In general, the quality characteristics that represented by how easy user interfaces of the websites are easy to use are called usability [2]. In the proposed quality evaluation framework usability characteristic is replaced by operability but the same concept used to assess the quality of website. The overall quality of website considered for evaluation is calculated by summing up the individual quality obtained for the sub-characteristics encompassed under the operability. The sub-characteristics grouped under operability are: understandability, effectiveness, flexibility, interactivity, customization, learnability, multiple-lingual and aesthetics.

##### **i. 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 [2]. The way in which the website components are organized also complicate or simplify the understandability of the website. In order to illuminate confusion on user the components available on the webpage of the website should be in the way users understand. 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 [33].

##### **ii. Interactivity**

The interactive sub-characteristic in the framework concerned with the way by which end users and website communicate [33] [13]. Therefore, under this sub-characteristic facilities provided by the website which support the interaction of visitors or users with website are evaluated from the webpage of the website considered for evaluation. Specifically, in interactivity sub-

characteristic the interactive feedback between users and website are available. This can be made possible through email, FAQ, online community and suggestion form [33].

### **iii. Customization**

Customization sub-characteristic addresses the degree of the website can be tailored according to the needs and ability of specific users [16]. The visual aspects of people can be different based on the age interval of users which result in the needs of website available in different text sizes. The researchers proved that “Young people may be attracted by flashy graphics, sounds, and a high-speed interface and older people do not want blinking texts that are hard to read or animations that distract them from the use of the website” [33]. Therefore, in such cases when the needs of users are become different from one another customization plays great role on the usability of the website.

### **iv. Learnability**

The website should not be headache for the users while using it. There should be help features and other materials alternatively to make use of website easy for first time visitor [2]. The website overall design should be in such a way that he/she can be easily go through and find information they want for users.

### **v. Multiple-lingual**

Users may not able to understand the language by which the website is working, so in order to make any user to use with any language they want, the website should support multiple language [12] [2].The multiple-lingual sub-characteristic of the proposed framework dealt with the how many languages are supported by the website in order to switch it from one language to another language based on the user preferences. The website of Ethiopian healthcare website is designed for Ethiopian nation and nationalities. To be accessed by all nation and nationalities at least it should support nine regional states language in addition to English which is international language.

### **vi. Aesthetics**

As defined in MiLE website quality model aesthetics is a quality factor that assesses the graphic design and template of the website, the type of font, color, size, images, and other graphic features in a website [12]. Aesthetics used to measure the degree of attractiveness of the website to be used by the end user of the website. The researchers proved that the degree of using website increase if the user interfaces of the website are attractive, enjoyable and pleasant enough to create an emotional appeal to use the site [2]. Therefore, using of colors, audios, videos and other medias on the website should developed by taking in to account the wide range of users preferences. Number of links on the webpage should also limit to the international standards and website design guidelines.

### **4.7.3. Reliability**

Reliability characteristic is considered as high level characteristics in ISO 25010, Web QEM and other software quality evaluation models discussed under chapter 2 of this report [29] [2]. Reliability used in the proposed framework to access the websites components' maturity, which means is the websites navigation and links are matured enough for users [10]. Navigation and links maturity are measured in terms of whether links on the website leads to some information expected from the phrase of the link name [29]. The absences of features are not happened to user because of the browser they are using. In the proposed framework reliability of the healthcare website is the summed result of individual quality such as availability, fault tolerance and recoverability. The descriptions of three sub-characteristics of reliability in the proposed Ethiopian healthcare website quality evaluation are given as follows.

#### **i. Availability**

The availability sub-characteristic addressed the website can be accessible and online for users to use at any time they want to access at anywhere they want to access.

The availability measure the website whether it available 24 hour per day and 7 day per week (24X7) [2].

#### **ii. Fault tolerance**

The fault tolerance sub-characteristic of the proposed framework deals with how the website keeps its level of performance even if there are faults in the website while users are using the function of the website. Each and every links should work correctly and lead user to the page it is linked to.

#### **iii. Recoverability**

The recoverability sub-characteristic in the proposed framework included to address how the website can return to its previous working state even if faults happen to the website.

### **4.7.4. Performance efficiency**

The performance efficiency in the proposed healthcare website quality evaluation framework is used to address loading speed of the website and easiness of accessibility of the website while users are using the website on different devices as well as different browsers. The performance efficiency is a modified name of efficiency in ISO 25010 because efficiency in other website quality models is used to address the combination of performance and efficiency indicators of the website [29] [10]. The performance efficiency characteristic of the healthcare website in the proposed evaluation framework can be calculated by summing up the individual quality result of accessibility, time behavior and resource utilization sub-characteristics as discussed below.

#### **i. Accessibility**

Accessibility considered as a quality factor in MINERVA website quality evaluation model and used to address easy access of the website to all users (access for blind users, those with relative vision, or users with hearing problems), the possibility of using a variety of technologies to present information to users, and the functionality with a variety of explorers, operating systems, and devices [12]. The central idea of accessibility as concluded by researchers is about website used by large number of users with different preferences and different level of disabilities [16]. The definition given for the accessibility sub-characteristic in the proposed evaluation framework is the same with previous one. The accessibility sub-characteristic is used to measure the efficiency of the website.

### **ii. Time behavior**

The time behavior of the website used to measure the time to load the webpages of the website when users are using it. The amount of time the website takes to load or perform tasks should be short as well as users should be able to open pages within few clicks [2]. Page size plays great role on the quick loading abilities of website [29]. Smaller page sizes can be loaded quickly while bigger size webpages takes time to load.

### **iii. Resource utilization**

The resource utilization sub-characteristic of the proposed framework used to deal with the amount of resources the product required to operate and perform required activities. The page sizes also have a matter on the resource utilization. This means, if the page size is larger the website need larger size resource while its page size is small it needs smaller resource.

## **4.7.5. Content**

Content characteristic is considered as a characteristic in MiLE and 2QCV3Q quality evaluation models discussed under chapter 2 of this report. The content characteristic in the previous models and related works are used to assess information on the page of the website in multiple dimensions such as currency, authority, accuracy, relevance, multiple formats [2] [11] [7]. The content characteristics of the proposed evaluation framework used to deal with the quality of information on the each and every page of the website which is open for the end users to access the page. As it is proved by previous researchers on the area of healthcare website quality information have a great weigh. Information posted to the healthcare website which accessed by the end users should be first validated by health professionals for its completeness and accuracy. Word error and sentence error should be ignored in the information posted for end user on the healthcare website.

Content of the website are tried to defined by different researchers in the different website quality evaluation models even if the criteria's included under it is not enough. Content of the website as discussed in the MiLE website quality evaluation model is encompasses of quality of information on the pages of website depending on the intended user of the website and domain of

the website. Content of the website as discussed in the 2QCV3Q website quality evaluation model is composed of all about accuracy of information and coverage of information on the page of website.

Researchers in the area of healthcare proved that quality of information posted on the website is ranked in the first order while compared with characteristics of the website like functional suitability, operability, performance efficiency and reliability. The overall quality of information on the website measured from summing up the individual quality level of the following sub-characteristics listed and discussed as follows:

**i. Relevancy**

The information provided by the website depends of the domain of the website which means for medical domain the website holds information about health related for users [7] [33]. The relevance sub-characteristic used to measure whether the healthcare website holds information related to medical or not. Relevance of information on the healthcare website is depending on the satisfaction of the different user of the healthcare website. The potential users of healthcare websites are as listed in the chapter 3 of these report patients, doctors, physicians, and so on. Even though, the relevance of the information on the healthcare website is for all users the research only focuses on the patients' relevance.

**ii. Up-to-datedness**

The up-to-datedness sub-characteristic included in the proposed evaluation framework in order to assess the website posted on the website is quickly replaced by the newest version of information and is there any indication which identifies the newly posted information from the oldest one [33]. The establishment of healthcare website is for the improvement of society health therefore, the website information should be updated as much as possible quickly.

**iii. Authority**

The authority sub-characteristic of the proposed quality evaluation framework used to assess whether the author of the information on the healthcare website is clearly visible to patients or not in order to increase the confidence of users to use the website for the next time as well as for their life time to get health related information. The clear distinction between author of the information on the website page and webmaster should be indicated for users. The reference to the external information also should be clearly provided for the users [2].

**iv. Variety of presentation**

The variety of presentation sub-characteristic in the proposed framework addresses the metrics such as information on the website should be available for users in different formats like word document, pdf document, video and audio formats to make it comfortable to access [33]. The

advantage of making content and information available for user is user can interact with the format they selected freely.

#### **v. Impartiality**

The impartiality sub-characteristic in the proposed framework addresses the concept of each and every information posted on the website should be in objective manner to all users of the healthcare website. The healthcare websites should be free from political, cultural, religious partiality and it should in a neutral way [33].

#### **vi. Comprehensiveness**

The comprehensiveness sub-characteristic in the proposed framework used to addresses whether information posted on the healthcare website covers everything users expected from the website or not. Comprehensiveness of information increases satisfaction of user while using the website and initiate users to use again the website while they need health related information [33].

#### **vii. Identity**

The identity sub-characteristic of the proposed framework used to addresses whether the logo of healthcare institution is available or not as well as the owners of the page is clearly described for users. The identity used to clearly identify who own the website and who responsible for the information posted on the page of the website which in turn increases the confidence of users to use the website and recommend it to others.

#### **viii. Accuracy**

The accuracy sub-characteristic of the proposed framework used to measure the level of correctness of information on the healthcare website. The accuracy of health related information can be improved by reviewing information by specialist before posting it for user on the healthcare website. The accuracy of information can be judged from identification of the sources of information and reliability of them, information exactness, lack of spelling or grammar errors and legal in website [33].

#### **iv. Contact**

The contact sub-characteristic added to the proposed framework to assess the existence of clearly written contact information such as telephone numbers, email addresses, location of the healthcare provider in map or in text or in relative location. The age of the hospital also increase the awareness of the user on the hospital if provided on the hospitals website or healthcare providers' website [17].

#### **4.7.6. Service**

The service characteristic in the proposed framework included to assess the quality of services provided by the healthcare websites for end users. In Web-QEM website quality evaluation model service characteristic addressed as a domain specific functional qualities which includes services made available by the website for a website users in a particular domain of the website and the service of the website different from one to another depending on the domain of the website [29].

MiLE and 2QCV3Q website quality evaluation models gave the same name and definition for the service characteristic which is used to measure the overall functionalities provided by the website for the end user and the level of that particular functionalities that perform the required task for user with easily understandable way for users [12]. Therefore, the usefulness of services provided by the website depends on the domain of the website. In healthcare website researchers investigated and concluded deciding that the service must be included as characteristic [33].

The overall quality of service characteristic in the proposed framework is calculated from the individual result of multiple sub-characteristics categorized under it. Those sub-characteristics are listed and described in understandable format as below.

#### **i. Reception**

The reception sub-characteristic added to the proposed framework to measure the existence of service that facilitate the registration of new patients, provide about bed information, information on different departments and information on the available medical staffs of the healthcare providers on the healthcare website. This feature also facilitates patients to register for treatment, pay required bills for reservation they made, make appointment for treatment, get the presence information of medical specialist to make available them self physically at the healthcare center providers [33]. Providing full functional and easily accessible internet reception also increase the popularity of the website in addition to making the website have more users because of it saves time for patients.

#### **ii. Settlement**

The settlement sub-characteristic added to the proposed framework to assess whether the payment for the service they are going to occur from the healthcare provider can be possible using the website or not. In case of the emergency time this feature of the healthcare website provides great advantage to decrease the time of face to face payment. The existence of Internet settlement service of healthcare providers' bills, simplicity of paying methods, variations in paying methods for patients are among the most important features a hospital or medical website can provide for its patients [33].

#### **iii. Medical consult**

The medical consult sub-characteristic added to the proposed framework to measure the existence of free medical consult for patients not able to come at the healthcare center for face to face treatment by doctor. Since, there is a healthcare website which provides health related issues the patients should not sleep at their home until they die, they can use the website and get information from the appropriate doctors. The medical consult should be available for users as much as website is online and accessible at nights and at holidays when the scarcity of medical specialists happen most of the time. This service should be considered as a specialized service provided by the healthcare centers staff and it in turn increase the popularity of the website and number of website users.

