

# A Case Study to Identify Quality Attributes Relationships for Web-based Applications

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## Summary

Software quality is a complex concept containing a large number of quality criteria. These quality criteria are usually interactive where preference outcome of one criterion over another criterion is always influenced by the remaining criteria. However, to avoid complexity researchers always tend to construct independent criteria which causing some bias effect in evaluation. This paper presents a method to investigate and identify the relationships of quality criteria in the development of web-based applications (WBA). Experienced-based approach and an online survey were conducted to gather the intended relationships. The results have shown that there exist relationships and interaction between the quality attributes. These relationships will be used later on in the aggregation procedure for the evaluation of the WBA.

## Keywords:

*Quality attributes, quality attributes relationships, Web-based Applications, aggregation.*

## 1. Introduction

The evaluation of the Web-Based application (WBA) is a complex process since it consists of multiple criteria or attributes to be measured. Researchers have developed software quality models ([1], [2], [3]) that were intended to be comprehensive and applicable to all software development.

One of the difficulties with earlier models was the inability to account for dependency among the quality criterion. Since the influence of individual quality criteria is not always independent, individual or groups of quality criterion can influence the overall quality in conflicting ways [4].

This paper presents a method to explore the problem of interacting quality attributes in the development of web-based applications (WBA). The relationships among the quality attributes were derived by experience-based approach. An online survey was conducted to identify the relationships among the quality attributes.

The rest of the paper is organized as follows. Section 2 presents the quality characteristics definitions and its relationships. Then, the survey design, covering research question, assumptions and hypotheses, strategy and method, and sample are introduced in the section 3. The last two sections describe the results, conclusion and the future work.

## 2. Quality Characteristics for WBA

Quality model generally define software product qualities as a hierarchy of factors, criteria and metrics. A quality factor represents behavioural characteristics of the system and a quality criterion is an attribute of a quality factor that is related to software production and design, while a quality metrics is a measure that captures some aspect of a quality criterion.

The anticipated quality characteristics used in our study are described in Table 1 along with their definitions, which are referring to the evaluation of web-based application. The quality characteristics are adopted from ISO/IEC 9126 standards. The definitions and the choice of indicators are based on a set of Web usability guidelines ([5], [6]) and W3C standards [7].

Table1. Definition of quality characteristics

<i>Name</i>	<i>Description</i>
Functionality	The capability of the Web site to provide functions and properties which meet stated and implied needs when the site is used under specified conditions
Usability	The capability of the Web site to be understood, learned and liked by the user, when used under specified conditions

Name	Description
Reliability	The capability of the Web site to maintain a specified level of performance when used under specified conditions.
Efficiency	The capability of the site to provide appropriate performance, relative to the amount of resource used, under stated conditions.
Maintainability	The capability of the site to be modified. Modifications may include corrections, improvements or adaptation of the site to changes in environments, and in requirements and functional specifications.
Portability	The capability of the site to be transferred from one environment to another.

### 2.1 Quality Attributes Relationships

The individual measures of software quality do not provide an overall measure of software quality. For this, the individual measures must be combined or aggregated. Occasionally the individual measures of quality may conflict with each other, and compromises may have to be reached.

To judge the relationships, a survey is used to elicit information from the developer, management and user. Previous works (refer Table 2) have shown that this technique is the most common approach that has been used to judge the relationships.

Table 2. Techniques to explore relationships between quality attributes

Ref	Attributes	Purpose	Techniques used
[8, 9]	Correctness Reliability Integrity Usability Efficiency Maintainability Testability Flexibility Portability Reusability Interoperability	To study the relations of different quality goals attribute in developing software	Survey - questionnaire
[10]	Performance Adaptability Maintainability	To address the importance of design decision made during software development	Case Study - Interview

Ref	Attributes	Purpose	Techniques used
[11]	Usability Time to market Reliability Usability Correctness Portability	To increase the understanding of software quality attributes and their relations	Research Literature and Survey – structured interview
[12]	Quality attributes in 3 different perspectives: management, developer and user perspective	To merge different view and discuss the relationships between the quality attributes	Discussion (meeting and offline discussion)

Table below summarizes the relationships published in [8, 9, 11, 12]. The attributes that are not considered in our study are removed from the table.

Table 3. Quality Attributes Relationships

Functionality	Functionality					
Reliability	+	Reliability				
Usability	+	+	Usability			
Efficiency	O	O	-	Efficiency		
Maintainability	+	+	+	-	Maintainability	
Portability	O	O	O	-	+	Portability

From the above table, there are three types of interactions can be recognized. We also present the definition of the relationships among the characteristics.

