The influence of software quality requirements on the suitability of software cost estimation methods

Marc Giombetti[1], Ricardo Valerdi[2], Stefan Wagner[3]

{giombett, rvalerdi}@mit.edu, wagnerst@in.tum.de

Abstract

With the growing size, number and importance of software systems since the 1960s, the need to accurately estimate the schedule, effort and consequently cost of these more and more expensive systems led to the development of the first software cost estimation methods. Over the years, different estimation techniques have been developed in industry and academia, primarily with the objective of improving the accuracy of schedule, effort and cost estimates. These estimation techniques can primarily be subdivided into two major categories: formal methods (parametric models such as COCOMO) and expert-judgment based methods. There is no simple answer to the question which type of method is *"better"*. The more important question should rather be: *When are formal estimation methods more appropriate then expert-based judgments?* (Jørgensen & Boehm 2009).

This research focuses on this question by analyzing when formal estimation methods are more useful than expert-based estimation given specific software quality requirements. Quality attributes such as usability, maintainability or portability, as defined in the ISO/IEC 9126 standard (International Organization for Standardization 2001) are different in nature. They all have a particular influence on the software and system architecture and subsequently on the effort, schedule and cost necessary to develop the particular system. As the need for high quality software increases, it becomes more and more important to analyze the influence of quality requirements on costs. The goal is to more accurately predict the costs originating from high quality requirements. It is first important to understand those implications so that the inclusion of quality costs into project estimates will allow software companies to make better predictions. This will avoid big cost overruns because of unrealistic expectations and allow companies to justify quality costs towards their customers.

This research accommodates both the demand in quality software as well as the development in cost estimation methodology. It empirically analyzes the influence of software quality requirements on the selection of the appropriate cost estimation approach. We conducted interviews with software professionals to see how cost and effort estimation is handled in industry projects with special quality requirements. Based on a literature review, a comparison between formal estimation methods and expert estimation methods was made. It is followed by an analysis on the influences of quality requirements on the cost of software systems, as well as cost estimation methods.

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[1] Visiting Research Assistant at Lean Advancement Initiative, Massachusetts Institute of Technology & Graduate Student in Computer Science at Technische Universität München, Germany

[2] Massachusetts Institute of Technology

[3] Technische Universität München

In a further step, a controlled experiment was used to elaborate both expert estimation and COCOMO with respect to different foci on quality. The intentions of the experiment were twofold. First we wanted to analyze how much estimators expect specific quality requirements, such as usability and security, to influence the development time of an information system. The estimations were made by students using an expert estimation approach. Second, we wanted to analyze the differences between estimates using the expert estimation approach and the outcomes of a COCOMO estimation. The experiment was conducted with one group of graduate students from Massachusetts Institute and Technology[4] and is planned to be conducted with a second group of students from Technische Universität München[5] in the near future.

The major contribution of this work is to provide a holistic view on the advantages and limitations of cost estimation techniques in respect to certain quality requirements. The understanding of the influences of quality requirements onto costs will give new opportunities to make software cost estimates more accurate. The analysis is based on practical experience from software professionals, on the findings from literature and is supported by experimental results.

This research is related to previous work on cost/benefit-aspect of software quality assurance (Giombetti 2008). Previous work comprises the study of COCOMO (Boehm 1981) , COQUALMO (Chulani & Boehm 1999), Cost of Quality (Krasner 1998; Slaughter et al. 1998; Wagner 2006) and a set of quality assurance techniques for economically sound decision-making in software engineering.

Research Methodology

Figure 1 gives an overview of the presented research which follows the following methodology:

1. Literature review commenting on the similarities, dissimilarities advantages and limitations of formal methods and expert judgment-based methods. The review includes references to the work on software quality and the influence of quality on development costs.
2. Identification and evaluation of significant quality attributes influencing software cost estimates.
3. Conduction of interviews with software professionals: Collection of knowledge and experience from estimators on how quality attributes influence cost estimates in industry.
4. The compiled information is used to conduct an experiment with graduate student in the role of expert estimators. The estimators are given a requirements description and project settings for an information system. The estimators are subdivided into two groups. The first group gets a set of additional security requirements for the system, and is asked to estimate the duration of development for the new system. The second group has to perform the same estimation task, but is given usability requirements instead of security requirements. An analysis is conducted to analyze the relative influence of the specific quality requirements on the development schedule of the basic system.