#### **iv. Medical information**

The medical information sub-characteristic added to the proposed framework in order to assess whether the information on the medical website is contains correct, complete, and comprehensive for different diseases, medical treatments and prevention methods [33]. If medical information posted and accessed by wide range of users is valuable for them then the number of visitors increase to use the website.

#### **v. Communication**

The communication sub-characteristic added to a proposed framework to assess whether the website facilitates the connection between staff professionals and patients need consult from the staff or not. It also includes communication of a doctor with other doctors in order to consult or interchange the information through doctors' communities, helps to improve their knowledge. The healthcare website should support patients to communicate with particular doctor for consulting and treatment, free of charge consulting then the quality of the website increment through the visitors' viewpoint [33].

#### **vi. Newsgroup**

The newsgroup sub-characteristic added to the proposed framework to assess on the page of the website as there is news on the most recent medical achievements, medical issues, and health related information. The level of quality of the service provided by the healthcare websites to send weekly or monthly emails and news letters about the most recent information.

#### **vii. Updating list**

The updating list sub-characteristic included in the proposed framework to measure the level of website updates and presenting or showing the updated component on the first page of the website as users can easily identified what updates are exist on the website page. It is all about informing the end users of the website about newest and most up-to-date information added to the website [33].

#### 4.8. Quality evaluation criteria(Indicator) for the proposed framework

In this section detail description for the proposed Ethiopian healthcare website evaluation metrics are discussed. The high level and sub-characteristic under which the metrics categorized also listed down hereunder for the sake of making clear the use of metric. The purpose of metrics also described with the aim why the metric included in the framework. This means the metrics added to the proposed evaluation framework to measure which website quality sub-characteristic.

**Table 12: Quality evaluation indicators for the proposed framework**

Characteristics	Sub-characteristics	Indicators	Purpose of indicators
Functional suitability	Search	<ul style="list-style-type: none"> <li>• Scoped search</li> <li>• Global search</li> </ul>	<ul style="list-style-type: none"> <li>• Website provides function to search option on type of disease, doctors, physicians then patients select their own desire to search</li> <li>• Search available on all page of the website to decrease the journey to the home page</li> <li>• User can search using keyword what they want from the website</li> <li>• The search find relevant information for user by sweeping the entire site</li> <li>• The search result of the user must be short and brief as user expect it to be</li> </ul>
	Navigation	<ul style="list-style-type: none"> <li>• Backward navigation</li> <li>• Current location</li> <li>• Finding home page</li> <li>• Navigation prediction</li> <li>• Scrolling</li> </ul>	<ul style="list-style-type: none"> <li>• Users must be able to browse to the previous or home page from current page</li> <li>• Users must be able to know where they are</li> <li>• Users must be able to go to the main page of the website from any page with single click</li> <li>• The name of the link title should be descriptive and must clearly tell to user where they go to save their time</li> <li>• Appropriate horizontal and vertical scrolling of the content of the webpage, menus, and others should be available to make the site comfortable to use</li> </ul>
	Suitability	<ul style="list-style-type: none"> <li>• Appropriate functionalities provided to users</li> </ul>	<ul style="list-style-type: none"> <li>• Services provided by the website is expected by the users</li> <li>• Everything user want from the website implemented as a functionality and work</li> </ul>

			for users
Operability	Understandability	<ul style="list-style-type: none"> <li>• Website help users how to move through the website</li> <li>• Term used are understandable</li> </ul>	<ul style="list-style-type: none"> <li>• Website must be implemented in different methods like sitemap, alphabetical index, table of contents, image maps in order to provide help how user easily understand the structure of the website</li> <li>• The terms used on the website for information posted on its page should consider the ability of the users</li> <li>• Words used in the website should be in the consideration of the users experience</li> </ul>
	Interactivity	<ul style="list-style-type: none"> <li>• Facility for users to ask question</li> </ul>	<ul style="list-style-type: none"> <li>• The website must support user how to use the website</li> <li>• FAQ and feedback function must be available for user for collecting user comment on the website</li> <li>• Summary answer of the users question should answer because of it represent many users opinion</li> </ul>
	Customization	<ul style="list-style-type: none"> <li>• Website allows user selection on content and function they need</li> </ul>	<ul style="list-style-type: none"> <li>• The website must allow the users to configuration on layout, content and functionality based on their desire</li> <li>• With low effort website support the end users to deliver their own math function, colors, size and etc.</li> </ul>
	Learnability	<ul style="list-style-type: none"> <li>• Easy to learn how to use the website</li> </ul>	<ul style="list-style-type: none"> <li>• Users learn how to use the website with minimal effort</li> <li>• Familiarity of user interfaces with users previous experience decrease learning time for users</li> </ul>
	Multiple-lingual	<ul style="list-style-type: none"> <li>• Multiple language supported by the website</li> </ul>	<ul style="list-style-type: none"> <li>• In order to make the website clear and useful for all users of the website it should be presented in different Ethiopian languages by considering the nation and nationalities of Ethiopia</li> </ul>
	Aesthetics	<ul style="list-style-type: none"> <li>• Clear text layout, page layout, font size and font color</li> </ul>	<ul style="list-style-type: none"> <li>• Page should not be overcrowded with texts, links and information's</li> <li>• Label colors, spacing character's, font sizes, background and position of navigation should be clear</li> </ul>
	Availability	<ul style="list-style-type: none"> <li>• Downtime and</li> </ul>	<ul style="list-style-type: none"> <li>• The website must be available for 24X7</li> </ul>

Reliability		uptime	
	Fault tolerance	<ul style="list-style-type: none"> <li>• Link error</li> <li>• Orphan pages</li> <li>• No absence of feature</li> </ul>	<ul style="list-style-type: none"> <li>• Links should take users to the place the link name inform user or to the page user predict from the link name</li> <li>• There should not be invalid link or not exist links which means not lead to any page than error</li> <li>• There should not be the absence of features of the website due using the browser on different browser</li> </ul>
	Recoverability	<ul style="list-style-type: none"> <li>• Time to recover</li> </ul>	<ul style="list-style-type: none"> <li>• After the error occur the website should take minimum mean time to recover to its last stage</li> </ul>
Performance efficiency	Accessibility	<ul style="list-style-type: none"> <li>• Information accessibility</li> </ul>	<ul style="list-style-type: none"> <li>• Information on the website and website itself able to available in a text-only version</li> <li>• Information on the website and website should support multiple browser with the same content availability</li> </ul>
	Time behavior	<ul style="list-style-type: none"> <li>• Load time</li> </ul>	<ul style="list-style-type: none"> <li>• Time delay of finding the website and displaying its page must be less than 15 seconds</li> </ul>
	Resource utilization	<ul style="list-style-type: none"> <li>• Smaller website size</li> </ul>	<ul style="list-style-type: none"> <li>• Static page of the website size should be as much as possible smaller to save resources</li> <li>• The website should support the readability by deactivating browser image features</li> <li>• Lower size website needs lower space to access</li> </ul>
Content	Relevancy	<ul style="list-style-type: none"> <li>• Patient- oriented information</li> </ul>	<ul style="list-style-type: none"> <li>• Information posted on the website should be in focus of patients or on a medical related information's as much as possible</li> </ul>
	Up-to-datedness	<ul style="list-style-type: none"> <li>• Website last update indicator</li> <li>• Author information</li> </ul>	<ul style="list-style-type: none"> <li>• Page when information created and updated should be indicated clearly</li> <li>• On order to increase the users confidence the author and its professional detain should be indicated clearly</li> </ul>
	Authority	<ul style="list-style-type: none"> <li>• Reference to citation used</li> <li>• Qualification of the author of the page</li> </ul>	<ul style="list-style-type: none"> <li>• The detail of the author for reference should be clearly written for user and resource used also referenced carefully</li> <li>• Detail of the author like level of education, certification and etc. should</li> </ul>

			be indicated
	Variety of presentation	<ul style="list-style-type: none"> <li>• Format of content</li> </ul>	<ul style="list-style-type: none"> <li>• Information should be made available for user in the multiple formats like word documents, pdf documents and text documents</li> </ul>
	Impartiality	<ul style="list-style-type: none"> <li>• Objective information</li> </ul>	<ul style="list-style-type: none"> <li>• Information or anything appeared on the content of the website should not be in a need of specific group and it should be respect every users culture, norms etc.</li> </ul>
	Comprehensiveness	<ul style="list-style-type: none"> <li>• Scope of information</li> </ul>	<ul style="list-style-type: none"> <li>• Medical information on the website should be in a way it contains all necessary information to satisfy the need of patients, doctors and other viewers.</li> </ul>
	Identity	<ul style="list-style-type: none"> <li>• Website mission and vision</li> <li>• Website property</li> <li>• Healthcare providers logo(brand)</li> <li>• Copyright information</li> </ul>	<ul style="list-style-type: none"> <li>• Detail information of the mission and vision of the healthcare provider should clearly available on the website</li> <li>• The healthcare providers logo must be available on the website main page for the user to identify easily</li> <li>• Copyright information should be available on the website in a visible place</li> </ul>
	Accuracy	<ul style="list-style-type: none"> <li>• Grammar and spelling error</li> <li>• Clear information</li> </ul>	<ul style="list-style-type: none"> <li>• In order to avoid confusion on the content or information viewer specifically patients, grammar and spelling error should be avoided</li> <li>• Information posted on the website should be complete</li> </ul>
	Contact	<ul style="list-style-type: none"> <li>• Address detail</li> </ul>	<ul style="list-style-type: none"> <li>• Contact information such as telephone number, email address, location of the healthcare center should be clearly presented</li> </ul>
Service	Reception	<ul style="list-style-type: none"> <li>• Inpatient reception information</li> <li>• Outpatient reception information</li> </ul>	<ul style="list-style-type: none"> <li>• Inpatients should be clearly informed about free beds, department and doctor available, pay fee, related forms from the website</li> <li>• Outpatients should be clearly informed how to register for the appointment for to meet the doctor they are looking for, receiving follow up code, and availability of specialist in the hospital</li> </ul>
	Settlement	<ul style="list-style-type: none"> <li>• Payment information</li> </ul>	<ul style="list-style-type: none"> <li>• The website should inform different payment option to be treated at the</li> </ul>

		<ul style="list-style-type: none"> <li>hospital</li> <li>In case of emergency time this helps to save time and life</li> </ul>
Medical consult	<ul style="list-style-type: none"> <li>Medical related advice available</li> <li>Consult time and date available</li> </ul>	<ul style="list-style-type: none"> <li>The website should support or provide a page that doctors, specialists, physicians, and etc. use to provide advice for patients freely</li> <li>The time of patients can get advice from which specialist should be informed by the website to user with date</li> </ul>
Medical information	<ul style="list-style-type: none"> <li>Exclusive healthcare providers information</li> <li>Link to other medical related information</li> </ul>	<ul style="list-style-type: none"> <li>The available hospital specialist those patients not get from others should be informed clearly</li> <li>Facilities only received in the hospital also clearly provided to users</li> <li>Job opportunities also provided</li> <li>Introducing doctors schedule, address and hotels, parking lots as well as shopping around the hospital</li> <li>Link to medical related systems and websites should presented like Ministry of health, Patient information Management system and etc.</li> </ul>
Communication	<ul style="list-style-type: none"> <li>Health professional to patients</li> <li>Health professional to health professional</li> <li>Social media support</li> </ul>	<ul style="list-style-type: none"> <li>The website should provide a service that enables patient get communication with health professionals</li> <li>The website should support exchange of information between professionals</li> <li>The website should support the social media interaction of end users and professional</li> </ul>
Newsgroup	<ul style="list-style-type: none"> <li>Inform new issue</li> <li>Calendar related issue</li> </ul>	<ul style="list-style-type: none"> <li>The website should help the member to receive weekly or monthly email, newsletter about most recently medical achievements, warnings and etc.</li> <li>The website should support presenting of hospital calendar on anything to member</li> </ul>
Updating list	<ul style="list-style-type: none"> <li>New information posted</li> <li>Where it posted</li> </ul>	<ul style="list-style-type: none"> <li>The website should provide a place to post new or host issue</li> <li>Presenting newly updated information on the main page and marking as it is new post increase its visibility</li> </ul>

**Summary:**

Quality evaluation framework contains characteristics, sub-characteristics and quality indicators as prescribed in the existing software and website quality evaluation models and which is highly relevant to evaluate the website it is intended to evaluate than the existing models and standards. The proposed framework for quality evaluation of Ethiopian healthcare website contains properties of website that patients user expected from it. Therefore, in this chapter for the proposed framework; characteristics, sub-characteristics as well as metrics was discussed which can be measured from the webpage of healthcare websites directly and in the next chapter the result of testing the proposed framework on three case study websites in the form of questionnaire with target users will be discussed.

