A quality assessment method for application management

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Abstract

In this paper we describe some of the work performed in the Esprit AMES (Application Management Environment Support) project. We describe our assessment matrix for evaluating a company’s effectiveness at performing application management and our process model around which the assessment procedure is defined. This assessment matrix is loosely based on the work on the SEI’s Capability Maturity Model (CMM) but has been specialised to make it applicable to software maintenance. In addition some of the major criticisms of the CMM questionnaire have been rectified. This has in turn led us to develop an assessment procedure which is capable of evaluating both qualitative and quantitative responses. This assessment procedure is fully described in the paper. A method for process improvement is also presented that allows an organisation to focus resources into areas that have been identified during the assessment process as requiring improvement. Finally we will describes some of the results that have been obtained by companies from the AMES consortium from using the assessment method.

1 Introduction

The main goal of the AMES project is to provide methods and tools for an effective support to application management. The term application management has been defined by the AMES consortium as -

“the contracted responsibility for the management and execution of all activities related to the maintenance and evolution of existing applications, within well-defined service levels.”

One objective of the AMES project has been the creation of a methodological framework. This includes an application management process model and methods for process assessment. The AMES model is described briefly in this paper and uses a three layer approach considering a company’s maintenance strategy, maintenance management and the provision of the maintenance service. Questions from our assessment method map directly onto
the three AMES layers and give us the opportunity to apply company assessment to each layer of the AMES model.

The AMES assessment method provides a company, which is considering employing a maintenance service provider or wishing to look at their own application management process with a method by which they can determine whether the necessary services can be provided. If the assessment shows potential weaknesses, an organisation can decide on appropriate action, e.g. undertake process improvement or sub-contract. Thus the AMES model and assessment method can encourage subcontracting of certain aspects of the maintenance process. This will then give the organisation a means to improve their maintenance process by acquiring the skills of the maintenance service provider. The following steps are seen by a number of people within the AMES consortium as being required in order to have complete control over the application management process.

1) Determine the current situation
2) Determine what the desired goals are
3) Identify the improvements needed to move from the current position to the desired goals
4) Once the desired goals have been achieved, ensure they are secured.

The following sections in this paper define the approach we have adopted to create our assessment method in order to primarily address the first objective. A series of initial results are presented which highlight our findings, and conclusions are drawn about the AMES assessment method.

2 AMES Method and Process

Before looking at the evaluation method and questionnaires, it is necessary to first present the AMES process model. This model separates application management into three layers, i.e. strategic, management and technical. At the strategic layer an organization takes decisions with respect to an application in order to plan future support for its, or its customer’s business. The management layer represents the middle management function of an organisation, i.e. it plans, organises and controls the necessary actions and people who will provide the application management service. In the technical layer, the maintenance tasks specified in the management layer are carried out. Figure 1 shows how the three layers of the AMES model interact and the key areas that each layer addresses.

Each layer contains several process areas that need to be addressed when performing application management. Associated with each process area are a number of tasks (see table 1 for a list of the tasks at each layer of the AMES model). Hence, to be able to successfully perform application management it is necessary to have the capability to successfully perform the activities associated with each process area at each of the three levels, hence there is a need for an assessment method [1].
3 Basis of the AMES Assessment Method

As a basis for our assessment method, the Capability Maturity Model (CMM) [2, 3] has been used. This is a detailed model for the assessment of an organisation’s software development process. The model was developed by SEI during the 1980’s and early 90’s as a means for the American Defence Department to assess an organisation’s ability to deliver the required software product. In addition, other models such as SPICE [4] and BOOTSTRAP [5] have helped in formulating our assessment questionnaires and method.

In a broad sense, the CMM addresses a number of issues that are relevant to application management. It is therefore possible to use the CMM as a basis of a method for the evaluation of a organisation’s ability to perform application management. The CMM has already been modified to help in reuse [6] by providing a method of assessing a company’s strengths and weaknesses. Furthermore, an implementation model has been created that helps to establish
goals and strategies for evolving an organisation’s reuse practice.

The CMM has already been employed for assessing software maintenance organisation [7] to allow an assessment to be made of maintenance practices in a safety critical application. A series of metrics, databases, analysis and feedback loops have been employed to give a more detailed view of the maintenance process. The metrics information allows for extremely effective process improvement feedback [7].

4 Evaluation Frameworks and Questionnaires

To provide a means for assessing the capability of an organisation to perform application management, an evaluation framework and questionnaire will be used. Figure 2 shows a top level representation of how the CMM and the AMES model have been used to create the AMES assessment method and evaluation questionnaires.

