Efficient Quality Assurance in Process Models – An Example: The Combination of Team Reviews and Pass Arounds

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Abstract: Quality Management (QM) is an integral part of process models for software engineering. Due to the neglect of quality assurance (QA) measures, such as reviews, software projects face a high risk to fail or be postponed. Software companies look for effective and efficient QA measures that can easily be integrated in their projects. While inspections (technical reviews) are used for crucial modules and documents, additionally other less formalized review types can and should also be used for the QM in a software engineering project. A review method that combines team reviews and pass arounds is described: Group discussion and email-based evaluation (GREME). The proposed method can be used in the different phases of a process model: analysis, design, and implementation. The possible products to be reviewed may comprise user interfaces, documentations, manuals, user guides and working processes. The use of GREME on three examples shows, that it can be used to review non-crucial products in an economical, efficient and effective way. The team can detect errors and aberrations at an early stage, propose solutions and assess the quality of a product. The adherence to delivery dates is high. The ratio of GREME review time to development time lies with 16 to 29 percent in the common range of inspections (10 to 50 percent).
Keywords: Process model, Software engineering, Review, Quality management, Quality assurance, Project management.

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Introduction

Software engineering projects often suffer from lack of time, which may lead to the disregard of quality assurance measures. This neglect causes failure or postponement of 50 to 80 percent of IT projects [Ba98, LL07 Wi01]. Scientific research and experiences of commercial software companies show the benefit of the implementation of practical and efficient quality management.

Process models for software engineering intend to raise the quality of both processes and products. Integral parts of process models are project management, risk management, cost-benefit analyses, process descriptions for software engineering and quality management [LL07, So06]. The use of quality assurance methods, for instance reviews, is to be integrated in any process model for software engineering [Wi01].

Quality assurance (QA) methods for software development are to be used on processes, prototypes and products. The purpose is to avoid or to identify and eliminate errors and aberrations as early as possible. Quality assurance aims to achieve effective and efficient software development processes and high quality products. QA means are differentiated (a) in error prevention by organizational measures and development standards and (b) in defect detection by testing and reviewing. While tests in large part can be automated, reviews require the manual examination of a product by a team of moderator, author and peers [Ba98, LL07, So06].

Reviews are time consuming procedures and require experience in moderation and in product centred software assessment. Common review types are inspections (technical reviews), team reviews, walkthroughs, pair programming, peer desk check, pass around and ad hoc review. The level of formalization follows a descending order: From inspections, that are well defined and formalized, down to ad hoc reviews, which are casual reflections and discussions during the development process [Ba98, LL07, Wi01].

In the following a review method is outlined that combines team review and pass around: Group discussion and email-based evaluation (GREME). The purpose is to facilitate structured, comprehensible and economical quality assurance during software engineering for non-crucial modules and documents. An example shows the experiences with this model so far. The integration in process models for software engineering and the GREME review characteristics are discussed. An outlook completes this paper.

Background

Software engineering and IT projects deliver products, such as software modules, documents, process descriptions, project and budget plans. Reviews represent a part of QA, which is compulsory for any process model for software engineering.

Inspections (technical reviews) are used for crucial modules and documents (e.g., important interfaces or requirements specifications). The team consists of a developer (author), a moderator and four to five experts. The procedure is well defined. The experts assess the quality of the product against certain specifications by identifying errors, failures and strengths [Ba98, LL07, So06, Wi01].

In **team reviews** further perspectives are considered: Domain experts, users, quality managers and marketing experts supplement the board of experts. In guided group discussions the team assesses the quality of the product, discusses strengths and weaknesses, identifies errors and makes suggestions how to solve a problem. The benefit for the participants is the opportunity to find solutions and to learn from each other [Wi01].

A central part of both review types – inspections and team reviews – is the meeting, where the moderator, the author and the experts evaluate and assess the status of a product. For technical reviews the meeting procedure is well defined. Team reviews are less formalized. Nevertheless, the team meetings require a specified etiquette for the group discussion and a skilled moderator [LL07, Wi01].

A **pass around** is initialized by an author who delivers a product to peers asking for their written feedback and suggestions. The product is for instance attached to an email or stored on a server. The feedback arrives via email, letter or orally. The author decides whether he considers the feedback in his work [Wi01].

