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Business Impact, Benefit, and Cost of Applying GQM in Industry: An In-Depth, Long-Term Investigation at Schlumberger RPS

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Abstract

Many success stories have been reported on specific effects of measurement. But little is known about the multiple interactions of measurement programmes with the business environment of a software organisation. This paper summarises industrial experiences with the Goal/Question/Metric (GQM) approach to software engineering measurement. They are based on long-term observation and additional detailed investigations at Schlumberger RPS. The paper reports the business impact of GQM in terms of identified benefit, cost models, and factors for successful application of GQM.

1. Introduction

Experiences from measurement programmes have been reported from numerous organisations (cf. [4], [5], [6], [7], [9], [10], and [11]). However, quite little is known about the detailed benefit, cost, and success factors of measurement.

At Schlumberger Retail Petroleum Systems (RPS), measurement according to the Goal/Question/Metric (GQM) approach [1] [8] has been introduced in 1994. The measurement activities have been the object of continuous observation and several in-depth studies. Some of which have been conducted in European technology transfer projects like CEMP[2] and PROFES[3].

Improvement initiatives at Schlumberger reach back to 1989 [16]. In the course of the Schlumberger improvement programme, the RPS division has achieved a level 2 on the SEI Capability Maturity scale and has been certified according to ISO 9001 and TickIT. Comprehensive measurement activities started in 1990. The early measurement database contained several weaknesses that made it hard to draw useful conclusions from the data. With the introduction of GQM, measurement became more effective and more useful to the organisation [8]. The process of GQM measurement is depicted in Figure 1. It is structured according to the six steps of the Quality Improvement Paradigm (QIP) [2].

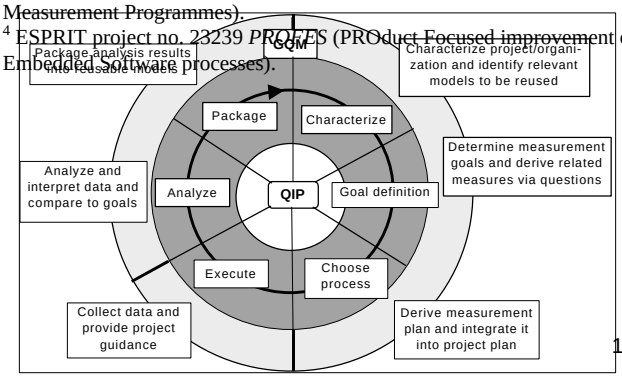

Figure 1: The activities of a GQM measurement programme, structured according to the six steps of the Quality Improvement Paradigm (QIP).

This paper reports recent results from project PROFES and complements them with previous results and experience. Focus is put on the interaction of GQM measurement with the business context in which it is applied. We report benefit, cost, and success factors of GQM and suggest enhancements of the GQM process. Additional information on the results reported can be found in [3].

2. Benefit from GQM Measurement

GQM measurement at Schlumberger RPS has had various benefits: Achievement of improvement goals, financial gains, higher capability to perform improvement programmes, and several unplanned yet useful impacts on software development practices. In the following, some example benefits are reported.

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Activity *type*	GQM Expert *initial*	GQM Expert *routine*	Facilitator *initial*	Facilitator *routine*	Manager *initial*	Manager *routine*	Per Engineer *initial*	Per Engineer *routine*	10 Engineers *initial*	10 Engineers *routine*	Total *initial*	Total *routine*
Prepare Measurement Programme	24	4	32	-	4	2	4	-	40	-	100	6
Identify and Define GQM Goals	18	8	8	-	2	1	1	1	10	10	38	19
Prepare & Conduct GQM Interviews	35	40	35	-	2	2	1	2	4	8	76	50
Develop GQM plan	156	32	80	-	2	1	½	1	5	4	243	37
Develop Measurement plan	40	8	58	-	-	-	½	-	5	2	103	10
Perform Data collection	-	24	16	-	-	1	3	1½	30	15	46	40
Data Analysis and Interpretation per Feedback Session	12	28	48	-	8	2	4	2	40	20	108	70
Perform Data Analysis and Interpretation (5 feedback sessions)	60	240	240	-	40	10	20	10	200	100	540	350
Package Experiences	8	16	8	-	-	1	-	½	-	5	16	22
Total	341	372	477	-	50	18	30	16	294	144	1162	534

Table 1: Combined effort model for two variants of GQM (effort in person hours): Initial introduction of GQM (left number) and routine application of GQM (right number). The model is based on six measurement programmes in the context of ESSI project CEMP and ESPRIT project PROFES.