![Evaluation Frameworks and Questionnaires](image)

Figure 2: Basis of the application management assessment method

Before an evaluation questionnaire can be defined it is necessary to first establish a framework which contains the key process areas and success factors that need to be achieved. Such a framework provides the necessary structures onto which questions can be attached. Three frameworks have been created with respect to success factors for:

- Senior Management,
- Project Manager, and
- Software Maintainers.

Each framework defines the key process areas in terms of the success factors that need to be achieved. The initial key process areas for each role have been identified through current literature including the CMM, and practical experience [8, 9]. The following table shows a top level view of the main tasks as defined by the AMES model.
Table 1: Overview of the AMES model

<table>
<thead>
<tr>
<th>Layers</th>
<th>Tasks (Main process areas to be assessed)</th>
<th>Roles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategic</td>
<td>Marketing, Budget allocation, Business risk management, Application quality management, Organisational control, Workforce training, Process improvement</td>
<td>Application Owner (Senior management)</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Definition and monitoring configuration and version management, Progress tracking &amp; planning, Evolution of service, Problem management, Preparation of intervention, Decision on implementation, Closure of the intervention</td>
<td>Problem Solver (Project manager)</td>
</tr>
<tr>
<td>Technical</td>
<td>Problem understanding, Localization, Solution analysis (Soln. spec and Impact analysis), Submit solution proposal, Implementation (Update Documentation Convert Data), Regression testing, Acceptance testing, Change application operating procedures, User training, Submit modification report, Re-insertion, Help desk operation, Configuration and version management</td>
<td>System and Software Engineers (Software maintainer)</td>
</tr>
</tbody>
</table>

In order to obtain the necessary information required to assess an organisation’s current capability, it has been necessary to define the key success factors in terms of their goals. Based on this, a series of questions relating to the success factors have been created that are roughly based on the following criteria used to define key practices in the CMM [2, 3]:

- commitment to perform,
- ability to perform,
- activities performed,
- measurement and analysis, and
- verifying implementation

The evaluation questionnaires employ two types of question in order to
gain a complete picture of an organisation’s capability to perform application management. These two types of question are an open-ended explanation of a task and a utility assessment of an organisation’s ability to perform a task [10]. The open-ended questions provide the opportunity to have an in-depth description of how a task is currently performed. The utility assessment questions provide a means by which activities can be easily assessed, and a value assigned to it [11]. In addition, a number of metrics have been incorporated into the evaluation questionnaires to provide a quantifiable baseline on which process improvement can be gauged [12].

Tailoring and defining the questions used in the AMES assessment method has been necessary for a number of reasons. The basic CMM provides a detailed assessment of a general software development process. However, the CMM and the AMES model represent two different (but related) aspects of software engineering. The AMES model represents current thinking in the field of application management, and the CMM represents current thinking in software development. The two models share a number of similar process areas, however there are also significant differences (table 2). It has therefore been necessary to define questions that elicit the required information about the processes defined in the AMES model in order to assess an organisation’s capability to perform application management. Issues and questions identified in the CMM which are relevant to application management have formed the basis for some of the detailed questions created. However, these have been tailored to allow more detailed information to be obtained.

Table 2: Applicability of CMM Key Process Areas to Application Management.

<table>
<thead>
<tr>
<th>Key process areas of the CMM applicable to AMES</th>
<th>Key process areas of the CMM not applicable to AMES</th>
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</thead>
<tbody>
<tr>
<td>Software project tracking and oversight</td>
<td>Software subcontract management</td>
</tr>
<tr>
<td>Software quality assurance</td>
<td>Software product engineering</td>
</tr>
<tr>
<td>Software quality management</td>
<td>Integrated software management</td>
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<tr>
<td>Defect prevention</td>
<td>Software product engineering</td>
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<tr>
<td>Organisation process focus</td>
<td>Intergroup coordination</td>
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<tr>
<td>Training programme</td>
<td>Peer reviews</td>
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<tr>
<td>Process change management</td>
<td>Quantitative process management</td>
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<tr>
<td>Software configuration management</td>
<td>Technology change management</td>
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<tr>
<td>Organisation process focus</td>
<td></td>
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<tr>
<td>Organisation process definition</td>
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During the development of the AMES assessment method it was found necessary to define questions that require a more detailed response than simple yes/no answers, as specified in the CMM assessment questionnaire. These detailed questions allow a practitioner in the field of maintenance to define their current practices rather than simply saying yes or no we perform a given task. This detailed information is required in order to gain a complete picture of an organisation and how it performs application management.