## CHAPTER 5: TESTING THE PROPOSED FRAMEWORK

The aims of this chapter are two things those are: first, to test the proposed quality evaluation framework for Ethiopian healthcare website and secondly, evaluating level of quality the websites those are selected for a case study. The proposed quality evaluation framework tested by applying it as a case study to the selected website and analyzing of its reliability. The detail description of the chapter is discussed below.

### 5.1. Applying the proposed framework to case study Website

As listed in the table below questions was designed and grouped under which quality characteristics and subcharacteristics they are intended to address. The detail steps used to generate the questions listed in the table are discussed in the chapter 3 or methodology section of this report. In addition to the questions listed, the proposed framework comprehensiveness also showed by comparing the available software quality evaluation model in the area of healthcare website quality evaluation. The components of the proposed framework such as high level characteristics, subcharacteristics, indicators(metrics) and question to address each metrics was derived from existing standards, guidelines, models and frameworks researched by different researchers which makes the proposed framework strong enough to evaluate the healthcare website it was proposed for.

As discussed under chapter 3 of this report, the questionnaire derived from the proposed quality evaluation framework and applied to the case study websites. The results of the case study websites are discussed as follows.

**Table 13: Comparison of proposed framework with ISO/IEC 25010 model**

<b>Characteristics</b>	<b>Sub-characteristics</b>	<b>ISO/IEC 25010-1</b>	<b>Proposed Framework</b>	<b>Questions-to address the metrics</b>
Functional suitability	Search		Y	1,2
	Navigation		Y	3,4,5,6,7,8
	Suitability	Y	Y	9
Operability	Understandability	Y	Y	10,11
	Interactivity		Y	12
	Customization		Y	13
	Learnability	Y	Y	14
	Multiple-lingual		Y	15,16
	Aesthetics		Y	17
Reliability	Availability	Y	Y	18
	Fault tolerance	Y	Y	19
	Recoverability	Y	Y	20
Performance	Accessibility	Y	Y	21,22,23,24

efficiency	Time behavior	Y	Y	25,26
	Resource utilization	Y	Y	27
Content	Relevancy		Y	28
	Up-to-datedness		Y	29,30
	Authority		Y	31,32
	Variety of presentation		Y	33
	Impartiality		Y	34
	Comprehensiveness		Y	35
	Identity		Y	36,37
	Accuracy		Y	38,39
	Contact		Y	40
Service	Reception		Y	41,42
	Settlement		Y	43
	Medical consult		Y	44,45
	Medical information		Y	46,47,48
	Communication		Y	49
	Newsgroup		Y	50,51
	Updating list		Y	52,53

- “Y” represents the quality characteristics available in the model and framework.
- The blank indicates characteristic not available in ISO 25010 quality model

The detail of questionnaire used for testing the proposed framework attached to this document on the APPENDIX D.

## 5.2. Analysis of the data collected

Data collected from end user in the form of questionnaire. The questionnaire made available for participants on the <http://ethiohealth.000webhostapp.com> website and the address distributed to the participants through IT workers in the hospital and incorporation of the researcher. The website contains the page that takes users to three selected websites and to the questionnaire used to evaluate the websites. In addition to this, the website contains contact page and address details of the researcher as well as aim of the questionnaire.

Among the intended 210 participants to evaluate three Ethiopian hospital websites as a case study websites selected, only 140 respondents evaluated the case study website with valid data. Others didn't provide demographic information's correctly and others refused the evaluation. 64 respondents evaluated Kadisco general hospital website with valid data, 34 respondents evaluated St. Paul's hospital millennium medical college with valid data and 42 respondents' evaluated Wudassie diagnostic center website with valid data.

The results of the respondents are discarded from the data if the respondents not know any hospital website in Ethiopia, having the concept that if evaluators at least know the healthcare

website they may know what information and services are expected from the health related websites.

Finally, 140 respondents response on three selected case study website and their responses considered for analysis and validation of tools as well as to identify the level of quality of each websites from the end user perspectives. Hospital IT workers was participated in informing of the questionnaire address and the aim of questionnaire was informed to the respondents in parallel.

The questionnaire was aimed to be used by the respondents those at least understand the terms in the area of the website like links, home page or first page, pages and etc. respondents are asked to browse through the website before going to the questionnaire page.

The summary of demographic information of the respondents those participated in evaluation of the three case study website was summarized as follows:

1. Among sixty four (64) respondents of KGH evaluators; their education level (4 of them are high school complete, 23 of them diploma level, 25 first degree and 12 are second degree), their gender (male 40 and female 24), their experience of visiting KGH website in Ethiopia (46 visited before and 18 not visited before) and their frequency of using KGH website 47 was visited based on needs as well as 17 was for their first time. The graphical representation of the summary of respondents given below in chart with the percentages.

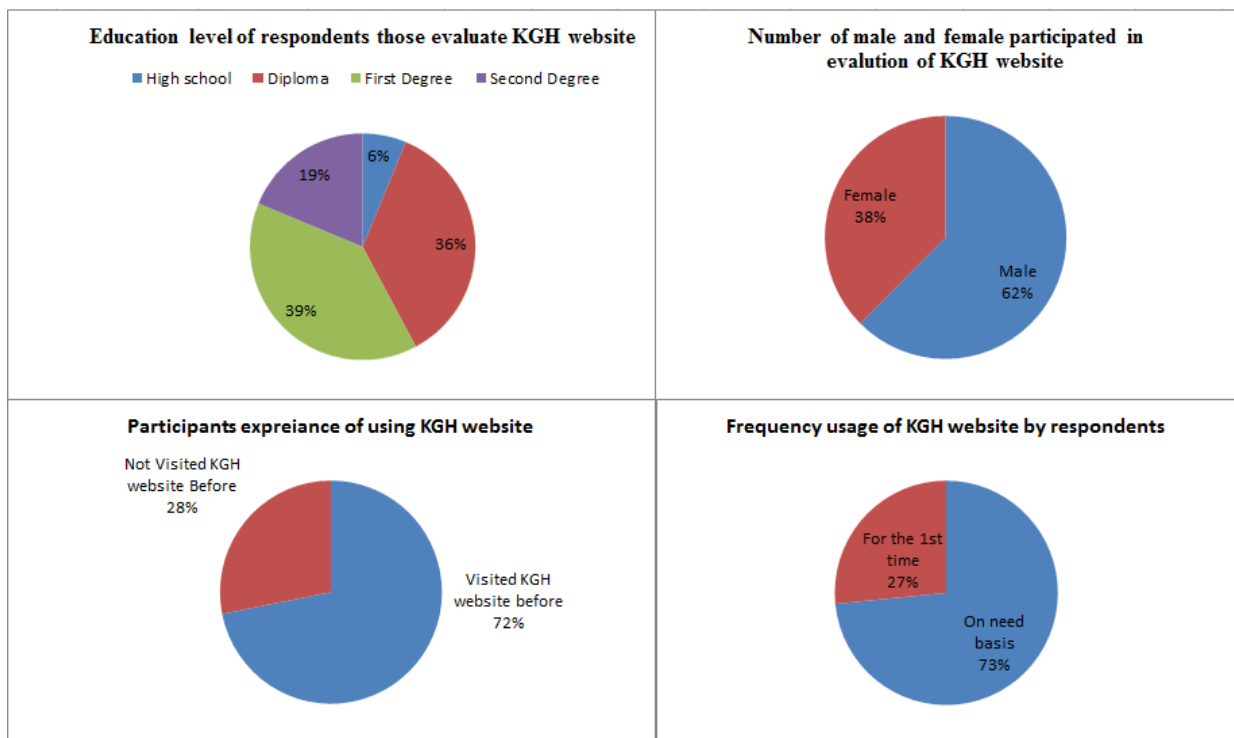


Figure 12: KGH evaluator's demographic information

2. Among forty two (42) respondents of WDC evaluators; their education level (3 of them are high school complete, 7 of them diploma level, 27 first degree and 5 are second degree), their gender (male 28 and female 14), their experience of visiting WDC website (19 visited before and 23 not visited before) and their frequency of using WDC website (monthly 3, based on their needs 16 and 23 used for the first time). The graphical representation of the summary of respondents given below in chart with the percentages.

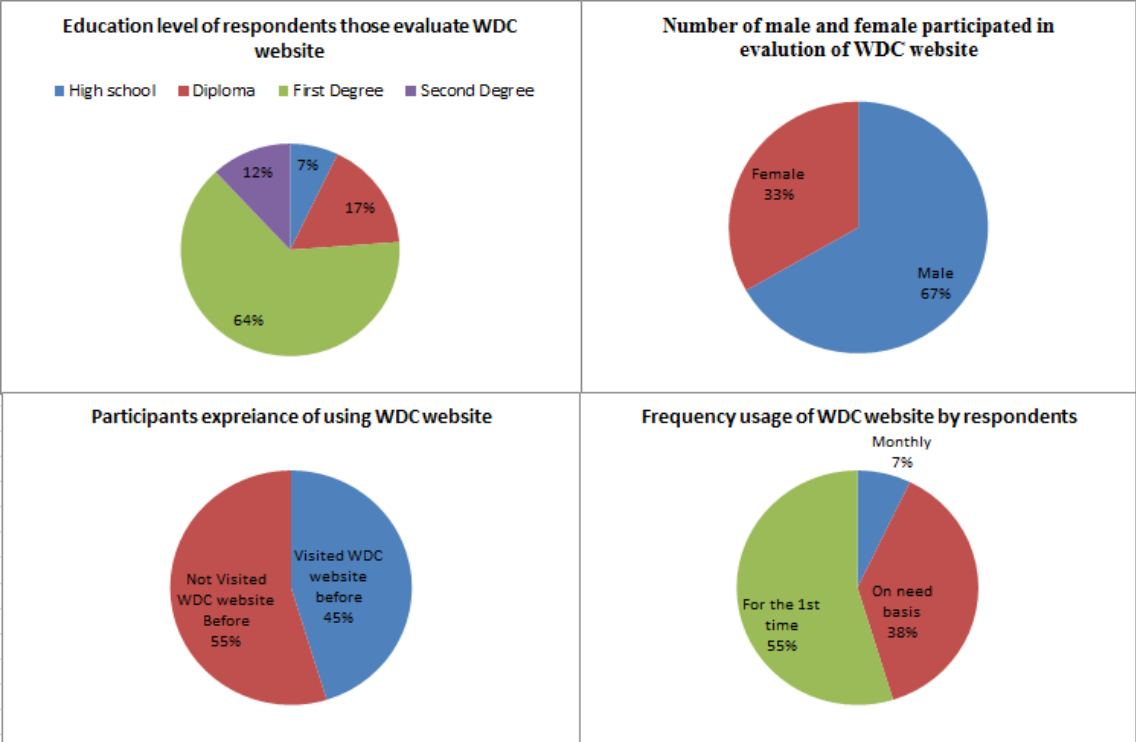


Figure 13: WDC evaluator's demographic information

3. Among thirty four (34) respondents of SPHMMC evaluators; their education level (5 of them are high school complete, 1 diploma level, 20 first degree and 8 are second degree), their gender (male 27 and female 7), their experience of visiting SPHMMC website (28 visited before and 6 not visited before) and their frequency of using SPHMMC website (monthly 3, based on their needs 25 and 6 used for the first time). The graphical representation of the summary of respondents given below in chart with the percentages.