Goal achievement. A process improvement goal at Schlumberger RPS was to reduce the effort of support activities. A GQM measurement programme was set up with the goal to analyse the time spent on all support activities related to a certain product. Due to the measurements the developers have understood better their maintenance effort. They have become able to plan maintenance work more accurately and the performance of maintenance activities has improved [15].

Financial gains. One of the measurement programmes at Schlumberger RPS investigated the interrupts of developers during their work. Based on the findings, work and communication practices in the team were improved, and the number of interrupts was cut significantly. This resulted in improved productivity of software development and reduced cost.

Higher capability to perform improvement programmes. GQM has made improvement programmes at Schlumberger RPS more stable and successful. The project teams use GQM as a change agent for improving their work practices and the products they develop. GQM also helps to keep improvement programmes focused, because improvement actions are selected and implemented on a well-informed, quantitative basis.

Improved group synergy. In all projects the teams' group synergy improved due to the GQM measurement programmes. Early in the projects, the team members had multiple meetings to identify and define GQM goals, questions, and metrics. These discussions stimulate interaction between team members and trigger an increased interest in the performance of work practices [14].

Increased quality awareness and QA involvement. GQM measurement programmes involve the personnel of software projects actively in the investigation and improvement of quality [14]. Project managers and QA manager at Schlumberger RPS observed that this makes quality aspects more visible and important to the teams. Also the involvement of quality assurance with the development teams was intensified.

3. Cost of GQM Measurement

This section presents an operational cost model of GQM measurement programmes that has been derived from the experience with GQM measurement at Schlumberger RPS (see Table 1). Cost is stated in terms of the effort at which personnel is involved in the measurement programme. It is listed per role and activity of the measurement programme. There are two separate cost models: One for initial application of GQM, and one for routine application.

3.1. Underlying Assumptions

The cost models have the following underlying assumptions: Participants are one GQM expert, one manager as interviewee, and four non-management roles as interviewees. The project team has 10 engineers. In the initial application of GQM, the GQM expert is external to the organisation. He/she is supported by an additional role, the facilitator, who is trained to take over the role of the GQM expert in future measurement programmes.

Furthermore, the tool infrastructure for the measurement programme is built gradually during initial GQM application. Later measurement programmes can use it without investing much additional effort in infrastructure set-up. Considerable effort for training and briefing is needed only during the initial measurement programme.

It is assumed that five GQM feedback sessions are needed during the measurement programme. Usually, a measurement programme lasts about one year.

3.2. Effort Model and Cost Structure

Table 1 shows the effort model for GQM as it has been derived from the experience at Schlumberger RPS. The table rows list the major activities of the measurement programme. The columns contain the effort per role involved. Each table cell has two entries: The first one is the effort (in person hours) for the initial GQM measurement programme, the second one stands for routine application of GQM. The remainder of this section describes the cost structure underlying the model.

Total effort. An initial GQM measurement programme requires an effort of eight person months (PM). For routine application, three PM are needed. The difference comes mainly from three factors: (1) Comprehensive training and infrastructure implementation effort

occur only in the initial measurement programme. (2) Increased experience and routine makes GQM-related activities more efficient. (3) Later measurement programmes can often reuse work products (e.g., parts of GQM plans or measurement plans) from previous measurement programmes.

Planning and preparation vs. execution. During the initial measurement programme, planning and preparation effort is about as high as execution effort. Most effort is needed for feedback sessions and development of the GQM plan. For routine application of GQM, planning and preparation require only 30 percent of the total effort. About 70 percent go into feedback sessions, which are the most important part of GQM measurement programmes [8].

GQM effort vs. total project effort. For the initial GQM measurement programme, approximately two percent of the project team's total working time is required for measurement-related activities. In routine GQM measurement programmes, this portion is reduced to approximately one percent.

Effort of GQM expert vs. total GQM effort. In every measurement programme, about two thirds of the total effort are consumed by the GQM expert (and the facilitator, respectively).