The user-centred software engineering established the application of **social research methods**, such as interviews, questionnaires and observations [Ni93]. Feedback can be collected also via email or a web forum. Goal of the user-centred software engineering is to learn about the users' needs, ideas and requests. All these methods result in textual materials. In order to fulfil the qualifications as working material in software engineering the texts must be comprehensibly analyzed [WWS06a]. Qualitative text analysis, a social research method [BD03, Ma00], facilitates such an analysis. The results can be used immediately in the ongoing software development (see for instance [We06]).

The use of qualitative research methods, such as interviews and observations, is more and more common in computer science [WWS06a]. It is encouraged by experiences reported by colleagues and in literature, by training programs and well established software for the computer supported text analysis (e.g. [Ve08]).

Based upon this background the **GREME review** combines

- Team review: Group discussions guided by a moderator. A team discusses with the author a product and identifies errors, open requirements and solutions; and

- Pass around: The team members send feedback via email on certain stages of the development process. The texts are comprehensible analyzed by means of qualitative text analyses. The results are used immediately in the ongoing development process.

GREME

A research team developed the GREME review during its work on a web-based information system on hospitals [WWS06b]. The team used GREME for the work on several modules that were needed for the online release of the information system [We07].

Purpose and Areas of Application

GREME was developed to facilitate structured, comprehensible and economical quality assurance during software engineering. It is intended to build a further component in the review portfolio. GREME

- Is to be used for analysis, design and implementation of software, user interfaces, documentations, manuals, user guides and working processes.

- Is not intended to replace inspections, audits or tests.

- Shall offer the development team immediate insights on the ongoing product development and possible improvements.

- Is also intended for software engineering processes where classical approaches are not used due to time or human resources restrictions.

- Can and should be implemented across-the-board of development teams and departments (a) to gain third party insights, (b) to improve the communication in an organization, (c) to learn from each other – Overall: GREME is intended to empower learning organizations.

Roles and Tasks

Executives or a **project manager** identify a product to be reviewed with GREME. The project manager appoints the team size and the team members.

The **team** extends from six up to twelve persons. This group size fosters a purposive communication and collaboration [Se02]. The team consists of moderator, author and peers. To gain multidisciplinary insights the peers are software engineers, domain experts, other staff members of the organization (e.g. marketing) and users.

The **moderator** manages the review process. He guides and documents the group discussions. Furthermore he analyzes the collected email feedback texts and documents the result in a short report.

The **author** uses the particular report and the insights from the group discussions for his work. He triggers the pass around by announcing a new delivery of the product via email to the team. The product is stored on a shared server. To ease the feedback either the author or the moderator may communicate to the team topics for the individual feedback cycle.

The **peers** assess the product, give feedback via email on time and take part in the group discussions. The term "on time" is defined during the first meeting of the group, for instance two working days. Table 1 lists tasks, results and the persons in charge.

Task	Result	In charge
Selection of the product to be reviewed with GREME		Executive or Project Manager
Appointment of the team members: moderator, author, peers		Executive or Project Manager
Management of the GREME process		Moderator
Delivery of the prototypes and the final product	(Intermediate) product	Author
Triggering of the pass around	Email	Author, supported by the moderator
Reflection on the product and in time feedback	Emails	Peers
Documentation, analysis and report on the pass around	Report	Moderator
Guidance of the group discussion	Professional working atmosphere	Moderator
In advance reflection on the product and active participation in the group discussion	Passing	Peers, author and moderator
Documentation and delivery of the group discussion's protocol	Protocol	Moderator

Table 2: GREME steps

Skills

The work in a group, the review of a product, and the use of qualitative research methods require both professional expertise and several social skills from the group members. They have to be open minded for the approach and new insights. Furthermore, they have to collaborate reliably and give feedback and take part in the discussions in a polite, open and supportive way. The persons involved have to bear in mind, that the subject of the review is the product and not the developer's performance [DL99, LL07, Wi01].

The moderator has to be able to guide the group discussions neutrally and goal-oriented. Reflections on the group dynamics and the ability to focus on the contributions of the group members support this [Se02, LL07, Wi01]. To perform the text analysis of the email feedback he needs basic knowledge in the collection of qualitative data and in qualitative text analysis. Examples on introductory literature and training programs are for instance [BD03, Ma00, WWS06a]. The text analysis can be performed computer supported (for instance with [Ve08]).

