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Modeling Metrics for Monitoring Software Project Performance Based On the GQM Model

Mariayee Doraisamy, Suhaimi Bin Ibrahim, Mohd Naz'ri Mahrin

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***Abstract*—**There are several methods to monitor software projects and the objective for monitoring is to ensure that the software projects are developed and delivered successfully. A performance measurement is a method that is closely associated with monitoring and it can be scrutinized by looking at two important attributes which are efficiency and effectiveness both of which are factors that are important for the success of a software project. Consequently, a successful steering is achieved by monitoring and controlling a software project via the performance measurement criteria and metrics. Hence, this paper is aimed at identifying the performance measurement criteria and the metrics for monitoring the performance of a software project by using the Goal Question Metrics (GQM) approach. The GQM approach is utilized to ensure that the identified metrics are reliable and useful. These identified metrics are useful guidelines for project managers to monitor the performance of their software projects.

***Keywords*—**Software project performance, Goal Question Metrics, Performance Measurement Criteria, Metrics.

I. Introduction

THE phenomena of software projects being unsuccessful has always been a problem in the software industry. CHAOS Reports state that 32% of all projects are delivered on time and on budget; whereas 24% are challenged due to being late, over budgeted, and 44% fail as these may have been cancelled prior to completion or before the software is delivered and used (2012) [1]. Failures occur from many perspectives such as an overrun schedule, overruns in cost, impaired functionality and inexperience of project managers and for other valid reasons. In conjunction to this, software industries have started to work closely to address this problem and come up with some practical solutions.

One of the methods recommended in reducing software crisis is by monitoring and controlling. Monitoring and controlling are two significant elements for the success in software projects and are also the elementary disciplines in project management. The purpose of monitoring is to ensure the software project is progressing according to schedule, accurately budgeted and with quality expectations in project management [2]. Various established methods, techniques and approaches are introduced for monitoring software projects such as monitoring the cost and schedule (Earned Value Analysis). However, as in most cases, software crisis does not only occur because of cost and schedule attributes but also due to the cost of the software project and scheduling which may be overrun. The overrun may be due to various factors which may arise from existing human factors such as the project managers, the top management personnel and the vendors. Thus, measuring the performance of these attributes will help project managers to monitor and manage the software projects successfully.

Neely [3] defines performance measurement as a process of enumerating the efficiency and effectiveness of an action. In line with this, the performance of a software project attributes need to be monitored consistently and therefore reduce possible software crisis. Metrics is one of the most widely practiced measurement methods which can measure the attributes of software projects [4]. The performance of a software project with attributes is measured so that it can be monitored and controlled to be successful. Hence, this paper introduces a list of performance measurement criteria and the related metrics that are needed to be monitored and controlled during the development of a software project. The Goal Question Metric Model is used in this study to achieve the set objective.

Firstly the paper begins with a discussion on the theoretical background information of the Goal Question Model (GQM). Followed by Section III activities in generating metrics in stages for the software project performance monitoring are then provided. Finally, the conclusion and suggestions for future work on this research are presented.

II. Goal Question Metric (GQM)

There are numerous methods to develop the metrics for monitoring the performance of a software project. The GQM is one of the many well-established software measurement methodologies. The GQM is an organized way to tailor and integrate the determinations of an organization into measurement goals and then convert them into measurable values [5], [6].

The GQM has four important phases which are planning, definition, data analysis and interpretation. The first two phases use the top-down approach while the last two phases utilize the bottom-up approach. The GQM classifies the measurement process into three important parts which are describing the goal, setting of questions based on the goal and setting of metrics to address each question. The identified metrics could be objective or subjective in nature. Hence, the GQM is used in this research to gather a performance measurement criteria and metrics that are related to the monitoring of the performance of the software project.

Mariayee Doraisamy is a postgraduate student at the Advanced Informatics School, Universiti Teknologi Malaysia, Kuala Lumpur, Malaysia (e-mail: maarisa75@gmail.com).

Suhaimi Ibrahim and Mohd Naz'ri Mahrin are with the Advanced Informatics School, Universiti Teknologi Malaysia, Kuala Lumpur, Malaysia (e-mail: suhaimiibrahim@utm.my, mnazrim@utm.my).



Fig. 1 GQM Model

The GQM approach is used in this study to develop the metrics for monitoring the performance of software projects. This study comprises four important activities that are needed to be conducted for the development of the metrics. This is illustrated in Fig. 2. The activities are explained in detail as follows.

