CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The incredible growth of the internet has made the world to function on web applications. Data and information are available on the web, either as a static page or a dynamic page. Thus the process of building a web application takes the key attention. The web application developed must be reliable and this must be ensured using a systematic and organized methodology. The prime feature that is to be available in all the software is that, it must function in an error free fashion. Frequently a web application and web sites are considered to be the same but they are different. The web site is a collection of more no of web pages and similarly web application is a composite of web pages that are both static and dynamic and include some processing units in it that could fetch and display data that are geographically distributed.

Building a web application with high quality is a demanding situation, to do so, every activity concerned with the development of the web application has to be ensured for quality evaluation. The quality in a wide-range specifies to adhere to the end user specification and also the quality standards. Quality holds various perspectives to various sets of end users and various personnel in the web application development process. Ensuring that the developed software has met all the specification has to be done right from
the initial stage. The failure of any component in the software may lead to carry the error to the later phases of software development.

In the conventional methodology, the quality of the web application or website is evaluated using meta models or in reference to the error log files that reflect the functionality of the application. Certain other methodology tries to evaluate the quality of the developed websites only on a limited perspective. The quality evaluation is either constrained to a single quality attribute or to a limited set of quality attributes. Most of the quality evaluation methodology is associated with the rating process of the functional website or web application. Ensuring quality into the web application right from the development phase to the functional phase under a collection of quality perspectives and preference is the basic requirement. This essential requirement has paved the base for the research.

1.2 SOFTWARE QUALITY MODELS

Quality model is a framework that holds a set of characteristics, sub characteristics and explains the relationship between characteristics and sub characteristics (Hamid & Hasan 2013, Jamwal 2010, Kumar et al. 2015, Suman, MW & Rohtak, MDU 2014). This quality model satisfies the requirement analyst, developers, tester and end user requirements of the software application to be developed. These quality models explain about the set of quality characteristics that were available.

- McCall’s Quality Model

McCall’s quality model was devised under the two perspectives, namely User’s viewpoint and Developers viewpoint. This model is built under the hierarchal fashion. The top part of the hierarchy holds three divisions, namely
Product Revision, Product Transition and Product Operations. Product operation deals with the building of customer requirement, next Product Revision are related with error correction, system adaptation and finally Product Transition deals with rapid change of requirement. This model has a disadvantage as it could not provide an accurate measurement of quality. It could be found that around 23 criteria are defined in this quality model.

- **Boehm Quality Model**

The next quality model is the Boehm quality model which deals with the total quality of the application. This quality model overcomes the defects of the previous quality model and to overcome the defect hierarchy structure is devised for the Boehm Quality Model. The model has its concentration on the Hardware performance.

- **ISO / IEC 9126 Quality Model**

The International Organization for Standardization (ISO) in hand with the International Electro-technical Commission (IEC) developed a standard for product evaluation (Abran et al. 2005, Acharya & Sinha 2013). ISO / IEC 9126 was the first quality model that was used for the quality maintenance of the software. This quality model is a general quality model that suits to any software that is to be developed. Also, this quality model holds six basic characteristics, namely Efficiency, Functionality, Maintainability, Portability, Reliability and Usability. This quality model was devised from McCall and Boehm quality models. This
model holds three different parts that explain about Internal Quality, External Quality and Quality in Use.

- **Dromey Model**

  Dromey model holds a quality evaluation framework where the software component qualities are evaluated based on the measurement of product’s tangible quality properties. The tangible quality properties are falling under four categories, namely Correctness, Internal, Contextual and Descriptive. These properties are used to evaluate the quality of the components. The model suits for more dynamic applications.

- **FURPS Model**

  The FURPS quality model holds the characteristics, namely Functionality, Usability, Reliability, Performance and product Support. The functionality characteristic is divided into Functional requirement and Non-Functional requirement. The notable problem is that portability characteristic is not considered.

- **Quint2 Model**

  Quint2 model is the extended model of ISO / IEC 9126 quality model. The quality characteristics of the ISO / IEC 9126 quality model has been enhanced with 11 sub characteristics making it functional for web applications. Functionality, Maintainability, Reliability and Usability are the criteria that were enhanced with additional sub characteristics. Usability criteria were improvised with the user perspective of a web application.
**Web based quality model**

Certain quality model is used for evaluation under three dimensions, namely quality, feature and phases (Anusha 2014, Fath-Allah et al. 2013, Marchetto & Trentini 2007). The evaluation method is not considering the mechanism of comparing each attribute with another.

These are initial versions of the software quality model, and there are few more quality models which hold various perspectives on usage. The utility of any of these quality models generally enhances the quality of the software.