The developer must be capable to reformulate the report on the email feedback in tasks and to classify them as Must, Should and Can measures [IE90].

Flowchart

The formative Group Discussion and Email based Evaluation (GREME) is performed in iterative cycles (Figure 1).

Group discussions and pass arounds alternate (red font). In-between the development proceeds (black font). The result is a new delivery of the product (blue font).

The pass around is triggered by the announcement of the author on a new delivery of the product and consists of the email feedback by the peers and the text analysis by the moderator. The peers send their emails to the whole group. The pros and cons of this approach are discussed later. The moderator's report is the result of the pass around.

The author uses the report to identify Must, Should and Can measures and integrates them in his work.

The group discussions are integrated in routine meetings, for instance weekly department meetings. The duration is set to approximately 30 minutes. This facilitates continuous work on the topic and avoids extra effort for scheduling and performing additional meetings.

During the group discussions the author presents the prototype as well as open questions and problems. The team discusses them and makes suggestions for solutions. The team reaches consensus on further actions: For instance the author must revise the Must, Should and Can measures or he can proceed with the development. The final group discussion is characterized by the passing of the product by the group. The moderator summarizes the results of each individual group discussion in a short protocol and delivers this to the group members.
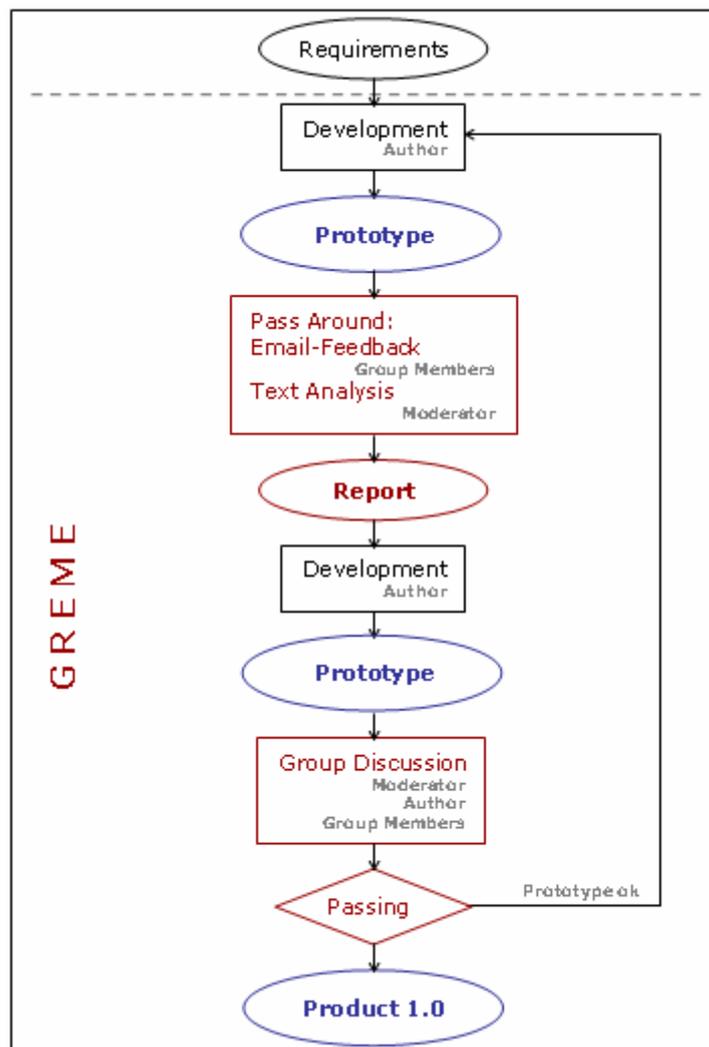

Figure 1: GREME Flowchart

Comprehensible Review Results

A good documentation and a well-grounded data collection and analysis during a review enhance the quality of the review [Ba98, LL07, So06, Wi01]. In GREME this is ensured by two procedures:

1. Group discussion: The moderator writes a short protocol and delivers this to the group members. It builds a communication paper during the ongoing work. Furthermore, a peer is still able to take part in the proceeding review if he left out a meeting.

2. Pass around: The moderator collects the emails and performs a qualitative text analysis. He documents the results in a short report which is to be used by the author for his ongoing work. The text analysis is based on social research methods and is performed computer supported. An approach is outlined in the following section.