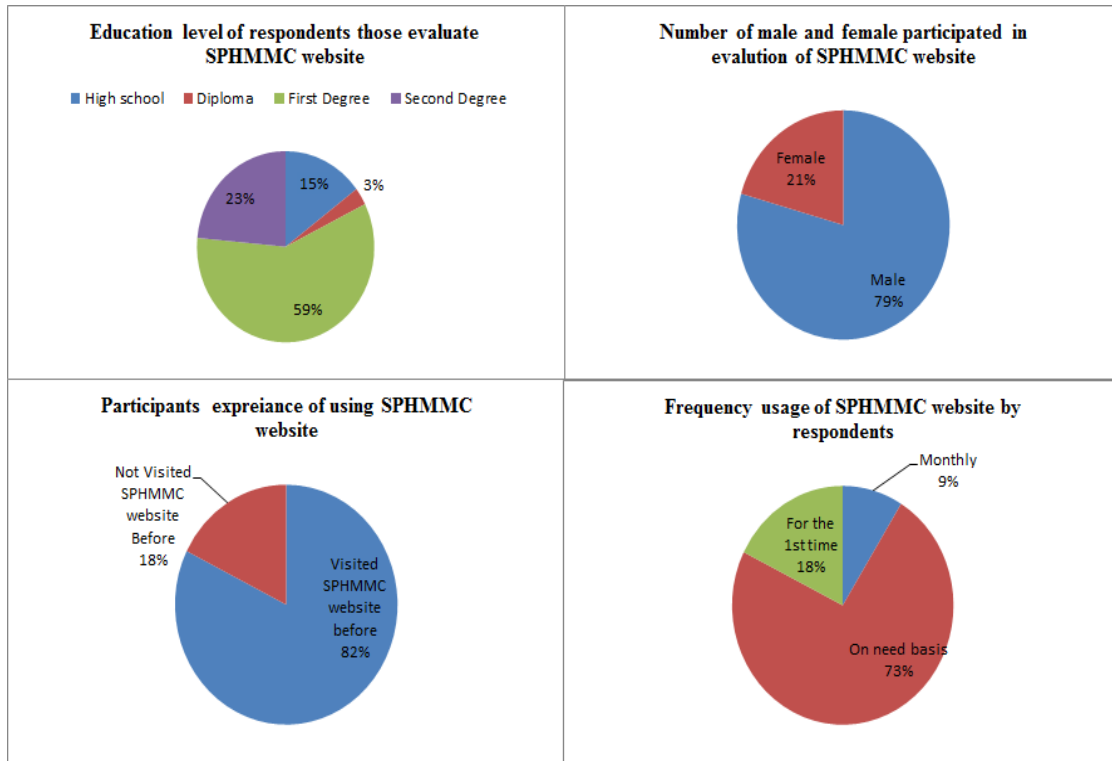


Figure 14: SPHMMC evaluator's demographic information

### 5.2.1. Reliability analysis of Items in the proposed framework

The reliability of items (questions in a questionnaire) in a proposed framework analyzed using Cronbach's alpha and item-total correlation. As discussed in the chapters 3 of this report Cronbach's alpha and item-total correlation are used to measure the internal consistency of the questions used in a questionnaire. The rule-of-thumb of the Cronbach's alpha says the internal consistency is high in the items if the value of Cronbach's alpha is greater or equal to 7 [34].

The item-total correlation in a tool should be positive and if item negatively correlate to the total item in a tool there should be need to modify the item or remove the item [2]. As discussed in chapter 1 of this study the proposed quality evaluation framework for Ethiopian healthcare websites internal consistency was intended to be proved by applying the framework to existing hospital websites and analyzing the result in order to measure the reliability of the tool.

The proposed quality evaluation framework applied to KGH, WDC and SPHMMC healthcare websites in the form of questionnaire. The questionnaires prepared from the metrics in the proposed quality evaluation framework and are used to gather the level of agreement of users as a patient on the hospitals website. Many researchers in the area followed the same way which is preparing questionnaire for validating the proposed quality evaluation framework [1] [4] [39] [43] [2] [33]. The reliability of proposed framework discussed in the next section which was interpreted from the output of R software and Microsoft Excel.

The Q1, Q2, Q3, Q4... Q53 in the data analysis part was used to represent 53 questions in a questionnaire, those used to collect data. The short form used to represent the longest question in the data analysis.

The reliability of the new quality sub-characteristics in the proposed quality evaluation framework applied to three hospital websites are discussed as follows:

**Table 14: Total Cronbach’s alpha value of the proposed framework**

<b>Websites</b>	<b>KGH website</b>	<b>WDC website</b>	<b>SPHMMC website</b>
<b>Alpha reliability</b>	<b>0.9412</b>	<b>0.9378</b>	<b>0.7795</b>
<b>Number of items(Questions)</b>	<b>53</b>	<b>53</b>	<b>53</b>

The value of the Cronbach’s alpha in the table above shows the proposed quality evaluation framework for Ethiopian healthcare website applied to a three Ethiopian healthcare website and its reliability were in the interval of Excellent (on KGH website and WDC website) and Acceptable on the SPHMMC website.

The value of Cronbach’s alpha greater than 0.7 means the internal consistency of the items (questions) used in the proposed framework is acceptable internal consistency. If items in the framework have above acceptable internal consistency then the framework proved as valid and can be used in different websites evaluation in the area of healthcare websites.

The full reliability analyses for 53 questions in the proposed framework are available on the **APPENDIX E** of this report.

The table below contains necessary information regarding the internal consistency of the items in the framework. The alpha reliability if items deleted indicates the value of Cronbach’s alpha if that particular question removed from the framework. If alpha reliability after items are deleted greater than the alpha reliability when item exist, it can be possible to remove the item from the framework [2].

The result of scale reliability of items for the new quality metrics in a proposed quality evaluation framework applied to three Ethiopian healthcare websites are given in the table below:

Table 15: Scale reliability for new quality metrics in the proposed framework

Reliability deleting each item in turn:						
Items	KGH website		WDC website		SPHMMC website	
	Alpha	r(item, total)	Alpha	r(item, total)	Alpha	r(item, total)
Q.1	0.9424	-0.0396	0.9348	0.6996	0.7854	-0.2436
Q.2	0.9438	-0.3959	0.9344	0.7763	0.7823	0.0399
Q.3	0.9363	0.9194	0.9352	0.7352	0.7714	0.3714
Q.4	0.9376	0.8053	0.9372	0.3743	0.7652	0.5718
Q.5	0.9366	0.9336	0.9368	0.4675	0.7825	-0.0780
Q.6	0.9389	0.6995	0.9361	0.5494	0.7686	0.6013
Q.7	0.9363	0.9206	0.9363	0.5648	0.7674	0.5583
Q.8	0.9372	0.8238	0.9347	0.8348	0.7747	0.3050
Q.12	0.9471	-0.5660	0.9357	0.6105	0.7723	0.3341
Q.13	0.9434	-0.3526	0.9378	0.2395	0.7761	0.2258
Q.15	0.9425	-0.0666	0.9370	0.4117	0.7646	0.6683
Q.16	0.9426	-0.0878	0.9403	-0.0193	0.7835	-0.0729
Q.17	0.9382	0.7650	0.9405	0.0062	0.7760	0.2282
Q.28	0.9379	0.8674	0.9368	0.4536	0.7761	0.2590
Q.29	0.9424	-0.0595	0.9366	0.4793	0.7703	0.4021
Q.30	0.9394	0.7977	0.9375	0.3698	0.7722	0.3260
Q.31	0.9426	-0.0878	0.9378	0.2915	0.7673	0.4174
Q.32	0.9427	-0.1506	0.9361	0.5406	0.7729	0.3071
Q.33	0.9394	0.7977	0.9374	0.3715	0.7785	0.1486
Q.34	0.9414	0.3019	0.9367	0.4792	0.7864	-0.0322
Q.35	0.9378	0.8673	0.9358	0.7139	0.7712	0.4804
Q.36	0.9372	0.8397	0.9362	0.6488	0.7841	-0.0516
Q.37	0.9388	0.6785	0.9362	0.5345	0.7668	0.4783
Q.38	0.9401	0.4726	0.9344	0.7482	0.7675	0.4660
Q.39	0.9419	0.1491	0.9365	0.4817	0.7794	0.1328
Q.40	0.9405	0.3895	0.9426	-0.3820	0.7727	0.3373
Q.41	0.9383	0.7731	0.9361	0.5406	0.7693	0.5764
Q.42	0.9374	0.8342	0.9365	0.5217	0.7796	0.0636
Q.43	0.9457	-0.3556	0.9354	0.6319	0.7716	0.3964
Q.44	0.9412	0.2390	0.9385	-0.0301	0.7817	0.0205
Q.45	0.9375	0.8698	0.9356	0.6108	0.7771	0.1929
Q.46	0.9384	0.7401	0.9396	0.0184	0.7667	0.4834
Q.47	0.9410	0.2739	0.9359	0.6075	0.7885	-0.2656
Q.48	0.9408	0.3315	0.9367	0.4696	0.7881	-0.1696
Q.49	0.9400	0.5232	0.9376	0.3294	0.7818	0.1053
Q.50	0.9393	0.7127	0.9363	0.5382	0.7932	-0.2916
Q.51	0.9426	-0.1084	0.9380	0.2501	0.7881	-0.0919
Q.52	0.9397	0.7527	0.9335	0.9142	0.7970	-0.3202
Q.53	0.9410	0.3038	0.9394	0.0057	0.7914	-0.2870

In the following section the description for the new quality metrics in the proposed quality evaluation framework discussed in terms of the alpha reliability and item-total correlation with in the components of the framework.

### **1. Functional suitability**

In the proposed framework the new sub-characteristics added under functional suitability are search and navigation.

- Search

In the proposed framework Q1 and Q2 were included to measure the search sub-characteristics. The alpha reliability of Q1 and Q2 after question (item) deleted was increased in KGH website (0.9424 and 0.9438 respectively), less in WDC website (0.9348 and 0.9344 respectively) and greater in SPHMMC website greater for Q1 (0.7854) but less for Q2 (0.7823). The item-total correlation were negative for both question in KGH (-0.0396 and -0.3959 respectively), positive for both question in WDC (0.6996 and 0.7763 respectively) and negative for Q1 (-0.2436) but positive for Q2 (0.0399) in SPHMMC website. Therefore, the question used to address the sub-characteristics need modification.

- Navigation

In the proposed framework Q1 through Q8 were included to measure the navigation sub-characteristic. The alpha reliability and item-total correlation of all question designed to address navigation sub-characteristic were internally consistent with all items in the proposed framework, but on question Q5 alpha reliability increased and have negative item-total correlation. Therefore, question Q5 need more clarification in order to make it more usable.

### **2. Operability**

The sub-characteristics added under operability in the proposed framework were interactivity, customization, multi-lingual, and aesthetics those are not addressed in ISO 25010 quality evaluation models.

- Interactivity

In the proposed framework Q 12 were added to measure the interactivity sub-characteristic of the websites. The alpha reliability of the question 12 after Q12 deleted increased in KGH website (0.9471) as well as its item-total correlation was -0.5660 but in both WDC and SPHMMC website the internal consistency of the question was good.

- Customization

In the proposed framework Q 13 were added to measure the customization sub-characteristic of the websites. The alpha reliability of the question 13 after Q13 deleted increased in KGH website

(0.9471) as well as its item-total correlation was -0.5660 but in both WDC and SPHMMC website the internal consistency of the question was good.

- Multiple-lingual

In the proposed framework Q15 and Q16 were added to measure the Multi-lingual sub-characteristic of the websites. The alpha reliability of the question 15 after Q15 deleted; increased in KGH website (0.9425) as well as its item-total correlation was -0.0666 but in both WDC and SPHMMC website the internal consistency of the question 15 was good. The internal consistency of the Q15 in both WDC and SPHMMC websites was good.

**Table 16: alpha reliability and item-total correlation for Q16**

Reliability deleting each item in turn:						
Items	<i>KGH website</i>		<i>WDC website</i>		<i>SPHMMC website</i>	
	Alpha	r(item, total)	Alpha	r(item, total)	Alpha	r(item, total)
Q.16	0.9426	-0.0878	0.9403	-0.0193	0.7835	-0.0729

The table above shows that the question 16 in the proposed framework was internally not consistent in three websites evaluated in a case study. The alpha reliability after question 16 removed was greater than the alpha value of the scale reliability as well as the question was negatively correlated with total added item in the framework. Therefore, it should be either reframed or removed from the tool.