### 1.3 SOFTWARE METRICS

The quality of the software developed is decided from the better functionality of the software and also the acceptance rate of the software. Incorporating quality into the software to be developed is not an easy process. A systematic approach is required to incorporate quality into the software. Software quality holds various definitions over it, for few quality software means holding more reusability nature, for some it is fitting for use and for some it is conformance to requirements. The quantitative measurement of the quality is obtained by measurement of quality indicators. The measurement refers to the scale of attainment of the quality. Similarly, quality metric is restricted to measure the attainment of particular quality attribute of the product or process of the software developed.

Software quality metrics are a set of metrics that are grouped under various perspectives, as depicted in Figure 1.1 which holds the Process Quality Metrics, Product Quality Metrics and Project Quality Metrics (Dhyani & Bhowmick 2002, Ladan, 2012, Zia, Q 2015). The process quality metrics
aids in the software development and maintenance such as determination of
development time and metrics associated with process improvement. The
process quality metrics are also called as Maintenance metrics. Similarly
Product metrics can be referred as quality metrics. Product metrics help to
describe project characteristics like complexity of the design, size of the
program and so. Product metrics can be used for evaluation of the software at
any phase of the software development life cycle. Project metrics are used to
evaluate the effort and time of current working project by analyzing the
previous projects. These metrics deal with the effort and time of the
programmers. Project metrics help to minimize the development time and also
defines the measure for cost, schedule and productivity.

![Software Metrics Diagram](image)

**Figure 1.1 Types of Software Metrics**

### 1.4 SOFTWARE PRODUCT METRICS

The process metrics are those metrics that are used to measure the
performance and effectiveness of the processes involved in the software
production done by the software organization. The Software product metrics
help to evaluate the product at various stages of the software development life
cycle. These metrics are used to evaluate the product whether it meets the user
requirement. Early detection of the problem reduces the risk of transformation
of the error to the later stages. The project metrics help to access the project, predict the risks and helps to manage the production time by scheduling the quality evaluation using the product metric. This gives a clear state that the product metrics hold a higher order of preference among the software metrics discussed. The categorization of product metrics is understood through the Figure 1.2.

![Figure 1.2 Types of Software Product Metrics](image)

The internal metrics deals with the static measure of the software that is being developed. To be specific it deals with the internal part of the software that is in the development stage. This internal metrics are used to
evaluate the non executable software. Measuring the internal quality of the software helps to predict the overall performance of the software. The quality of the intermediate product has to be given more importance. Once the internal quality of the software is enhanced the overall quality of the software gets enriched for sure.

The external metrics deals with the dynamic measures of the software that is produced. These metrics, analyze the external characteristics of the software when it is executed under the working environment of the software. These metrics are more useful during the testing and operational period. The metrics are most useful when applied on the software that is the final product and not an intermediate product.

Quality in Use metrics is those metrics that function more similar to the external metrics which work on the final product but under the real time conditions. These metrics could be used to evaluate the achievement of user’s perspective under the real time condition. These metrics are used to evaluate under any context of use for which it was built.

When all these metrics are combined for the software quality evaluation the result will help to build the quality products. The quality is achieved through the better identification and classification of criteria and software product metrics. The Internal metrics, External metrics and Quality in Use metrics are interrelated, the impact of fault gets reflected on all these groups as they are interrelated.

1.5 IMPORTANCE OF DECISION MAKING METHODS

Availability of number of choices makes the decision making a tedious process. The decision making has to be done in a systematic manner which helps in eradicating the unnecessary options and choosing the right set
of choice. An efficient tool that removes the irrelevant options and that identifies the right option is the Multi Criteria Decision Making (MCDM) methods. When a number of options and decision makers are available then, the utility of the MCDM method makes the decision making an easier process. Two divisions of MCDM methods are available, namely Multi Attribute Decision Making (MADM) and Multi Objective Decision Making (MODM). Around 70 – 80 MCDM methods are available and a few of the important and frequently used methods are discussed here (Challa et al. 2011, Velasquez, M & Hester, PT 2013, Zhao, Y & Luo, X 2014).

- **AHP**

Analytic Hierarchy Process (AHP) is the most important and frequently used MCDM method (Ghosh et al. 2012, Jati 2009, Li 2006, Saaty T.L 2008). The methods function on the priority theory. AHP deals with problems involving more number of alternatives or choices. This model executes in an efficient way processing, judgment about the alternatives by the experts. Individual decision making cannot be considered as a valid decision, so the involvement of more no of decision makers is required. AHP holds a hierarchy structure that explains the complex decision problem. The complex problem is divided into simple structures and holds criteria, sub-criteria and alternatives in the hierarchical model. The pairwise comparison method is used to compare the alternatives and grade them using the Saaty’s scale. The Eigenvector method helps to identify the weights and priorities of criteria, sub – criteria and alternatives. The advantage of the AHP method is its hierarchy structure and its pairwise comparison where all the alternatives are compared with each other. AHP functions efficiently when
there are a fixed number of alternatives and the alternatives do not change frequently.