1. Positive, i.e. a good value of one attribute result in a good value of the other (synergistic goals).
  - Relationships definitions: If characteristic A is enhanced, then characteristic B is likely to be enhanced (+).
2. Negative, i.e. a good value of one attribute result in a bad value of the other (conflicting goals).
  - Relationships definitions: If a characteristic A is enhanced, then a characteristic B is likely to be degraded (-).

3. Independent, i.e. the attributes do not affect each other.
  - Relationships definitions: If a characteristic A is enhanced, then characteristic B is unlikely to be affected (0).

The relationships of quality characteristics need to be demonstrated as the definitions of the quality attributes in Web-based applications and the domains of the application are slightly different. We have identified fifteen relationships in our study, there are:

1. Functionality vs. Reliability
2. Functionality vs. Usability
3. Functionality vs. Efficiency
4. Functionality vs. Maintainability
5. Functionality vs. Portability
6. Reliability vs. Usability
7. Reliability vs. Efficiency
8. Reliability vs. Maintainability
9. Reliability vs. Portability
10. Usability vs. Efficiency
11. Usability vs. Maintainability
12. Usability vs. Portability
13. Efficiency vs. Maintainability
14. Efficiency vs. Portability
15. Maintainability vs. Portability

To determine how different quality characteristics relate to each other, we have to judge every pair of quality attributes. By using such pair wise comparisons, it is possible to see which kind of interaction there is between the characteristics. The survey approach has the possibility to handle a large number of attributes that are not clearly and explicitly expressed, either qualitatively or quantitatively. Information gather from interview can express the tacit knowledge and also explores the motivation for the focus on positive and negative relations based on the experienced problem.

### 3. Survey Design

This section describes the aim, method and sample for our survey.

#### 3.1 Research Question

The overall research question is “What are the quality characteristics of a good Web-based application? Is there exist any relationship between the quality characteristics? And what are their relations?”

In general, all of the general quality characteristics of software quality applied for conventional software is also apply to Web-based applications. However, we have identified (in section 2.) the most relevant quality characteristics, which can provide a useful basis for assessing the quality of Web-based applications.

#### 3.2 Survey issues

The survey has two issues to cover

1. Quality characteristics usage in developing Web-based applications, which are used.
  - Are the term quality characteristics familiar to the team?
  - Which quality characteristics are present in the web engineering process?
2. The opinions of relations among quality characteristics.
  - Do you sense any relations between the quality characteristics?
  - Is the relation stringent or working in opposite direction?

These issues are supported by the definitions of quality characteristics.

#### 3.3 Assumptions

There are some assumptions made, these are listed here.

- The people that take part in the interview are familiar with the term quality characteristics.
- The organization participating has normally handles the terms quality characteristics or some other term with similar meaning.
- The organization only uses a subset of the quality characteristics and not all quality characteristics are taken into consideration with in the process.

#### 3.4 Hypothesis

The following hypothesis is the basis for the line of questioning for this survey.

- Relations between quality characteristics exist. The relations indicate that there are conflicting as well as supporting relations between quality characteristics.

### 3.5 Strategy and method

The chosen strategy is survey. The motive is that survey is collecting information from a group of people in a standardized way, where you control the sample and which questions to ask. A survey can be both qualitative and quantitative, depending on the method used for the survey. The survey approach can also cover a great variety of questions, such as ‘how’, ‘what’ and so on.

At first, the chosen methodology was semi-structured interviews. These are found to be useful when extracting qualitative information from an individual. However, due to the unavailability participant to participate in the study, an online survey was conducted to replace the interview session.

### 3.6 Sample

The sample mainly was conducted as judgmental sampling or purposive sampling. We prefer the sample based on whom we think would be appropriate for the study. This is used primarily when there are limited numbers of people that have expertise in the area being researched. We have invited 57 companies to participate in the study. However, only 20 of them are willing to participate in the study.

## 4. Results

Results from the online survey have supported our hypothesis although we could not manage to conduct the interview survey. All respondents agreed that the quality characteristics are part of the development process and there exist relationships among them (see Figure 1). They also agree that the relations are depending on the type of the system being built.

Figure 2 illustrates the type of interactions exist between the fifteen identified relationships. By considering the majority, we summarize the relationships and interactions in Table 4. Six relationships have positive interactions; four relationships have negative interaction while five relationships are view as independent.

