Testability Estimation of Object Oriented Software
-Design Phase Perspective-

……

Research Scholar: Mohd. Nazir

Supervisor: Prof. K. Mustafa, Head, DCS, JMI.
Co-Supervisor: Dr. R. A. Khan, BBAU, Lucknow.

ABSRACT

This study was undertaken in view of the significance of testability and the development of a good measure of object oriented software testability in design phase. In the absence of any standard framework and / or guideline available for testability estimation early in design phase, it was considered necessary to propose a framework for the same. Subsequently, a review of relevant literature on testability estimation, approaches, techniques, metrics and models was undertaken. It was clearly revealed that the mechanisms available for testability estimation are only applicable at the later stages in the development life cycle. However, many of the researchers and practitioners frequently argued that testability estimation should be integrated throughout the development life cycle. Further, they emphasized on the need and significance of quantifying testability, early in the system development. It is advocated that estimating testability at design phase may yield the highest pay-offs. Hence, it is very obvious that a mechanism to quantify testability of object oriented software in design phase is highly desirable. This, along with other supplementary reasons, emphasized on the need for developing a framework that can estimate testability of object oriented software in design phase. Thereby, with considerable development, achievements and reasonable arguments given by experts in the area, it appeared feasible to develop a Testability Estimation Framework (TEF^{OOD}). It was also considered necessary to validate the utility and acceptability of the framework for estimating testability of object oriented software in design phase.

In the present course of study, five contributions have been made by the researcher, in addition to many macro-level direct or indirect findings. First contribution out of the five is the *Development of Testability Estimation Framework (TEF^{OOD}).* A critical review of the literature available on testability estimation reveals the fact that there is an urgent need of deducing a mechanism to compute software testability in the early stage of development life cycle. In the absence of any methodology or guideline for testability computation in design phase, it appeared worthwhile making an effort to develop a framework for the same. Therefore, researcher made an effort for the same and come up with the framework TEF^{OOD}. The framework comprises of seven steps namely *Testability Factorization, Software Characterization, Metric Selection, Correlation Establishment, Testability Quantification and Qualitative Assessment,* along with an additional common step of Design Review.

Secondly, a *Testability Fishbone Model (TFM^{OOD})* has been developed in order to further illustrate the idea of executing each of the steps described in the framework TEF^{OOD}. Ultimate objective of having a quantitative assessment of testability of object oriented design is to assist software engineers by ensuring a good testable design hierarchy. Quantitative estimate of testability helps in deciding the design hierarchy and may be changed or modified there only easily. Order of the execution of each step for testability quantification has been clearly mentioned in the model proposed.

In fact, there are many factors affecting software testability. Researcher identified a set of factors having a significant contribution in predicting software testability. Moreover, a minimal set of testability factors are obtained depending on the weightage of their contribution in estimating testability in design phase. Understandability and Complexity are the two factors identified having greater significance on quantifying object oriented software testability in design phase. In third and fourth contribution, *Understandability Estimation Model (UEM^{OOD})* and *Complexity Estimation Model (CEM^{OOD})* have been developed respectively to quantify Understandability and Complexity of object oriented design. The Models have further been validated using the same set of try-out data of C++ commercial software application. In order to strengthen the claim of correlation of Testability with Understandability and Complexity, statistical analysis has been made. Being highly correlated, Understandability and Complexity measures are used to develop *Testability Estimation Model (TEM^{OOD})* as a fifth contribution of the thesis. An empirical validation of the model is also carried out using try-out data.

Dromey's generic quality model has been taken as a basis to develop the UEM^{OOD}, CEM^{OOD} and TEM^{OOD}. Proposed model, for the assessment of high-level design quality attributes in object oriented design, has been experimentally validated using try-out data of ten projects. The proposed model is able to estimate overall design quality from design level information about an object oriented software project. It is also apparent from the validation of model that it may be used in monitoring testability estimation, early in design phase and hence controlling the quality of software right from the beginning in SDLC.

Furthermore, some of the primary research questions were also addressed during study and certain inferences are drawn with regard to the same. Therefore, on the successful completion of study, the researcher reflects upon some important observations and contextual inferences as follows:

- Early quantification of testability reduces costs and efforts of rework.
- There is a need for minimal set of testability factors object oriented design.
- TEF^{OOD} may be adapted to get Testability Metric in design phase for testability leveling.
- A tool may be developed for implementing the models, UEM^{OOD}, CEM^{OOD} and TEM^{OOD}.
- The models may be generalized and used by other researchers for making testability leveling of projects undertaken.

Testability estimation early in design phase is highly emphasized in the study; hence, considered important for the delivery of quality software. Even though the proposed framework TEF^{OOD} and model UEM^{OOD}, CEM^{OOD} and TEM^{OOD} uses simple and straightforward approach, the correlation with a limited set of projects has been found to be high. This gives an indication that models can be effectively used in estimating testability of software in design phase. TEF^{OOD} may be generalized to validate the metrics available in the literature. Like any other study, it cannot be argued that the current work does not suffer from certain limitation and delimitations. Therefore, in order to generalize the results, further study on large sample of data is needed.