Qualitative Text Analysis

The peers comment during the pass around on the quality of the product, open requirements, errors and possible solutions. To gain as much insights as possible from the email feedback, the texts are analysed based on social research methods and summarized in a short report. In GREME the moderator is in charge of the text analysis.

Qualitative social research methods aim to gain new insights [BD03, Ma00]. Qualitative text analysis facilitates this by its structured and comprehensible approach. The approach allows to consider all the comments in the emails and to estimate the relevance of individual comments. The method is easy to learn by IT experts and other non-social scientists [WWS06a].

The analysis should be performed computer supported. Figure 2 shows an example with MAXqdaTM [Ve08]. The documentation and storage of the data is easy. The transparency for the participants is high. Later re- or co-examinations are possible. These aspects increase the quality of this part of GREME. The emails of each pass around are stored as one "project". The content is examined inductive and deductive [Ma00].

The inductive examination aims for the identification of "categories" under which a comment can be stored, for instance "layout". During a first reading cycle the moderator identifies "categories". He may add "sub-categories", for instance "layout and colour". Then he reads the texts again and assigns individual text parts to the categories and sub-categories. It is possible to assign a text detail to several (sub-) categories. By repeating the categorization and assigning cycles the categories gain clarity and distinctness.

For the deductive analysis the moderator uses categories, which he determined before the first analytical reading, and looks for suitable text passages in the texts again. The analysis ends with a check of unmarked text details on overlooked aspects.

The interpretation can be supported by considering text details that are marked for two or more categories. This may give a hint on connected problems or common solutions. The number of text details assigned to a category is of interest, but the moderator should be aware that the quantity of comments on a certain category is just one criterion for the relevance of this category.

In GREME every group member has free access to the stored qualitative text analysis and the report. By this each member can clarify misunderstandings during the ongoing work, either via email to the team or during a group discussion.
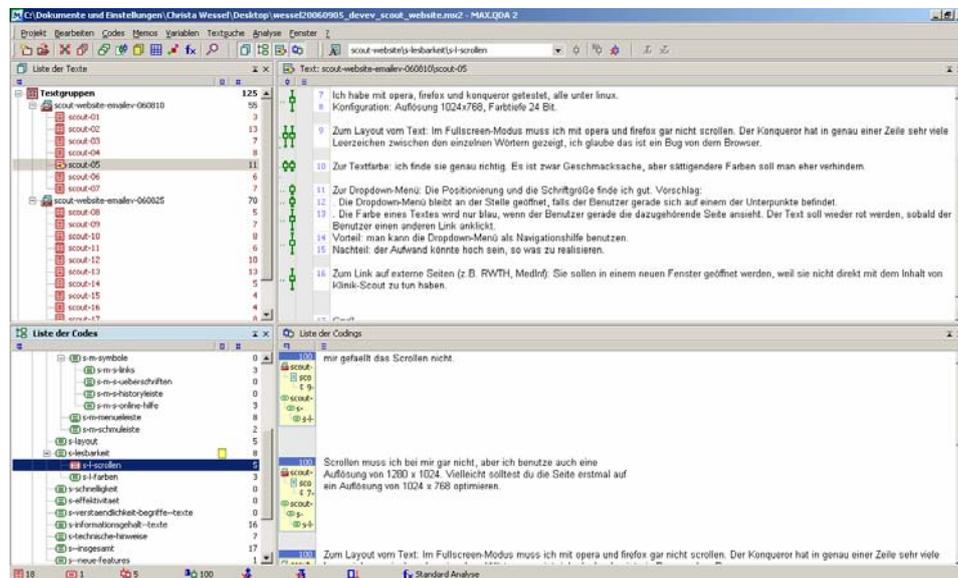

Figure 2: Computer Supported Qualitative Text Analysis with MAXqda^(TM) (in German)

Example

A research team developed and used GREME for the work on several modules that were required for the online release of a web-based information system on hospitals [WWS06b, We07]: (1) re-engineering of the web frontend for the presentation of hospital data in manner of tables, (2) development of the questionnaire content for the web-based evaluation, (3) implementation of the homepage for the web-based information system on hospital data. The course of the work on module (3), the homepage, is described more detailed.