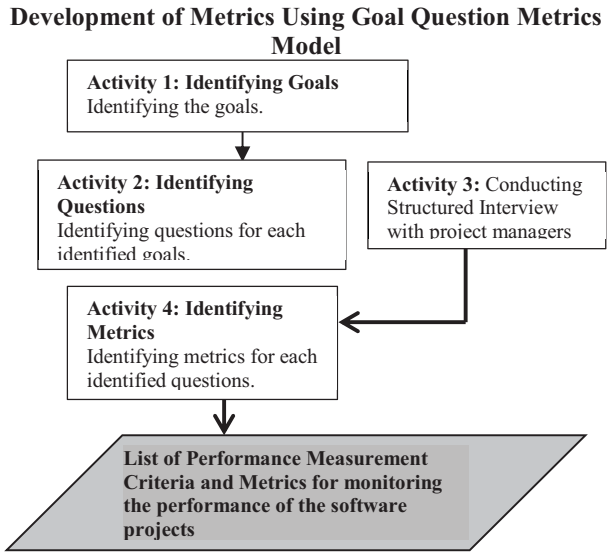


Fig. 2 Activities in GQM Model

III. Metrics Development Using GQM Model

The procedure starts with Activity 1 which is determining the goals. In this stage the goals are set. The performance measurement criteria that are derived from the Systematic Literature Review (SLR) study are formulated as the goals in this study. In this research, a SLR is conducted in the field of performance measurement criteria for monitoring software projects. With reference to reviewed literature, the aim of this activity is to explore the performance measurement criteria that are related to the monitoring of software projects. In order to conduct this SLR, a reference from Kitchenham [7] is used. Thirteen goals are obtained from an SLR study. They are *costs, schedules, project managers, team members, vendors, users, top management personnel, training, communication, projects, documentation, resources and governance*. These thirteen goals become the input for the GQM approach. These goals are the measurement goals for monitoring the performance of the software project.

Once the goals are identified, a series of questions are then generated in the next activity which is Activity 2. This study has very carefully generated a set of questions by defining the identified goals. It is ensured that a set of questions are created for each identified goal and the questions are basically describing the activities that are involved in each and every performance measurement criteria. Fig. 3 describes the GQM Model, which shows only two of the important performance measurement criteria (goals) and the questions.

The next step is Activity 3, which is conducting structured interview sessions. The purpose of the structured interviews is to identify the metrics that can be used to monitor the performance of a software project. A group of project managers are involved in the interview sessions. These identified project managers are currently managing software development projects in the Malaysian Public Sector. They are chosen based on their experience in managing software projects from 5 to 20 years. Besides this, they are also managing the outsourcing and in house software projects for the Malaysian Public Sector. Seven project managers are selected for this study. Initially, 10 projects managers were identified but three of the project managers could not commit to this study due to work constraints and were also unable to fit into the interview schedules.

Before the interview sessions, a discussion session was held with Project Management Consultants, MAMPU, Malaysia. Based on the discussion, 10 experienced project managers are identified and then the interview sessions with the project managers are scheduled. These project managers are contacted via email and telephone. The interview sessions are conducted individually with each respondent the sessions are conducted on face-to-face basis. The duration of each interview session ranges from 45 to 60 minutes. Each interview sessions is recorded and the field notes are for further transcription. At the end of each and every interview session, the data gathered is disclosed to the respondents for their acceptance and for confirmation of the accuracy on the data collected.

Activity 5 is the final stage which involves identification of the metrics based on the structured interview questions. The data collected through the structured interview sessions is transcribed and analyzed by using the qualitative data method. This method is known as the Thematic Analysis and it is a broadly-used qualitative data analysis method [8] as it suits the questions that are related to the respondent experience, or views and perceptions. It is one of the cluster of methods that focuses on identifying the patterned meaning across a dataset. Identifying patterns of meaning across a dataset is the main purpose of the Thematic Analysis and this provides an answer to the research question that is being addressed. The final product of this activity is a list of the performance measurement criteria and metrics. The identified metrics in this stage are considered as the potential metrics that can be used to monitor the software project performance.