- Aesthetics

In the proposed framework Q 17 were added to measure the aesthetics sub-characteristic of the websites. The alpha reliability of the question 17 after Q17 deleted was less than the alpha value of the reliability of scale and item-total correlation value was positive with others items in all case study websites. Therefore, the item has good internal consistency in the proposed framework.

### 3. Content

The content characteristic was not a part of ISO 25010 quality evaluation model, even though many researchers in the area of healthcare websites proved that the information posted on the health website have great impact on the user who read it, which refers the content of the website [31] [33]. In the area of healthcare website content quality was ranked in the first position to evaluate the quality of the healthcare website [7]. The following are subcharacteristics added under content characteristics in the proposed framework and question 28 up to question 40 was used to evaluate the content of case study websites and their result discussed hereunder.

- Relevancy

In the proposed framework Q 28 were added to measure the relevancy of information sub-characteristic of the websites. The alpha reliability of the question 28 after Q28 deleted were less scale reliability in all case study websites and inter-total correlation of the question was positive. Therefore, the internal consistency of question 28 in the proposed framework was good.

- Up-to-datedness

In the proposed framework Q 29 and 30 were added to measure the up-to-date sub-characteristic of the websites. The alpha reliability of the question 29 after Q29 deleted were greater than scale reliability and inter-total correlation of the question were negative in KGH website but good internal consistency in both WDC and SPHMMC websites. Question 30 shows good internal consistency in all case study websites. Therefore, in the proposed framework either the question 29 reframed or removed from the tool.

- Authority

In the proposed framework Q 31 and 32 were added to measure the authority sub-characteristic of the websites. The alpha reliability of the question 31 and 32 after Q31 and Q32 deleted were greater than scale reliability and inter-total correlation of the question were negative in KGH website but both questions showed good internal consistency in both WDC and SPHMMC websites. Therefore, in the proposed framework both question need some modification to be made similarly understand by all users.

- Variety of presentation

In the proposed framework Q 33 were added to measure the variety of presentation sub-characteristic of the websites. The alpha reliability of the question 33 after Q33 deleted was less than the alpha value of the reliability of scale and item-total correlation value was positive with others items in all case study websites. Therefore, the item has good internal consistency in the proposed framework

- Impartiality

In the proposed framework Q 34 were added to measure the Impartiality sub-characteristic of the websites. The alpha reliability of the question 34 after Q34 deleted was; less than the alpha value of the reliability of scale and item-total correlation value was positive with others items in KGH and WDC case study websites but g all case study websites but greater alpha reliability than scale reliability and negative item-total correlation in SPHMMC case study website. Therefore, the item has good internal consistency in the proposed framework even though small clarifications on question were required.

- Comprehensiveness

In the proposed framework Q 35 were added to measure the comprehensiveness sub-characteristic of the websites. The alpha reliability of the question 35 after Q35 deleted was less than the alpha value of the reliability of scale and item-total correlation value was positive with others items in all case study websites. Therefore, the item has good internal consistency in the proposed framework

- Identity

In the proposed framework Q 36 and 37 were added to measure the identity sub-characteristic of the websites. The alpha reliability of the question 36 and 37 after Q36 and Q37 deleted were less than scale reliability and inter-total correlation of the question were positive in all case study websites but question 37 in the result from SPHMMC website showed that the question need some clarification. Therefore, in the proposed framework both question has good internal consistency except question 37 SPHMMC website.

- Accuracy

In the proposed framework Q 38 and 39 were added to measure the accuracy sub-characteristic of the websites. The alpha reliability of the question 38 and 39 after Q38 and 39 deleted was less than the alpha value of the reliability of scale and item-total correlation value was positive with others items in all case study websites. Therefore, both items (questions) have good internal consistency in the proposed framework.

- Contact

In the proposed framework Q 40 were added to measure the contact sub-characteristic of the websites. The alpha reliability of the question 40 after Q40 deleted was; less than the alpha value of the reliability of scale and item-total correlation value was positive with others items in both KGH and SPHMMC websites and greater than alpha reliability of scale and item-total correlation value was negative with other items in the framework in WDC websites. Therefore, the item has good internal consistency in the proposed framework but, need small clarification on the question.

#### **4. Service**

The service characteristic was not a part of ISO 25010 quality evaluation model, even though many researchers in the area of healthcare websites proved that as the main aim of healthcare providers are to take care for peoples, similarly their website should provide specific and clear services online for users [7] [17]. Service of healthcare provider made available to patients users or any users want to get the health providers services. The following are subcharacteristics added under content characteristics in the proposed framework and question 41 up to question 53 was used to evaluate the content of case study websites and their result discussed hereunder.

- Reception

In the proposed framework Q 41 and 42 were added to measure the reception sub-characteristic of the websites. The alpha reliability of the question 41 and 42 after Q41 and 42 deleted was less than the alpha value of the reliability of scale and item-total correlation value was positive with others items in all case study websites. Therefore, both items (questions) have good internal consistency in the proposed framework.

- Settlement

In the proposed framework Q 43 were added to measure the settlement sub-characteristic of the websites. The alpha reliability of the question 43 after Q43 deleted was greater than scale reliability and inter-total correlation of the question were negative in KGH website but good internal consistency in both WDC and SPHMMC websites. Therefore, small clarification has needed on the question 29 in the proposed framework.

- Medical consult

In the proposed framework Q 44 and 45 were added to measure the medical consult sub-characteristic of the websites. The alpha reliability of the question 44 and 45 after Q44 and 45 deleted was less than the alpha value of the reliability of scale and item-total correlation value was positive with others items in all case study websites except result obtained for Q44 from WDC website that showed greater alpha reliability and negative inter-total correlation. Therefore, the internal consistency for both items was good even if small clarification required on question 44.

- Medical information

In the proposed framework Q 46, Q47 and Q48 was added to measure the medical information sub-characteristic of the websites. The alpha reliability of the question 46 after Q46 deleted was less than the alpha value of the reliability of scale and item-total correlation value was positive with others items in all case study websites. Therefore, the item (Q46) has good internal consistency in the proposed framework.

The alpha reliability of the question 47 and 48 after Q47 and Q48 deleted was; less than the alpha value of the reliability of scale and item-total correlation value was positive with others items in both KGH and WDC websites but greater than the alpha value of the reliability of scale and item-total correlation value was negative in SPHMMC website. Therefore, the results of SPHMMC website shows that both question 47 and 48 needs clarification.

- Communication

In the proposed framework 49 was added to measure the communication sub-characteristic of the websites. The alpha reliability of the question 49 after Q49 deleted was less than the alpha value of the reliability of scale and item-total correlation value was positive with others items in all

case study websites. Therefore, the item (Q49) has good internal consistency in the proposed framework.

- Newsgroup

In the proposed framework Q 50 and 51 were added to measure the newsgroup sub-characteristic of the websites. The alpha reliability of the question 50 after Q50 deleted was; less than the alpha value of the reliability of scale and item-total correlation value was positive with others items in both KGH and WDC websites but greater than the alpha value of the reliability of scale and item-total correlation value was negative in SPHMMC website. Therefore, result of SPHMMC website showed that question 50 needs small clarification.

The alpha reliability of the question 51 after Q51 deleted was; less than the alpha value of the reliability of scale and item-total correlation value was positive with others items in WDC website but greater than the alpha value of the reliability of scale and item-total correlation value was negative in both KGH and SPHMMC websites. Therefore, result of KGH and SPHMMC website showed that question 51 needs clarification.

- Updating list

In the proposed framework Q 52 and Q53 was added to measure the updating list sub-characteristic of the websites. The alpha reliability of the question 52 and 53 after Q52 and Q53 deleted was; less than the alpha value of the reliability of scale and item-total correlation value was positive with others items in both KGH and WDC websites but greater than the alpha value of the reliability of scale and item-total correlation value was negative in SPHMMC website. Therefore, result of SPHMMC website showed that both question 52 and 53 needs clarification.

### **5.2.2. WEBUSE analysis of the case study**

The WEBUSE analysis tool discussed in the chapter 3 of this report was used to analyze the quality level of the three case study websites. The WEBUSE analysis method was used and its reliability was proved by different researchers in the area of website quality evaluation as well as website usability evaluation [2] [35]. Therefore, depending on the formulas given in the chapter 3 for WEBUSE tool the responses of evaluators for three case study websites of Ethiopian healthcare analyzed as follows.

**Table 17: WEBUSE analysis result for all sub-characteristics**

Characteristics	Sub-characteristics	KGH website		WDC website		SPHMMC website	
		Merit value	Quality level	Merit value	Quality level	Merit value	Quality level
Functional suitability	Search	0.16	Poor	0.43	Moderate	0.45	Moderate
	Navigation	0.54	Good	0.43	Moderate	0.45	Moderate
	Suitability	0.38	Poor	0.18	Poor	0.40	Fair
Operability	Understandability	0.41	Moderate	0.34	Fair	0.33	Fair
	Interactivity	0.39	Fair	0.30	Fair	0.40	Fair
	Customization	0.21	Fair	0.23	Fair	0.38	Fair
	Learnability	0.76	Good	0.30	Fair	0.44	Moderate
	Multiple-lingual	0.15	Poor	0.25	Fair	0.49	Moderate
	Aesthetics	0.58	Moderate	0.37	Fair	0.40	Fair
Reliability	Availability	0.75	Good	0.29	Fair	0.38	Fair
	Fault tolerance	0.80	Good	0.38	Fair	0.37	Fair
	Recoverability	0.30	Fair	0.37	Fair	0.44	Moderate
Performance efficiency	Accessibility	0.51	Moderate	0.25	Fair	0.35	Fair
	Time behavior	0.79	Good	0.25	Fair	0.38	Fair
	Resource utilization	0.30	Fair	0.37	Fair	0.27	Fair
Content	Relevancy	0.56	Moderate	0.25	Fair	0.23	Fair
	Up-to-datedness	0.10	Poor	0.20	Poor	0.34	Fair
	Authority	0.13	Poor	0.20	Poor	0.36	Fair
	Variety of presentation	0.05	Poor	0.23	Fair	0.31	Fair
	Impartiality	0.99	Excellent	0.40	Fair	0.28	Fair
	Comprehensiveness	0.25	Fair	0.25	Fair	0.17	Poor
	Identity	0.76	Good	0.32	Fair	0.30	Fair
	Accuracy	0.69	Good	0.41	Moderate	0.31	Fair
	Contact	0.56	Moderate	0.33	Fair	0.29	Fair
Service	Reception	0.26	Fair	0.22	Fair	0.08	Poor
	Settlement	0.31	Fair	0.26	Fair	0.17	Poor
	Medical consult	0.11	Poor	0.17	Poor	0.17	Poor
	Medical information	0.15	Poor	0.29	Fair	0.21	Fair
	Communication	0.40	Fair	0.25	Fair	0.33	Fair
	Newsgroup	0.10	Poor	0.33	Fair	0.24	Fair
	Updating list	0.05	Poor	0.32	Fair	0.26	Fair

The detail description of the three case study website level of quality with respect to the six characteristics addressed in this research discussed below based on the result of responses gathered from respondents. Therefore, hereunder the quality of case study discussed in detail.

## **1. Functional suitability**

Search, navigation and suitability are the sub-characteristics included under functional suitability. The result of WEBUSE analysis showed that the search function of KGH website was implemented poorly whereas the search function of WDC and SPHMMC website was implemented moderately. The result of WEBUSE analysis showed that the Navigation function of KGH website was implemented goodly, whereas, the search function of WDC and SPHMMC website was implemented moderately. On both KGH and WDC websites the each and every function provided for end users was poorly implemented which means it was not what end user expect from the website, whereas it was fairly implemented on the SPHMMC website.