Additional information regarding the cost structure of GQM measurement programmes is reported in [3]. It also contains a discussion of factors that can cause cost variations.

General success factors of GQM:

- Management commitment
- Nomination and availability of an acting sponsor
- Positive attitude of project and organisation toward measurement
- Tentative identification of improvement goals and possible improvement actions
- Thorough planning of the measurement programme
- Existence or development of a descriptive process model of the processes being measured
- Access to researchers and results of research
- Measurement and improvement of the measurement processes
- Explicit and operational definition of the measurement processes

Success factors for initial application of GQM:

- Co-ordination of measurement programme with project schedule
- Small number of goals
- Viewpoint coverage of all important roles of the software project
- Measurement goals that can easily be measured and interpreted
- Comprehensive but simple tool support
- Comprehensive, role-specific training and briefing

Success factor for routine application of GQM:

- Advanced tool support

Note: A prerequisite for routine application of GQM is that both the GQM experts and the project team are experienced in GQM. This increased experience makes that most success factors for initial application of GQM are no longer critical.

Table 2: Success factors for GQM measurement.

4. Success Factors for GQM Measurement

Numerous success factors for measurement programmes have been reported in the literature (e.g., [5], [6], [7], [9], [10], and [11]). Some of these success factors are already a built-in part of the GQM method, which is applied at Schlumberger RPS. This allows us to address success factors on a more detailed level. In particular, we have found that the importance of success factors changes over time as routine with GQM measurement programmes increases.

Table 2 lists the success factors that were identified at Schlumberger RPS during a period of more than four years. They are structured in three groups: (1) General success factors of GQM, (2) success factors for the initial application of GQM, and (3) success factors for routine application of GQM. Detailed descriptions of the success factors and their rationales are provided in [3].

Success of a GQM measurement programme is much less critical once the project team is familiar with the approach. For instance, the number of GQM goals can increase, viewpoint coverage is no more crucial, and most of the training and briefing efforts are no longer needed. This suggests that the initial measurement programme should particularly focus on training the application of GQM. Its measurement goals should not be too ambitious and allow for quick results.

5. Suggested Enhancements of GQM Process Definitions and Support

We have been able to observe more than four years of GQM measurement at Schlumberger RPS. The application of GQM has been very successful. But we have also gained experiences based on which we can suggest further enhancements to the current GQM process definitions:

Management of measurement programmes. For the long-term success of a continuous measurement initiative, it is important that the interactions between technical measurement activities and their business context are considered sufficiently well. Therefore the management of measurement programmes should be stressed. The GQM process should be supplied with detailed guidance and advice for the following activities: (1) Initiate and set up measurement programme, (2) modify and evolve measurement programme, and (3) disseminate and extend measurement programme.

Detailed guidelines for two variants of GQM. We have identified two variants of the GQM process: Initial and routine application of GQM. Both variants differ significantly with regard to cost and success factors. For this reason future guidelines for technology transfer of GQM should reflect this distinction and provide specialised advice for either case.

Advanced tool support for GQM. Appropriate tool support is important for successful application of GQM. At Schlumberger RPS, a tool set has been developed gradually that consists of

integrated commercial-off-the-shelf business applications. It is useful and effective, but it required considerable effort and time needed to build it. For the ease of future users of GQM, an integrated tool infrastructure for GQM measurement programmes and related methodologies should be developed (cf. [12]).

6. Summary and Future Work

This paper has presented findings about the business impact of GQM measurement programmes that have been derived from Schlumberger RPS. They are based on more than four years of experience with GQM during which several focused in-depth studies about software engineering measurement have been performed. Additional information is reported in [3].

GQM measurement at Schlumberger RPS has been a success story. It plays a major role in the improvement of software product quality and software processes. Also other aspects of software development have been further improved with the aid of GQM. For instance, team synergy has increased and the attitude of the engineers toward quality and improvement is better than before.

Future work will address the further evaluation of the presented results (i.e., benefit, cost, and success factors of GQM). In addition, the suggested enhancements to the GQM process will be realised. Much of this work will be performed in project PROFES [13]. Particular focus will be put on the packaging of experiences from measurement, and on further enhancements of tool support for GQM.

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