Course

The team consisted of a moderator, an author and up to 10 peers, who were either IT or domain experts (health care). In advance the team had identified requirements and goals. Requirements were for instance full web accessibility for disabled persons, plain and sincere design, and very intuitive handling. Aimed goals were the integration of the web frontends for the data presentation (tables and map), of a diagram to visualize the database schema, of a web-based questionnaire and a free text entry form, of a user's guide and the development of a logo.

The author delivered a first prototype on the research server (compare figure 1). The insights from the first pass around documented in a short report by the moderator enabled the author to identify Must, Should and Can measures. She included this in her ongoing work. The Must, Should and Can measures and the following prototype were discussed during a group discussion. Problems to solve were the style of text presentation, the integration of the search, the presentation of questionnaire and free text for the web-based evaluation of the information system. The contributions of the team members, i.e. questions and ideas from both IT and domain experts, built the basis for the development of solution concepts.

The team proceeded with GREME, alternating pass around, development and group discussion (see table 2). The team gained consensus on the layout of the homepage, the solution of technical problems and the profiling via the logo. The author was supported in her work by other IT experts in the team, for instance in the work on some interface problems.

The working atmosphere was very good. For all three modules the team members showed a high motivation. They reported complete satisfaction both with the working process and the final products of the three modules [We07].

Resources

Review costs are generally based upon working time. Table 2 summarizes the GREME steps. Table 3 gives an overview of the effort (working hours) on the development, the GREME steps and the ratio of GREME and development.

Six weeks after the requirements analysis for module (3), the homepage, the author delivered a first prototype. After another four weeks the team passed the final product.

The team performed two pass around cycles. In the first cycle six peers participated and ten on the second. The peers reported an effort of approximately thirty minutes per peer and cycle for the reflection on the prototype and for the writing of the email. The moderator conducted two text analyses and wrote two reports. For each cycle the analysis and report took about three hours (Table 2).

The group discussions were embedded in the weekly research team meetings and lasted around thirty minutes. During the first two discussions the team dealt with Must, Should and Can measures and the prototypes. Eight team members (moderator, author and six peers) took part in each discussion. Eleven team members (moderator, author and nine peers) performed the third and final group discussion to pass the homepage.

Item	Reengineering	Questionnaire	Homepage
Group Discussions	2	2	3
Pass around			
- Email Feedback:	3	2	2
- Analysis and Report	1	2	2

Table 2: GREME steps

The author worked 96 hours on the analysis, design and implementation of the homepage, including the identification and revision of the Must, Should and Can measures. Overall, this results in a ratio of 27.5 hours GREME review to 96 hours development, ergo 28.7 percent (Table 3).

Item	Reengineering	Questionnaire	Homepage
Group Discussions: Sum(0,5 h * No of Persons)	8 h	7,5 h	13,5 h
Email-Feedback: No * 0,5 h	4.5 h	6 h	8 h
Analysis and Report: No * 3 h	3 h	6 h	6 h
GREME Effort	15.5 h	19.5 h	27.5 h
Development Effort	96 h	80 h	96 h
GREME / Development	16.2 %	24.4 %	28.7 %

Table 2: GREME effort

Accounting all modules the overall fraction of GREME lies between 16 to 29 percent. This corresponds to the values of 10 to 50 percent reported on standardized reviews [Ba98, LL07, Wi01].

Discussion

Integration of GREME in a process model for software engineering

The use of process models is more and more common in software engineering projects, to achieve effective and efficient software development processes and high quality products [Ba98, LL07, So06, Wi01]. One crucial part of software engineering is quality management. Nevertheless, an organization may abandon quality assurance measures such as reviews in software engineering projects due to time and budget restrictions. These projects are at risk to fail or suffer from postponements [Ba98, LL07, So06, Wi01]. To face this endangerment, different kinds of review types should be at hand for any software engineering project [Mo04].

The GREME review is intended as a further method for quality assurance in software-engineering and user-centred development. It combines team reviews and pass arounds. Application areas are analysis, design and implementation of software, user interfaces, documentations, manuals, user guides, working processes and – this is to prove – process models themselves.

GREME was used in a research project on three modules of a web-based information system on hospitals [WWS06b, We07]. The approach was evolutionary and incremental [LL07, So06]. Prototypes in a running system were required to enable the team to proceed with the development process.