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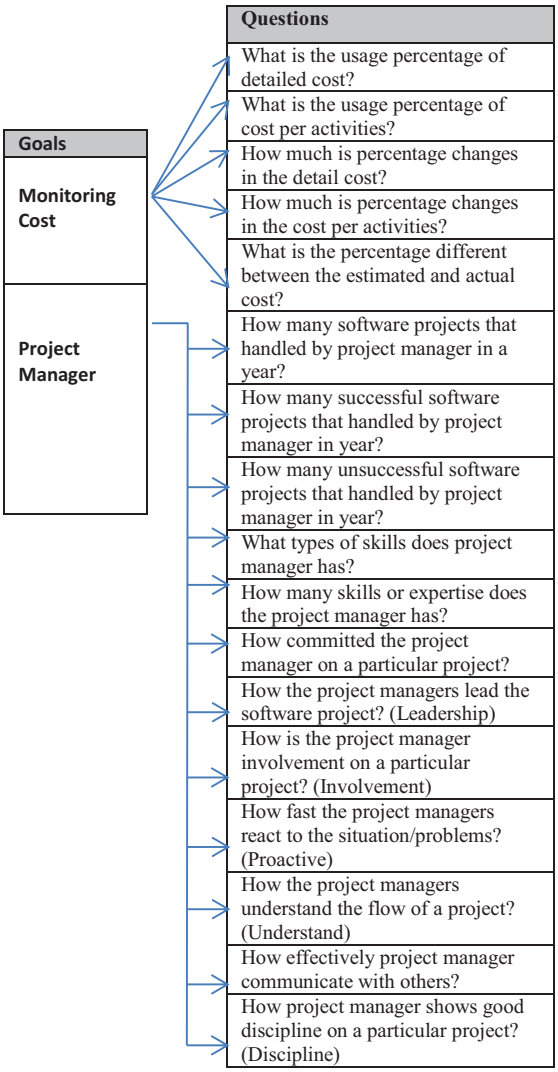


Fig. 3 GQM Model

Table I shows the identified metrics for the cost performance measurement criteria. The metric name, the purpose of metric, scale type, source or document to monitor and the targeted audience are created for each metric in this research study.

Table II shows the identified metrics for project performance measurement criteria. Four important metrics are identified for the project criteria and these are the percentage of achievement of objectives, software project scope, software project size in terms of cost and the level of complexity of a software project.

However, the given Tables I and II just describe two of the outputs of this research study. The same format of the table is used to derive metrics for different performance measurement criteria such as the schedule, the project the manager, the vendor, the governance, the top management, the communication, the documentation, the user, the training, the resources and the team members.

TABLE I
METRICS FOR THE COST PERFORMANCE MEASUREMENT CRITERIA

Metric Name	Purpose of the metrics	Metric scale type	Input to measurement	Target audience
% of usage the detailed Cost	What is the usage percentage of detailed cost?	ratio	Project Management Plan	Project Manager
% of usage Cost per activities	What is the usage percentage of cost per activities?	ratio	Project Management Plan	Project Manager
% of changes in detailed cost	How much is percentage changes in the detail cost?	ratio	Project Management Plan	Project Manager
% of changes in cost per activities	How much is percentage changes in the cost per activities?	ratio	Project Management Plan	Project Manager
% changes in estimated cost and actual cost (variance cost)	What is the percentage different between the estimated and actual cost?	ratio	Project Management Plan	Project Manager

TABLE II
METRICS FOR THE PROJECT PERFORMANCE MEASUREMENT CRITERIA

Metric Name	Purpose of the metrics	Metric scale type	Input to measurement	Target audience
% of achievement of objectives	How much the objectives of software project are achieved?	Ratio	Project Management Plan	Project Manager
Software project scopes	What is the scope of the software project?	Ordinal	Project Management Plan	Project Manager
Software project size in term of cost	What is the size of the software project?	Ordinal	Project Management Plan	Project Manager
Level of complexity of software project	What is the software project complexity level?	Ordinal	Project Management Plan	Project Manager

In this study, it is learnt that human factors are the most influential factors in managing software projects to achieve success. Human factors here consist of the project manager itself, the vendor, the team members, the top management personnel, the users and the people involved in the governance. In terms of the monitoring of the software project, there are numerous ongoing research works on the cost and schedule attributes in the existing literature. Therefore, more research is required to be carried out on how the human factor attributes can be measured. This research study addresses the above mentioned issue by producing complete and comprehensive metrics.

Although this study mainly refers to the Malaysian Public Sector perspectives but nevertheless the output of this study can be applied to similar public sectors set up in other developing countries especially in the Asian region. Furthermore, the complete and comprehensive metrics will be a foundation to expand further metrics in the future especially in the software project management and in the improvement of software processing.

IV. Conclusion and Future Work

This study shows the development of metrics for the

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Software Project Performance Monitoring using the GQM Model in detail. Metrics are truly meant for measurement as well as monitoring. Therefore, these metrics will be a useful measurement mechanism for monitoring the performance of software projects. However, this study has a few limitations. Only seven interviewees are involved in this metrics development. Although the participants are experienced project managers, but for future studies more respondents should be included for more accurate data and in addition participants should also be selected from the private sectors to get the private sector perspectives as well.

These identified metrics will also be evaluated in the context of the Malaysian Public Sector in future. Furthermore, these metrics can also be empirically validated in the future as they can be employed as a metric monitoring tool in the future.

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