## **2. Operability**

There are six sub-characteristics included in this study to address the level of usability of the Ethiopian healthcare websites. The result of WEBUSE analysis showed that, KGH website implemented in a moderate understandable way while other two websites are implemented in fairly understandable way. As the result of WEBUSE analysis showed all case study websites were provided for their users less interaction and facility that enable users interact with each other or health professionals. Similarly, all case study website does not allow change of colors, forms, etc. for end users to their own needs. The result showed that, it was easy to learn how to use KGH website were good, WDC website were fair and SPHMMC website were moderate. The Ethiopian nation and nationalities language were only supported by SPHMMC website as the result showed. The attractiveness to use the website was moderate in KGH website and fair in both WDC and SPHMMC website.

## **3. Reliability**

The availability, fault tolerance and recoverability sub-characteristics are included under the reliability dimension of the framework. The result of case study showed that availability of KGH website was good and others are fair. The result of case study showed that fault tolerance of KGH website was good and others are fair. The result of case study showed that recoverability of SPHMMC website was moderate and others are fair.

## **4. Performance efficiency**

The accessibility, time behavior and resource utilization sub-characteristics are included under reliability dimension of the framework. The result of case study showed that the accessibility of KGH were moderate for respondents whereas time behavior was good and resource utilization was fair level. Accessibility, time behavior and resource utilization of WDC and SPHMMC websites was fairly implemented as the result of case study website showed.

## 5. Content

Result of case study showed that the relevancy of information posted on the website regarding patients was; moderately satisfied users in KGH website and fairly satisfied users in both WDC and SPHMMC websites. Up-to-datedness of information on the website poorly satisfied users on KGH and WDC website but, fairly satisfied users on SPHMMC website. The case study result showed that the authority of information posted on the website is poor in KGH and WDC websites but, somehow greater than KGH and WDC websites in SPHMMC website. The information posted on the all case study websites are very limited in format as the result of case study showed. There was no partiality showed in KGH website but, in both WDC and SPHMMC the case study result showed that there was bias of information on the content of the website. The comprehensiveness of all case study website was less than moderate as showed by the result of case study. The case study showed that the identity of KGH website was good but the rest two are fair. Accuracy of information posted on the content was good in KGH website, moderate in WDC website and fair in SPHMMC website. Contact information provided moderately on KGH website and fairly on the rest case study websites.

## 6. Service

The service characteristics was included in the study to address facilities exist on the website for healthcare providers to serve their patients user online using the website. The result of case study showed that qualities of online reception on all websites are below the moderate level. In a summarized form the result of case study on the service characteristics showed that all sub-characteristics included under service characteristics are implemented on all case study websites below the moderate level of website quality. Therefore, for developer or owner there is need to focus on this characteristic.

The final result of WEBUSE analysis method for the six characteristics included in the proposed framework of three case study websites are given hereunder.

**Table 18: WEBUSE analysis result for all characteristics**

High level characteristics	<i>KGH website</i>		<i>WDC website</i>		<i>SPHMMC website</i>	
	Merit value	Quality level	Merit value	Quality level	Merit value	Quality level
Functional suitability	0.36	Fair	0.35	Fair	0.43	Moderate
Operability	0.42	Moderate	0.30	Fair	0.41	Moderate
Reliability	0.62	Good	0.35	Fair	0.40	Fair
Performance efficiency	0.53	Moderate	0.29	Fair	0.33	Fair
Content	0.45	Moderate	0.29	Fair	0.29	Fair
Service	0.20	Poor	0.26	Fair	0.21	Fair
<b>Average</b>	<b>0.43</b>	<b>Moderate</b>	<b>0.31</b>	<b>Fair</b>	<b>0.35</b>	<b>Fair</b>

The table above and the chart below are used to represent the same information or the result of case study website in simplified and variety of formats. As it possible to understand from the result of the case study websites, to improve the quality of the website in Ethiopia it needs great job for developers and owners with great responsibility. The quality any websites in any domain are advised as if its quality be at least in a good interval in order to satisfy the users. Generally, the WEBUSE analysis showed great improvement required for all characteristics of website considered in the proposed framework. The average result of the table above shows the overall quality of the case study websites which is the quality level of KGH website is moderate, WDC is fair and SPHMMC website is also fair.

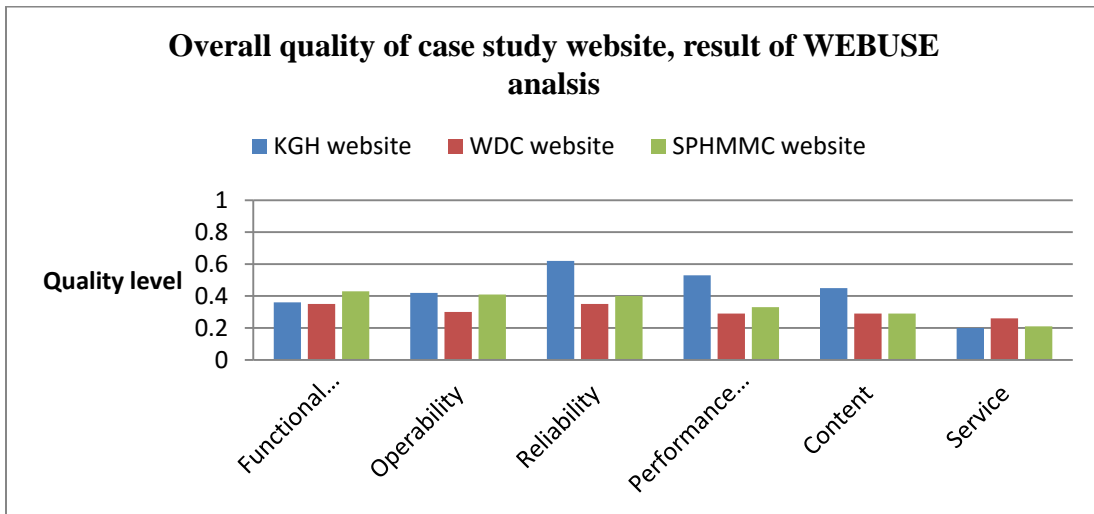


Figure 15: Overall result of WEBUSE analysis method

In this chart its shown that the levels of quality of functional suitability of SPHMMC website were greater than KGH and WDC websites, the level of quality of operability of KGH website were greater than WDC and SPHMMC websites, the level of quality of reliability of KGH website greater than WDC and SPHMMC websites, the level of quality of performance efficiency of KGH website were greater than WDC and SPHMMC websites, the level of quality of content of KGH website were greater than WDC and SPHMMC websites and the level of quality of service of WDC website were greater than KGH and SPHMMC websites.

### 5.2.3. Respondents perception on the case study websites quality

To gather the overall perception or quality level of the case study website an additional one question was added to questionnaire which have similar format with other questions in a questionnaire distributed to respondents. The question was asking evaluators to forward their feeling on the overall quality of website without specifying characteristics and sub-characteristics. The question contained five options. Those are: Bad [0-0.2], Poor (0.2-0.4), Good (0.4-0.6), Very good (0.6-0.8] and Excellent (0.8-1.0]. The value of bad, poor, good, very good

and excellent used for perception gathering matched to poor, fair, moderate, good and excellent are in WEBUSE analysis method.

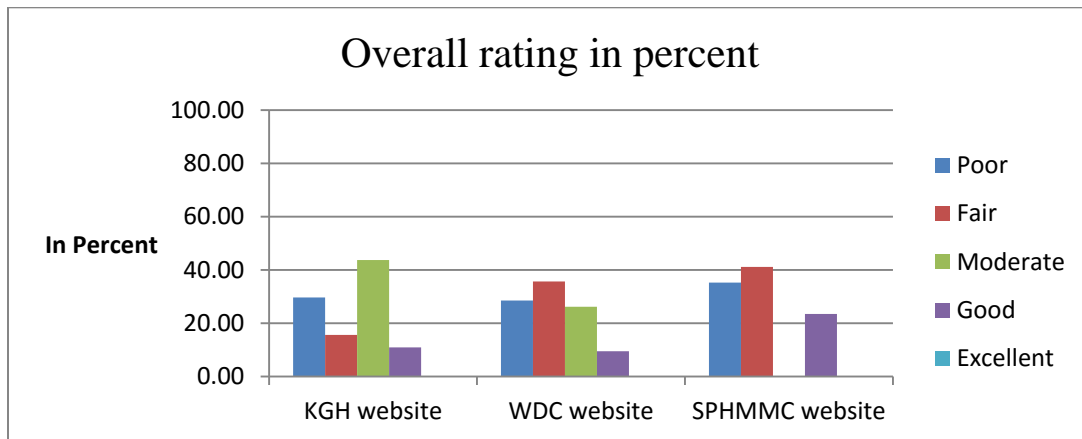
The response of the single question added in a questionnaire to gather perception of the evaluators on the three case study website was summarized as follows.

**Table 19: Response rate on perception gathering**

Quality level	<i>KGH website</i>		<i>WDC website</i>		<i>SPHMMC website</i>	
	N*=64	Percent (%)	N*=42	Percent (%)	N*=34	Percent (%)
Poor	19	29.69	12	28.57	12	35.29
Fair	10	15.63	15	35.71	14	41.18
Moderate	28	43.75	11	26.19	0	0.00
Good	7	10.94	4	9.52	8	23.53
Excellent	0	0.00	0	0.00	0	0.00

-N\* represents number of respondents rate the quality level

The above table shows that the result of the overall rating of respondents was 43.75% moderate, 29.69% poor, 15.63% fair, 10.94% good and none of them rated with excellent quality level in KGH website. The respondents rating for WDC website was 35.71% fair, 28.57% poor, 26.19% moderate, 9.52% good and none of them rated it with excellent. The respondents rating for SPHMMC website was 41.18% fair, 35.29% poor, 23.53% good and none of them rated it with moderate and excellent.



**Figure 16: Overall rating of respondents**

The above chart shows that the overall rating of respondents was for KGH website moderate and for both WDC and SPHMMC websites fair. No one rate the SPHMMC website with moderate.

In the chapter 3 or methodology section of this report the description of the method used to test the proposed framework for Ethiopian healthcare websites presented. The method used to test

effectiveness of the proposed framework was comparing the result of WEBUSE analysis method with the overall perception of respondents captured using five Likert scale question and discussed above. As it were showed in above two sections the result of WEBUSE analysis and respondents perception are similar. The result of WEBUSE analysis was moderate for KGH website and fair for both WDC and SPHMMC websites. Similarly, greatest percent of respondents rated KGH website with moderate and rated with fair both WDC and SPHMMC websites. Therefore, the quality evaluation framework proposed for Ethiopian healthcare website gives reliable result that similar with respondents' perception. This means, the framework represents patients' or end users' perception for evaluating the quality of healthcare website. This shows the proposed framework contains components to evaluate healthcare website that an end user expected from the website of healthcare.

***Summary:***

In this chapter the result of case study used to test the proposed framework was discussed. The result showed the proposed framework was more comprehensive than the ISO/IEC 25010 quality evaluation model for evaluating the website of Ethiopian healthcare website. This means, the proposed framework is effective to evaluate the healthcare related website from patients' end user perspectives. The quality levels of three case study websites are below expected quality of healthcare website. Therefore, the healthcare website in Ethiopia needs to put much effort in order to provide high quality website from patients' end user perspectives. This all are done in this chapter and in the next chapter the conclusion will be made from the solution and result of the case study as well as recommendations for future work will also be discussed.

## CHAPTER 6: CONCLUSION AND RECOMMENDATION

In this chapter the result obtained from this proposed work and the recommendation based on the identified problem as well as the objective of the study and the solution provided for the problem are discussed.

### 6.1. Conclusion

The general objective of this study was to develop the quality evaluation framework for Ethiopian healthcare website from patients' end user perspectives. In order to accomplish the general objective of the study many literatures in the area of software quality and website quality in general as well as specific to healthcare related website quality was reviewed. In addition to those literatures in the area of website such as website design guidelines, healthcare website design guidelines, uses of Ethiopian healthcare website was reviewed. The ISO/IEC 25010 quality model which contains eight characteristics used in order to design the proposed framework.

The study revealed that, existing website quality models, frameworks and standards are not considered comprehensive characteristics used to evaluate healthcare websites. In addition, they did not consider the perspectives of patients' user and their relevant characteristics. In the existing models for evaluation of website quality model ISO/IEC 25010 quality model division was identified as the model which contain more quality characteristics for software product and this model used as starting point to develop the proposed framework. The ISO/IEC 25010 quality model contains extensive list of characteristics, even though, this study showed that it does not contains enough quality characteristics for measuring quality of healthcare website from the perspectives of patients' users.

