1. INTRODUCTION

We cannot conceive of matter being formed of nothing, since things require a seed to start from...

(William Shakespeare)

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It is estimated that only 16% of the software projects are successful. The rest of them are either canceled, lately delivered, out of budget or offered less features than originally specified [The95]. One key aspect used to reduce project failures is the collection of quantitative data. These data can include effort assigned to work packages, measurement of progress, and quality and measurement from the effectiveness of Quality Assurance (QA) activities. Such information must be made available for project management. Project management aims for a successful conclusion of the project [LL10]:

> "[...] *Successful* means, that the project will produce all deliverables with required quality within time and resources [...]"

Success in the software design demands transparency. To allow transparency, projects and processes must be quantifiable in some form. Metrics are a way to quantify projects and processes. They represent characteristic attributes of the measured entity. In order to conduct the measure, a measure specification must be available. This measurement specification aligns the defined metrics to the organization through information needs. Moreover, it includes detailed information of what is to be measured, how it is going to be measured and how measures should be analyzed. Thus, the measure takes place either manually operated or supported by some tool. Metrics will be used during all phases starting from software design up to quality assurance and estimations.

The importance of metrics is reflected in industries best practices. A positive assessment in CMMI Level 3 for instance, requires organizational wide defined metrics [Sof10]. Management level metrics and their measure requirements will most likely be organizational wide defined. Although these metrics are applied throughout the organization, they need to be adapted or adjusted with identified information needs to fit project specific conditions. These changed metrics are called variations of the organizational wide defined metrics, whereas the adjustment process is called tailoring.

Figure 1.1.: Tailoring of project specific metrics from the organizational wide defined metrics

Like the family tree depicted in Figure 1.1, all defined metrics must be derived from the same trunk. That is, to adapt the organizational wide defined metrics to meet the project's objectives. Although this task is performed in many organizations; neither the methodology for the tailoring is understood, nor are sophisticated tools being used to assist it.

1.1. Objectives

The aim of this master thesis involves the development of a clear methodology for the tailoring of organizational wide defined metrics and provide tool support for this process. The methodology should include a method for variation point management in metrics. Furthermore, it should include a meaningful metaphor regarding derivation of project specific metrics from organizational wide defined metrics. The tool support should therefore cover the following functionalities:

Tailoring of metrics. The tailoring of organizational wide defined metrics to project specific should be possible, including: definition of the organizational wide defined metrics (including their variation points) and support of the tailoring.

Variation point management. This point involves the development of a variability modeling technique that supports the management of variation within the metrics. It should therefore cover the following functionalities: definition of variation points in metrics, documentation of the variation points and associations between different varieties of metrics.

1.2. Research Methodology

The goal of this research was to develop a methodology for the systematic tool supported tailoring of metrics. With this purpose in mind, the following steps were employed (as research methodology) to achieve the objectives introduced in the previous section:

Topic familiarization through literature review. The purpose of this step was to summarize, classify and compare prior research studies. This step involved the investigation about existing work related to usage of metrics in the organizations. The analysis included understanding the different practices used to tailor the metrics and a comparison with respect to the point of view established on this work.

Investigate and analyze the requirements for the methodology. The strategy followed during this step was to focus on a small study case. The study case consisted in analyzing a collection of metrics from an organization. The analysis was performed with the *MeDIC Tool*[1]. This step permitted an exploratory analysis on the organizational wide defined metrics, without the need of assumptions and/or theoretical ideas.

Development of an overall concept for the tailoring. Based on the previous steps, an initial generalized idea that could help to tailor organizational wide defined metrics was developed. However, this step required multiple refinement iterations. Based on the first iteration and in cooperation with the people involved, some changes to the methodology were pointed out. Based on a thorough analysis of these changes, the methodology was improved.

Design of the tool support. The technique used on this step was paper prototyping. This technique allowed rapid prototyping that permitted communication between the people involved. The feedback that was provided conducted to a re-design of the User Interface. This step was concerned with the visual composition of the tool.

Evaluation of the methodology and the tool support. The validation from the methodology and the tool support were based on the requirements and analyzing the overall process followed during the research

Document the work in written form. Parallel to the previous steps, the documentation of the results was performed.

[1] The MeDIC (Measure Documentation, Integration and Calculation) Tool is developed by the Research Group Software Construction (SWC) at RWTH Aachen University [VHLN08].

1.3. Overview

The remainder of this master thesis is organized in seven chapters. In the next lines, the contents of each chapter are explained in a brief manner.

Chapter 2 - Foundations: The second chapter covers the theoretical foundations. Within the theoretical foundations metamodeling, reusable software component models and software product line engineering (SPLE) are covered as well as the preliminaries to metrics. Finally, the topics of paper prototyping and metaphors within computer science are described.