- **TOPSIS**

The next important MCDM method used by the decision makers is Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) (Alptekin & Sevim 2015). This method tries to identify a solution that is close to the positive ideal solution and far away from the negative ideal solution. The Euclidean Distance (ED) method is used to identify the relative closeness between the alternative and ideal solutions. The advantage of the TOPSIS method converts the criteria dimension to non-dimensional criteria. The method gets the criteria weights as the input to rank the alternatives in the descending order. TOPSIS method works efficiently on a huge volume of alternatives.

- **ELECTRE**

Elimination and Choice Translating Reality (ELECTRE) is one of the MCDM methods that functions on the outranking relation concept. The outranking relation concept is dependent on the pairwise comparison method. The functionality of the ELECTRE method generates the coordination indices, namely concordance matrices and discordance matrices. These indices are used to analyze and outrank the alternatives. The most important alternatives are selected and the least opted ones are eliminated. This method functions efficiently when there is less amount of criteria and large number of alternatives.
• **PROMETHEE**

Preference Ranking Organization METHodology for Enrichment of Evaluations (PROMETHEE) method functions similar to ELECTRE method and this is also based on the outranking method. Different versions of PROMETHEE methods are available. Some go for partial ranking and some go for complete ranking. Basically the method consists of two phases where the first phase deals with the construction of outranking relation and the next phase deals with the ranking process.

• **GREY THEORY**

The Grey method is efficient enough to deal with the data that is incomplete, which is more efficient than the previous method. The Grey Relation methodology deals with the uncertain system and incomplete information to make relational analysis.

• **VIKOR METHOD**

The other name of the VIKOR method is the Compromise method. The feasible solution is the one that is close to the ideal solution and the compromise is established manually. This method works efficiently when there is no clear idea about the solution.

The above stated methodology each has a set of importance and each functionally is different from each other. The proposed integration method plans to evaluate the criteria through AHP method and finally the alternatives are ranked using the TOPSIS method.
1.6 OUTLINE OF THE THESIS

Chapter 2: Literature Review. This chapter deals with the past and recent research works done in the various areas like Quality models, Web Quality Models, Quality Criteria, Decision Making Methods, Web Application Quality Evaluation method and the other associated and related works.

Chapter 3: Problem Formulation. This chapter explains few quarters about the limitations involved in web metric selection, noted issues in the web application quality evaluation and later characterize the problem statement and finally explain about the research contribution done.

Chapter 4: Proposed Plan for Integrating Web Quality Models. This chapter gives detailed explanations about the quality models, namely ISO / IEC 9126 and Quint2 model, further explains about the experts involved and provides the overview about the Integrated Quality Model.

Chapter 5: Proposed Plan for Rating Quality Criteria using AHP. This chapter provides a detailed explanation about the AHP, the process of expert rating of the criteria, the utility of AHP for Quality Criteria ranking and finally concludes with a detailed explanation about the case study conducted on utilization of AHP in the web based environment.

Chapter 6: Proposed Plan for Ranking Quality Metrics using TOPSIS. This chapter explains about association of Quality Models in various phases of web application development, followed by a detailed explanation of TOPSIS. Metric ranking against the phases of SDLC is explained using usecase diagram and finally the result obtained by using the integrated method is explained.
Chapter 7: Conclusion and Future Enhancement. This chapter provides an overall conclusion about the utility of an integrated methodology for the web application quality evaluation. This chapter provides the detailed summary of work done and also explains about the limits of future enhancement.

1.7 CONCLUSION

The basic requirement of software development is to incorporate quality to various phases. The domain specific criteria are to be opted properly and the selection process is based on the software product to be developed. The criteria opted are used to build a quality model to evaluate the web application. Since various experts are involved a good collection of criteria is selected which covers the various features of web qualification in an efficient way. The relative importance of each criteria is evaluated by the AHP method which is quiet simple and uses the pairwise comparison method to reduce the biased decision. The TOPSIS method grades and ranks the metrics against each other under the perspective of each criteria. Based on the phase oriented weight of all the criteria the metrics are associated with various phases of SDLC (Tavana, M & Hatami-Marbini, A 2011). TOPSIS method is very simple and could handle more number of alternatives.