Therefore, based on previous work on the quality of healthcare website the quality evaluation framework for Ethiopian healthcare website was developed by considering the patients end users as a viewpoint. The proposed quality evaluation framework for Ethiopian healthcare website from the patients' end users perspectives contains hierarchical representation of characteristics, sub-characteristics and quality indicators or metrics. The developed framework contains 6 high level characteristics, 31 sub-characteristics grouped under high level characteristics and quality indicator or a group of quality indicators. Among 6 high level characteristics 4 are taken from ISO/IEC 25010 quality model and 2 are taken from related works for healthcare website quality evaluation. Since, the developed framework focused on the patients' user perspectives 4 characteristics those focused on other users' perspectives in the ISO/IEC 25010 quality model like maintainability, portability, security and compatibility are excluded from the developed framework.

As the aim of the first objective of this study was to develop quality evaluation framework for Ethiopian healthcare website the developed framework contained quality characteristics, sub-

characteristics and metrics for evaluation of healthcare website quality. In the proposed framework characteristics used to represent the broad quality of websites which narrowed down by dividing in multiple sub-characteristics. Sub-characteristics used to represent specific concepts measured from the website which in turn contains one or more quality indicators or metrics. Quality indicators or metrics used to represent the idea of patients end users which directly matched and measured from the web page of healthcare websites.

The second objective of the study was to prepare evaluation tool for the proposed framework which was in the form of questionnaire. Questionnaire composed of questions was prepared from the quality metrics in the proposed framework. The question in a questionnaire was prepared to address quality metrics or indicators in the proposed framework. In a questionnaire Likert scale questions was prepared and users of selected healthcare website for case study websites used to evaluate the website. The question was developed to evaluate the website based on the prescribed quality characteristics, sub-characteristics and metrics in the proposed framework

The third objective of this study was to apply the proposed framework to three currently working Ethiopian healthcare website as a case study in the form of questionnaire. The prepared questionnaire was used by respondents to evaluate the quality of the case study websites. The educational level of respondents those participate in the evaluation of case study website was consisted of high school, diploma, first degree and second degree.

The fourth objective of this study was to test the usefulness of the proposed framework for Ethiopian healthcare websites. To achieve the objective a methods employed in this study are: internal consistency of items, WEBUSE analysis methods and comparison of respondents' perception with WEBUSE analysis method. The internal consistency of the items or questions in a questionnaire was proved and all are above acceptable internal consistency. The WEBUSE analysis method used was revealed that the quality levels of the three case study websites are below moderate. The response gathered from the respondents about their perception on the overall quality of the three case study websites showed that the majority of respondents rated the case study websites below moderate on the overall quality level.

Therefore, the result of case study showed that the proposed quality evaluation framework for Ethiopian healthcare websites allowed patient users to evaluate Ethiopian healthcare website effectively. This means the characteristics, sub-characteristics and metrics included in the proposed framework represent what patients users are expect from the healthcare website. This shows the proposed framework is effective for Ethiopian healthcare website evaluation from patients' user's perspectives than ISO/IEC 25010 and other models.

The final objective of the study was to provide suggestions for improving the proposed framework and the discussion of this part given in the next section of this report.

## 6.2. Recommendations

The aim of this study is to solve the problem of Ethiopian healthcare website quality in order to make the peoples in the country to get information about health related from healthcare providers by sitting anywhere without distance barrier. Therefore, in order to accomplish the objective of the study which was satisfying patients' end users and increasing their satisfaction and confidence of using website in Ethiopia, the research was done focusing on the perspectives of end users. The proposed quality evaluation framework was intended to represent end users perceptions on healthcare website and it was as it intended.

Even though, the developed solution enables to improve quality of website from end users perspectives the following study should be carried out in the future. Those are:

- Developers perspectives of website quality also need framework in order to make the website have high quality in all perspectives
- Weighting of characteristics, sub-characteristics and metrics are another open issue in the proposed framework and needs further research
- Developing automated tools that simplify the evaluation process for the proposed framework
- The questionnaire only prepared in English language and participants were also selected on their ability to understand the keywords in the area. Converting the questions to local language increase the number of evaluators. Therefore, this is also another unaddressed issue.

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# APPENDICES

## APPENDIX A: Interview Questions

The questions used for identification of problem are listed hereunder.

1. Do you know the healthcare website or hospital website uses?
2. What you expect from the healthcare or hospital websites?
3. Is there any website you know which provides health related information and services?
4. Have you used that website before?
5. How much you are satisfied with that website?
6. What is your message in respect to website for Ethiopian healthcare?

## APPENDIX B: Healthcare related websites in Ethiopia

The table below contains the addresses of the available healthcare related websites with their names retrieved from Ethiopian website directory.

No.	URL Address	Name of Hospitals
1	<a href="http://www.mcmnet.org/">http://www.mcmnet.org/</a>	Myung Sung Christian Medical Center
2	<a href="http://addiscardiac.com/">http://addiscardiac.com/</a>	Addis Cardiac Hospital
3	<a href="https://cure.org/ethiopia/">https://cure.org/ethiopia/</a>	CURE Ethiopia Children's Hospital
4	<a href="https://www.nordicmedicalcentre.com/">https://www.nordicmedicalcentre.com/</a>	Nordic Medical Centre
5	<a href="http://www.suisseclinic.com/">http://www.suisseclinic.com/</a>	Suisse Clinic
6	<a href="http://www.wudassie.com/">http://www.wudassie.com/</a>	Wudassie Diagnostic Center
7	<a href="http://www.sphmmc.edu.et/">http://www.sphmmc.edu.et/</a>	St. Paul's Hospital
8	<a href="http://hamlinfistula.org/">http://hamlinfistula.org/</a>	Desta Mender
9	<a href="http://kadcogroup.com/">http://kadcogroup.com/</a>	KADISCO General Hospital
10	<a href="http://eahac.com/">http://eahac.com/</a>	East Africa Hearing Aid Center
11	<a href="https://www.gambohospital.org/">https://www.gambohospital.org/</a>	Gambo Hospital
12	<a href="http://www.hu.edu.et/">http://www.hu.edu.et/</a>	Hawassa Loke Hospital
13	<a href="http://www.moh.gov.et/">http://www.moh.gov.et/</a>	Federal Ministry of Health
14	<a href="http://www.etharc.org/">http://www.etharc.org/</a>	National AIDS Resource Center
15	<a href="http://sitotapsy.com/">http://sitotapsy.com/</a>	Sitota Center for Mental Health Care
16	<a href="http://www.ethiohealth.net">http://www.ethiohealth.net</a>	Health information resource about Ethiopia
17	<a href="http://www.ethiopiaid.org.uk">http://www.ethiopiaid.org.uk</a>	Black lion hospital-Ethiopia charity:ETHIOPIAID:United kingdom
18	<a href="http://www.ethiohealth.net">http://www.ethiohealth.net</a>	Ethiopian health directory
19	<a href="http://www.itacaddis.org">http://www.itacaddis.org</a>	Ethiopian health sector development program(hsdp)-Italian
20	<a href="http://www.enahpa.org">http://www.enahpa.org</a>	ENAHPA:Ethiopian North American Health Professionals Association
21	<a href="http://www.yemagedmedcenter.org">http://www.yemagedmedcenter.org</a>	Yemage Medical Center General Hospital, Harar,Ethiopia
22	<a href="http://www.ethioworld.com">http://www.ethioworld.com</a>	Ethiopia-Health

23	<a href="http://www.hamlinfistula.org">http://www.hamlinfistula.org</a>	Addis Ababa Fistula Hospital Ethiopia
24	<a href="http://www.fistulafoundation.org">http://www.fistulafoundation.org</a>	The Fistula Foundation:Home
25	<a href="http://www.cartercenter.org">http://www.cartercenter.org</a>	International Public Health Training Initiative in Ethiopia
	<a href="http://www.ethioprivatehospitals.com/">http://www.ethioprivatehospitals.com/</a>	PHA Private Hospital Associations We Are Facility Owners association.
26.	<a href="https://www.ephi.gov.et/">https://www.ephi.gov.et/</a>	Ethiopian public health institute

## APPENDIX C: Question utility checklist used

The question in the questionnaire included and excluded based on the question utility checklist given hereunder.

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 is identifiable beforehand or through questions from the questionnaire*

## APPENDIX D: Questions in the proposed quality evaluation framework

### Functional suitability

#### Search

1. Search helps/hints are provided when wrong keywords are entered
2. The website provides varied search options (e.g. by department, facilities, disease, specialists, etc)

#### Navigation

3. It is easy to go to the home page(First page) of the website from any other page
4. While navigating, I can immediately tell where I am in the website
5. I am able to move from one page to the other page without getting lost
6. I can easily navigate backwards through previously visited pages

7. I can know where I navigate/browse before clicking on the link
8. I can use mouse scrolling up and down as when required  
Suitability
9. I am satisfied with the functionalities of the website  
**Operability**  
Understandability
10. I think the overall structure of the website is clear
11. The terms on the website are based on users ability and experiences  
Interactivity
12. I know who I can contact for further information about anything in the website.  
Customization
13. I can change the websites' color, layout, and forms easily to my desire.  
Learnability
14. I think it is easy to learn how to use the website for new users.  
Multiple-lingual
15. The website provides its content and services with multiple Ethiopian nation and nationalities languages
16. It is easy to switch between languages in the site  
Aesthetics
17. The page colors, texts, links, font sizes, background positions, navigation positions and label colors throughout the website are attractive.  
**Reliability**  
Availability
18. I can access the website at any time I want.  
Fault tolerance
19. Every link on the website takes me to a valid page  
Recoverability
20. Whenever some error occurs, the website recovers quickly.  
**Performance efficiency**  
Accessibility

21. I can access the website with text-only version.
22. I can access the website on my favorite browser (like chrome, internet explorer, Mozilla Firefox etc.)
23. I can access the website on my favorite devices (like computer, mobile, tablet, etc.).
24. I think the website is accessible by different types of users (like older, visual disabilities and etc.)  
Time behavior
25. I can view the page I want without waiting more time.
26. It is possible to switch between pages with in a small amount of time  
Resource utilization
27. Accessing the website does not make my device busy.  
**Content**  
Relevancy
28. I think the website contains important or useful information for patients  
Up-to-datedness
29. It is obvious to find creation and update time of contents in the website
30. The website offers current & up to date information  
Authority
31. Author names and qualification of pages are available
32. Links to outside references used in the website are given  
Variety of presentation
33. I can find information on the website in various formats (like Doc, pdf, text and etc.)  
Impartiality
34. Information or anything appeared on the content of the website is not in a need of specific group and it respect every users culture, norms etc. of Ethiopian nation and nationalities.  
Comprehensiveness
35. I think the website contains all necessary information regarding patients.

- Identity
36. The name of the healthcare providers, logo and copyright information are available.
37. The healthcare providers vision and mission clearly provided
- Accuracy
38. The information provided in the website is clear.
39. The information on the website is free from grammar and spelling error
- Contact
40. Contact detail such as telephone number, email address of professionals and location of the healthcare provider clearly presented
- Service**
- Reception
41. I can clearly find information about free beds, department and doctor available, pay fee, related forms from the website.
42. I can clearly find information about how to register for the appointment to meet the doctor I am looking for, receiving follow up code, and availability of specialist in the hospital.
- Settlement
43. I can find information on the payment option from the website to get treatment at the healthcare provider.
- Medical consult
44. The website serves me to easily communicate with doctors, specialists

- and others employee of the healthcare provider to get advice freely.
45. The time and date I can get advice from health professionals in hospital is clearly available on the website.
- Medical information
46. The website gives me information about unique facilities and health professionals I cannot get from other healthcare providers.
47. The website also gives information about job opportunities available in the healthcare provider.
48. The link to other healthcare related websites are available.
- Communication
49. The website provides the interaction of health professional to health professionals, health professional to patients/users and social media communications.
- Newsgroup
50. I think new information's or updates are informed to patients through email, newsletter and phones.
51. I can find the calendar of the hospital for any services I need on the website.
- Updating list
52. The website has a separate place for new post or hot issues.
53. I can find newly posted information on the home page of the website and with marking that indicate it as new post

## APPENDIX E: Reliability analysis of all questions

This appendix contains the detail information of reliability analysis if item deleted or question deleted from questionnaire and its effects on the rest questions or items in the proposed framework.