Opinion collected from the survey state that the relations are also depending on the type of the user of the develop system. For instance, for ordinary user, too functionality sometimes makes them confused, then less efficient (e.g. composing e-mail with too many advanced features) and for system administrator, more functionality make more efficiency (e.g. web-based firewall configuration panel).

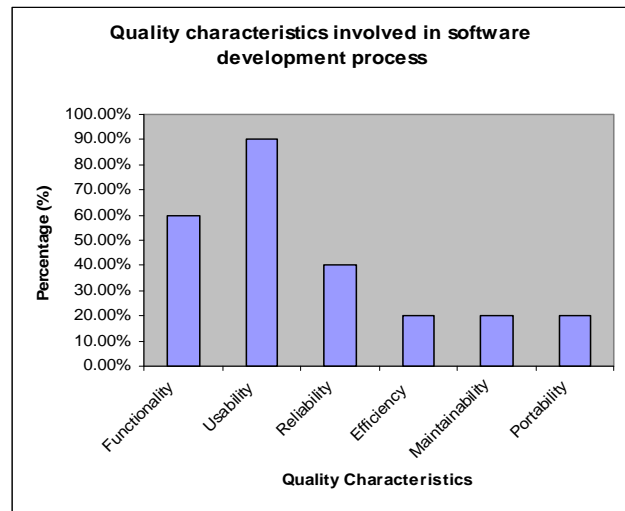


Fig. 1 Quality characteristics involved in the software development process

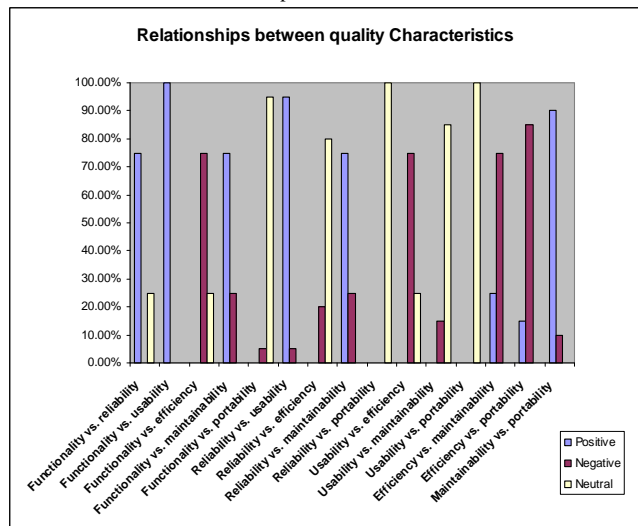


Fig. 2 Relationships between quality characteristics

The relationships identified from the survey are slightly different from the literature summarized in Section 3. These are normal as the opinions of the relationships are depending on the nature of the system being built. Furthermore, it was not an easy task to extract some explicit relations from the interviewees; this was based on that there was no explicit knowledge about the relations; the answers were therefore based on experience from the interviewees. However, the main important issue that we want to highlight is the relations among quality characteristics were agreed upon and the relations stated.

Table 4. Relationships identified from the survey

<b>Relationships</b>	<b>Interaction</b>
1. Functionality vs. Reliability	Positive
2. Functionality vs. Usability	Positive
3. Functionality vs. Efficiency	Negative
4. Functionality vs. Maintainability	Positive
5. Functionality vs. Portability	Independent
6. Reliability vs. Usability	Positive
7. Reliability vs. Efficiency	Independent
8. Reliability vs. Maintainability	Positive
9. Reliability vs. Portability	Independent
10. Usability vs. Efficiency	Negative
11. Usability vs. Maintainability	Independent
12. Usability vs. Portability	Independent
13. Efficiency vs. Maintainability	Negative
14. Efficiency vs. Portability	Negative
15. Maintainability vs. Portability	Positive

## 5. Conclusion and future work

This paper has presented an approach to identify the relationships between the quality attributes or characteristics for the WBA. The relationships are derived by an experience-based approach and a survey was used to gather the data. Generally, the opinions of the respondents regarding the quality attribute reconfirm the view expressed from our literature and by this means confirm the stated hypotheses, i.e. there exist quality attributes that are relate to each other (either supporting each other or in conflict with each other).

The identified relationships will be used in establishing the aggregation of the score for the evaluation of web-based application. The common aggregation approach, which is weighted average or weighted sum, cannot be used as this approach only assumes that the criteria are independent. This will be our future work.

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