The examples show that GREME can be used to review non-crucial products economically, efficiently and effectively. GREME was easy to integrate in an ongoing software engineering project. The efficient and effective communication fostered the fast recovery of new insights. The team detected errors and aberrations at an early stage, designed solutions and assessed the quality of a product. The effort for the participants was foreseeable. This and the across-the-board communication of IT and domain experts led to a high acceptance of GREME. The adherence to delivery dates was high.

Process models like the Rational Unified Process (RUP), the Spiral Model and Agile Programming consider characteristics, such as evolutionary and incremental development, flexibility and multidisciplinary teams [LL07, So06]. Thus, the integration of GREME in a software engineering project, that follows one of these models may be of interest for organizations (industrial or research) for the above mentioned application areas. The governmental models like the V Model are very explicit – an attribute that also RUP adheres [LL07]. The integration of GREME in explicit process models requires the tailoring of the process model to the organization's needs. At the same time the organization must take into account the contracts involved in the individual software engineering project. This applies for instance for contracts with governmental institutions and the obligation to use certain models.

The use of GREME within the research project showed, that it requires, but also supports a defined and institutionalized project management, controlling of schedules budget and human resources (this includes measuring the progresses), quality management and quality assurance and the performance of structured requirements analyses. These attributes correspond to the Capability Maturity Model® Integration level 2 [CM06]. Experiences of other organizations with GREME could reveal whether the planned, structured and documented use of GREME can make a contribution to the progress of an organization during the CMMI® process.

A closer look on the GREME review

The GREME method is structured and comprehensible. The workflow, e.g. the number of pass arounds, can be adapted to the needs of a particular software engineering process. The cost of 16 up to 29 percent is similar to classical reviews, for which a range of 10 up to 50 percent is reported [LL07]. Using GREME the expenditure of time is kept small for the participants by the integration of group discussions in routine meetings. The moderation of the group discussions helps to avoid long and tedious discussions [Se02, Wi01]. The peers can deal with the product and give feedback via email in a reasonable and foreseeable time.

Many teams and organizations are multidisciplinary composed. This offers the possibility to get feedback from different perspectives and professional categories [DL99, Wi01]. The GREME review performed by moderator, author and neutral colleagues (experts from IT and other domains) facilitates the integration of IT knowledge and user perspective [Ni93, Wi01].

Reviews may suffer from tight project plans and dependency on certain experts. Wiegers [Wi01] and Ludewig / Lichter [LL07] suggest asynchronous reviews, if such problems occur and presume that the quality of the review may be reduced. GREME's strength lies in the independency from coordinating meetings and certain peers. If a peer does not participate in a group discussion during a routine meeting or in an email feedback cycle this is balanced by the work of the others. On the other hand, a peer can leave out a cycle and nevertheless contribute to the evaluation work in a subsequent turn, as the protocols of the group discussions and the emails are sent to all group members.

One may argue that a criticism, positive or negative, is adopted by other peers, if the emails are sent to all participants [Wi01], or that the creativity of a peer may be reduced by the comments of the others ("Ah, he already mentioned this. Why should I look for another solution?" Fictitious sentence.). The use of GREME in the examples showed, that the emails led to a sort of brainstorming, where the idea of one peer inspired a further idea of another [We07]. Further studies could investigate in which situations email feedback should be send only to the moderator and the author.

The moderator in the examples was experienced in qualitative research methods. Novices in this approach need training and a learning curve has to be considered [WWS06a]. The training as a moderator is necessary and already part of human resources development [LL07, Se02, Wi01].

The dealing with a product not only by developers and IT experts, but also by members of other professions, facilitates the assessment of a product at an early stage from a "third" perspective [Wi01]. This work beyond established development teams and professional areas can strengthen the identity of an organization and foster organizational learning. The staff members hear about the work performed by their colleagues, learn from each other and may use this for their own work [DL99, Se90, Wi01].

Outlook

GREME was developed and used by a team that existed for four years. Team members changed but the self-conception of the group was developed in a sense that led to high motivation and reliable collaboration (see [DL99, Wi01]). The use of GREME in other teams – both in an organization and with external participants (e.g. users and customers) – has to show whether GREME is appropriate for other settings. The success will depend on the goodwill of the stakeholders of the organization, the selection of appropriate products to be reviewed with GREME, and on the skills of the moderator and the team.

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