Chapter 3 - Related Work: The third chapter reviews the usage of metrics in the industry. The chapter exposes the different mechanisms used to incorporate and structure the metrics within the organizations. These mechanisms include the creation of organizational wide defined metric programs, metric repositories and metric frameworks.

Chapter 4 - Tailoring Concept: The fourth chapter defines the term of tailoring within the context of metrics. Moreover, a metaphor regarding tailoring of metrics is explained.

Chapter 5 - Conceptual Approach: The fifth chapter presents the conceptual approach used for the tailoring of metrics. The conceptual approach uses as starting point the metaphor introduced in chapter four. The key concept from the approach is the metric framework.

Chapter 6 - Tool Support: The sixth chapter contains a horizontal prototype of the tool supporting the conceptual approach described on chapter five. Furthermore, this chapter provides an application scenario from the tool.

Chapter 7 - Evaluation: The seventh chapter contains the evaluation of the developed solution. An evaluation of the conceptual approach from chapter five and an evaluation of the tool support from chapter six are covered on this chapter.

Chapter 8 - Summary and Outlook: The eighth chapter summarizes the research conducted during this master thesis. A discussion with proposal ideas for future research on this topic concludes this section.

8. SUMMARY AND OUTLOOK

Speaking is no different than
thinking: to speak is to think.

(Octavio Paz)

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In this chapter the contents of this master thesis are summarized. Furthermore, an outlook with proposal ideas for future research on this topic is given.

8.1. Summary

The topic of this master thesis is concerned with the usage of metrics within an organization. As explained in this work, a large variety of metrics are applied throughout the organization. Each of those metrics must be adapted in order to meet specific project conditions. The resulting metrics are called *variations* of the organizational wide defined metrics whereas the adaptation is called *tailoring*. Although this is performed in many organizations, the methodology for the tailoring is not understood. The tailoring can be performed based on the composition from the metrics, which consists of common and variant parts. This composition requires variation management, which can be provided with a variability model. In practice, the usefulness of the methodology can be accompanied by tool support. The conception of a methodology and its tool support are treated in this work.

This works starts describing an analogy between the organizational wide defined metrics and an *object oriented framework*. The analogy introduces the idea of having metrics that can be adapted by composition, i.e. filling the *hot-spots*. However, the adaptation covered by this work is seen more as a process rather than a technical detail. For this reason, the tailoring process is defined. Furthermore, the methodology or conceptual approach is introduced. The conceptual approach takes advantage of the analogy previously described and formalizes the term of **metric framework**. The purpose of the metric framework is to support the tailoring process of the organizational wide defined metrics, providing them a common structure. The common structure is known as a metric frame, which contains a *variability model*. The variability model is used to represent the attributes from the metrics that can be adjusted.

Afterwards, the *tool* supporting the tailoring process of organizational wide defined

metrics is covered. A brief explanation about the internal working of the tool is reviewed. Subsequently, an application scenario is used to show the process followed during the tailoring process. A design of the User Interface (UI) that follows the process from the application scenario is covered. Finally, the evaluation of the conceptual approach and the tool support conclude this master thesis by discussing the mains results obtained. The results showed that the metric framework permits understanding and management about the variation in the metrics. The metric frame allows a structuring that is tool supported.

8.2. Outlook

The conceptual approach is effective in identifying the parts of the metrics that can be adjusted and controlling this adjustment process. However, there are points where the conceptual approach can be improved or extended. In addition to the research directions discussed regarding the conceptual approach from chapter five and the tool support from chapter six, numerous improvements and evolutions could be considered. These improvements are listed to conclude this master thesis. Several aspects remain that need to be validated in order to show the true benefit of applying the conceptual approach for the tailoring of metrics. The scenarios provided here demonstrate that it is possible to adjust metrics from the organizational level. Applying the approach on multiple case studies will not only validate it further, but also will enable to extend it with a body of best practices. An example of this, is the construction of metric frames and a more robust collection of constraints and relation dependencies.

In relation to the tool support, the metric framework represents the core asset that allows its operation. The scenario depicted in this thesis shows how the tool is used to assist stakeholders during tailoring of metrics, e.g. through consistency checking, guidance and validation. These tasks are sustained by the metric frames. A metric frame is defined and created by a metrics expert. In this situation, the creation of the metric framework is still a linear process in which a metrics expert is involved. The metrics expert must define and provide all the metric frames. The role of the metrics expert can be assisted by the tool regarding this task of defining the metric frames. Further research can be directed on this branch by extending the conceptual approach. The conceptual approach should be able to look at the project specific level and abstract new potential metric frames. These candidate frames should be then reviewed by the metrics expert, which will decide whether they become part of the metric framework. The development of a software tool used for the systematic tailoring of metrics is another research direction that can be followed. The metric framework should be used as foundation basis for its development.