Items	KGH website		WDC website		SPHMMC website	
	Alpha	r(item, total)	Alpha	r(item, total)	Alpha	r(item, total)
Q.1	0.9424	-0.0396	0.9348	0.6996	0.7854	-0.2436
Q.2	0.9438	-0.3959	0.9344	0.7763	0.7823	0.0399
Q.3	0.9363	0.9194	0.9352	0.7352	0.7714	0.3714
Q.4	0.9376	0.8053	0.9372	0.3743	0.7652	0.5718
Q.5	0.9366	0.9336	0.9368	0.4675	0.7825	-0.0780
Q.6	0.9389	0.6995	0.9361	0.5494	0.7686	0.6013
Q.7	0.9363	0.9206	0.9363	0.5648	0.7674	0.5583
Q.8	0.9372	0.8238	0.9347	0.8348	0.7747	0.3050
Q.9	0.9380	0.7410	0.9351	0.9019	0.7762	0.2231
Q.10	0.9457	-0.7970	0.9365	0.4922	0.7811	0.0954
Q.11	0.9380	0.8244	0.9364	0.5176	0.7670	0.4697
Q.12	0.9471	-0.5660	0.9357	0.6105	0.7723	0.3341
Q.13	0.9434	-0.3526	0.9378	0.2395	0.7761	0.2258
Q.14	0.9374	0.8844	0.9336	0.9144	0.7781	0.1639
Q.15	0.9425	-0.0666	0.9370	0.4117	0.7646	0.6683
Q.16	0.9426	-0.0878	0.9403	-0.0193	0.7835	-0.0729
Q.17	0.9382	0.7650	0.9405	0.0062	0.7760	0.2282
Q.18	0.9374	0.8946	0.9346	0.8338	0.7839	-0.0009
Q.19	0.9369	0.9623	0.9371	0.3924	0.7915	-0.4118
Q.20	0.9423	0.0898	0.9379	0.2545	0.7686	0.4885
Q.21	0.9424	-0.0595	0.9374	0.3531	0.7649	0.5196
Q.22	0.9394	0.7977	0.9355	0.6669	0.7717	0.3834
Q.23	0.9386	0.7096	0.9364	0.5107	0.7763	0.2176
Q.24	0.9420	0.0526	0.9373	0.3552	0.7592	0.6279
Q.25	0.9370	0.9650	0.9345	0.7713	0.7650	0.4959
Q.26	0.9375	0.8698	0.9385	0.2467	0.7704	0.4085
Q.27	0.9403	0.4344	0.9369	0.4348	0.7593	0.6890
Q.28	0.9379	0.8674	0.9368	0.4536	0.7761	0.2590
Q.29	0.9424	-0.0595	0.9366	0.4793	0.7703	0.4021
Q.30	0.9394	0.7977	0.9375	0.3698	0.7722	0.3260
Q.31	0.9426	-0.0878	0.9378	0.2915	0.7673	0.4174
Q.32	0.9427	-0.1506	0.9361	0.5406	0.7729	0.3071
Q.33	0.9394	0.7977	0.9374	0.3715	0.7785	0.1486
Q.34	0.9414	0.3019	0.9367	0.4792	0.7864	-0.0322
Q.35	0.9378	0.8673	0.9358	0.7139	0.7712	0.4804
Q.36	0.9372	0.8397	0.9362	0.6488	0.7841	-0.0516
Q.37	0.9388	0.6785	0.9362	0.5345	0.7668	0.4783
Q.38	0.9401	0.4726	0.9344	0.7482	0.7675	0.4660
Q.39	0.9419	0.1491	0.9365	0.4817	0.7794	0.1328
Q.40	0.9405	0.3895	0.9426	-0.3820	0.7727	0.3373
Q.41	0.9383	0.7731	0.9361	0.5406	0.7693	0.5764
Q.42	0.9374	0.8342	0.9365	0.5217	0.7796	0.0636

Q.43	0.9457	-0.3556	0.9354	0.6319	0.7716	0.3964
Q.44	0.9412	0.2390	0.9385	-0.0301	0.7817	0.0205
Q.45	0.9375	0.8698	0.9356	0.6108	0.7771	0.1929
Q.46	0.9384	0.7401	0.9396	0.0184	0.7667	0.4834
Q.47	0.9410	0.2739	0.9359	0.6075	0.7885	-0.2656
Q.48	0.9408	0.3315	0.9367	0.4696	0.7881	-0.1696
Q.49	0.9400	0.5232	0.9376	0.3294	0.7818	0.1053
Q.50	0.9393	0.7127	0.9363	0.5382	0.7932	-0.2916
Q.51	0.9426	-0.1084	0.9380	0.2501	0.7881	-0.0919
Q.52	0.9397	0.7527	0.9335	0.9142	0.7970	-0.3202
Q.53	0.9410	0.3038	0.9394	0.0057	0.7914	-0.2870

## APPENDIX F: Website designed for data gathering

The website that contains address of case study website and address of questionnaire used to evaluate the case study website.

# Ethiopian Hospital Website Quality Evaluation Questionnaire

HOME
ABOUT
CONTACT

The questionnaire contains different sections, with each section contains more than one question intended to address the quality of website aimed to be evaluated. Before proceeding to the next section click on the link below:

1. Kadisco General Hospital: <http://kadcogroup.com/kgfh/>
2. Wudiassie Diagnostic Center: <http://www.wudassie.com/>
3. St. Paul's Hospital Millennium Medical College: <http://www.sphmmc.edu.et/>

The link takes you to the hospital website currently providing services for Ethiopian nation and nationalities. The questionnaire available on the link below constructed from the website quality evaluation framework proposed for evaluating Ethiopian healthcare website qualities. Follow the instruction and forward your questionnaire result with patience.

- Choose only the website you have informed to evaluate it
- Go through all pages as much as possible for at least 20 minutes

When you have finish all the page, click on the link bellow: While you are answering the questions, please keep in mind that you are not examined just for fail and pass, it is about providing the level of quality of the website you have browsed, in the perspective of you.

Questionnaire used to evaluate the website: [Answer the Questions](#)

**Lami Garoma, Adama, Ethiopia**

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## APPENDIX G: The first page of questionnaire

The first section of questionnaire, that tells the highlight of the internal contents and section of the questionnaire to respondents and contact information.

# Ethiopian Hospital Website Quality Evaluation Questionnaire

Adama Science and Technology University

July 18, 2017

Dear Participant:

I would like to get your help. I am a graduate student in Software Engineering at Adama Science and Technology University. I am conducting a survey on Website quality evaluation coping for my Master's Thesis. The purpose of the study is to develop a quality evaluation tool for Ethiopian healthcare websites. Evaluating the quality of Kadisco General Hospital, St. Paul's Hospital Millennium Medical College and Wudassie Diagnostic Center websites help me to test the proposed tool for Ethiopian healthcare website quality evaluation.

Would you please help me by going through the the above listed websites and complete this survey. The survey contains nine (9) sections in including this, section 2 used to collect the demographic information, from section 3 to section 8 used to collect data with respect to the tool, the last section used to collect the website overall evaluation by you.

If it is necessary in between of the answering questions, go back the Hospital website and check the availability of the component on the website. The survey should only take about 20 -30 minutes of your time. Your answers are secret. All answer will be kept confidential.

Only group results will be presented or documented, not individual answers. Your help with this research is strictly voluntary. Your answer is required for any question in the survey. Submitting of an answered survey will indicate your consent to participate in this study.

The results of this survey will be used to validate the proposed tool and presented publicly at Adama Science and Technology University.

If you have questions or concerns, please contact me at,  
+251 920 02 21 89,  
[lamiGAROMA@gmail.com](mailto:lamiGAROMA@gmail.com)

Thank for your time and consideration.  
Sincerely,  
Lami Garoma  
Student Researcher

NEXT

## APPENDEX H: Demographic questions

Questions in a questionnaire used to gather demographics information of respondents.

\* Required

### Ethiopian Hospital Website Quality Evaluation Questionnaire

What is level of your education (E.g. Elementary or Bachelor's degree or master's degree or others)? \*

Your answer: \_\_\_\_\_

What is your professional (E.g. Administrator, accountant, Doctor or others)? \*

Your answer: \_\_\_\_\_

Sex:

Female

Male

Do you know any hospitals' website in Ethiopia? \*

Yes

No

Have you visited St. Paul's hospital millennium medical college website before? \*

Yes

No

How often do you St. Paul's hospital millennium medical college website? \*

Daily

Weekly

Monthly

On need basis

For the 1st time

## APPENDEX I: Main Questions for evaluation

Sample question used to evaluate case study website based on the proposed framework. As the sample of the page shown in the figure below the main section designed to evaluate the case study websites was contains six (6) sections. Each section contains navigation called “**BACK**” and “**NEXT**” which allows respondents go backward and forward throughout the questionnaire before submitting. Respondents able to edit their response before they hit “**Submit**” button at the last section. Once they hit submit button they can't edit the response.

## Ethiopian Hospital Website Quality Evaluation Questionnaire

\* Required

### Ethiopian Hospital Website Quality Evaluation Questionnaire

1. Search helps/hints are provided when wrong keywords are entered \*

- Strongly Disagree(=1)
- Disagree(=2)
- Neutral(=3)
- Agree(=4)
- Strongly Agree(=5)

2. The website provides varied search options (e.g. by department, facilities, disease, specialists, etc) \*

- Strongly Disagree(=1)
- Disagree(=2)
- Neutral(=3)
- Agree(=4)
- Strongly Agree(=5)

### APPENDIX J: Question for overall rating

The question used to gather the overall quality perception of respondents on the case study websites.

## Ethiopian Hospital Website Quality Evaluation Questionnaire

\* Required

**This is the final section of the survey, You arrived here! Thank you for your Dedication and Patience.**

How do you rate the overall quality of this website (St. Paul's Hospital Millennium Medical College Website)? \*

- Excellent (= 0.8 upto 1 out of 1)
- Very good (= 0.6 upto 0.8 out of 1)
- Good (= 0.4 upto 0.6 out of 1)
- Fair (= 0.2 upto 0.4 out of 1)
- Poor (= 0 upto 0.2 out of 1)

BACK

SUBMIT

# APPENDIX K: Home page of the case study websites

This appendix contains the home page for the case study websites

The screenshot shows the home page of Kadisco General Hospital. At the top, there is a navigation menu with links for HOME, ABOUT US, SERVICE, LOCATION, GALLERY, and CONTACT. The main header features a large image of the hospital building with the text "Welcome to Kadisco General Hospital" and a "SERVICE WE PROVIDE" button. Below this, three columns describe the hospital's Mission, Vision, and Goal. The Mission is to provide accessibility to high quality health care. The Vision is to be the most efficient, competent and courteous provider of comprehensive health care. The Goal is to expand other departments such as ophthalmology, telepathology to meet the needs of the society. At the bottom, there is a logo for "Wudassie and Family Business PLC" and "Wudassie Diagnostic Center" with Amharic text. A secondary navigation menu includes HOME, ABOUT US, SERVICES, CSR, MEDIA, GALLERY, and CONTACT US. The footer contains the phone number +251-111-574343 and the address Churchill Road, Pass Theodoros Square, MK Building.

The screenshot shows the home page of St. Paul's Hospital Millennium Medical College. The header includes the college's name in Amharic and English, along with social media icons. A navigation menu lists various services and departments. The main content area features a large banner for "The final result for applicants of 2009 EC. Academic year for Medicine Programme". Below the banner, there is an announcement for registration for the 2009 EC. Academic year Applicants of Medicine Programme. The page also includes a search bar, a "RESEARCH CONFERENCES" section for the 2nd SPHMMC Annual Research Conference, and an "ANNOUNCEMENT" section for the 2009 EC. Academic year Applicants of Medicine Programme.