This abstract describes work in progress. Preliminary results will be shared with the community at the 24th International Forum on COCOMO and System/Software Cost Modeling.

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[4] Lecture: *ESD.361/16.866 - Cost Estimation & Measurement Systems* – Dr. Ricardo Valerdi – Massachusetts Institute of Technology, Cambridge, USA

[5] Lecture: *Project-Organization and Management in Software Engineering* – Prof. Dr. Dr. h.c. Manfred. Broy, Technische Universität München

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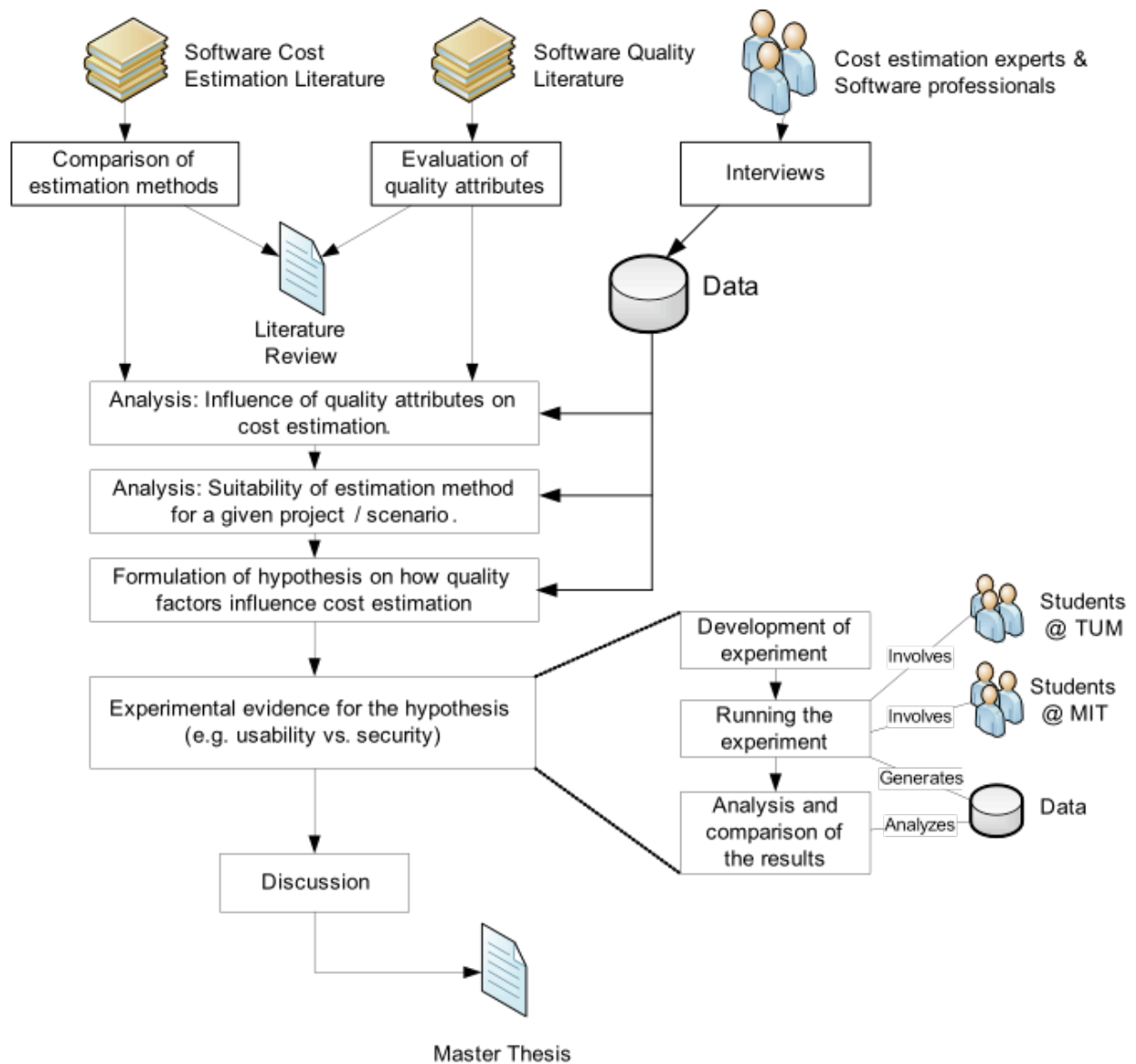
Appendix

Figure 1: Research methodology