The questionnaire can be enhanced once practical results are obtained. Situations or goals that first appear relevant may become obsolete, other goals may be identified and should be incorporated into the questionnaire. Enhancement of the questionnaire allows the evaluation process to be tailored to a specific domain, i.e. questions relevant for an aerospace application may be less relevant to commercial systems. This practical experience will aid future assessment tasks by focusing on issues that are relevant to a given domain.

5 Evaluation Method

The evaluation method that we have defined is based on the assessment of the answers provided to the questionnaires. Both a qualitative and quantitative assessment is made. Depending on the ‘degree’ to which the questions are answered for a given process area, this will indicate the maturity of that area. An overall maturity can then be calculated for the maintenance organisation’s service provision. If an organisation is unable to provide any answers then this indicates that it is at an undefined layer of process maturity as no methods exist by which a given task is performed or controlled. Careful assessment of answers provided needs to occur if a representative maturity value can be assigned.

The problems with performing such an evaluation are numerous but include:

- both qualitative and quantitative assessments methods are required,
- the assessments must be weighted in order of importance and an agreed value judgements set, and
- it is necessary to obtain an overall maturity assessment per layer of the AMES model.

We will now consider solutions to each of these problems in turn.

Qualitative and Quantitative Assessment For the AMES evaluation method, quantitative assessments are defined as those which can generate quantity estimates. Qualitative assessments are conversely those which can not obviously generate quantity estimates. Instead they are concerned with a subjective measure. Assessment of a quantitative measure requires assessing the attained target against a previously defined benchmark. The closer the assessment is to the benchmark, then the higher the level of maturity that has been attained. However, attaining a perfect assessment will not necessarily assure that an organisation has attained level five as some near perfect assessments will be required at
the lower levels depending on the type of questions asked. For example, if a strategic decision is to attain a cost saving of 15%, then this will require detailed assessment of all areas, at all levels to identify where cost savings can be made.

Qualitative assessment are much harder to perform. This form of assessment requires a subjective value judgement to be made about a given situation. In order to provide consistency throughout our method we use a ‘utility’ measure. Value judgements can then be placed on qualitative assessments such as ‘ease of use’ on a linear scale from 0 to 100 (100 being a perfect score). Quantitative utility assessments can be produced in the same way with the defined baseline being set at the 100 utility score. Preferably maintainers should also be able to rely on data from previous developments or maintenance projects to generate the utility assessments and give a more accurate picture of the existing situation. In the BOOTSTRAP questionnaires [5] a scale of 1 to 4 is used as the utility rating, associated with the scale are labels, e.g. 1=weak, 2=fair, 3=good, 4=excellent. By using an utility assessment on a scale of 0-100, a subject is able to give a more precise answer to the question, rather than being forced to select a predefined value. With utility assessments it is possible to use multiple regression to evaluate together both the results of quantitative and qualitative assessments [11].

By using a consistent assessment procedure for evaluating quantitative and qualitative assessments we are able to gauge the effects of each of these on the maintenance process.

Weighting Value Judgements

Once the answers provided to the questionnaires have been assessed, it is then necessary to group the results. By grouping results, the key areas of an organisation can be focused upon. Grouping can be achieved by assigning a weighting value to the questions (initially these would be equal). Some questions will be more important than others and thus giving questions an equal weighting will distort the results. For this reason we apply individual weightings to questions.

Weightings are assessed in two ways: initially standards are set in the questionnaire, once set, consultants are able to update these weightings based on their experience. Any alteration to weightings needs to be carried out before the assessment of an organisation. In this way organisation specialisations are made and, in addition, it is also feasible to generate project specific questionnaire weightings based on the experience reports from previous iterations of the maintenance process.

Evaluating Assessments for the AMES Layers

Given that both qualitative and quantitative assessments have been produced and weightings for the individual questions are available maturity assessments for each of the layers of the AMES model can be made. Expectation baselines are used to indicate the level of assessment required for attainment at various levels of maturity. This is calculated using the following method:

1) Utility assessments for each question are made,
2) Assessments are scaled depending on the weighting applied to each question,
3) Responses from all questions are totalled to indicate an assessment for each of the AMES layers,
4) Expectation baselines are set for the value of each maturity level, and
5) Assessments for each layer are compared to each expectation baseline to indicate the achievement for each layer of the AMES model.

With the assessment method described above, we are able to both identify each question assessment and assign a maturity level to each layer of the AMES process. Furthermore, by relating questions across layers, we are able to identify strengths and weaknesses to be identified. This allows specific areas where process improvement is desirable, to be identified and addressed.

6 Application of the Assessment Method

Having defined the evaluation questionnaires and method, a brief discussion now follows as to how best to employ them in order to assess an organisation’s capability to perform application management. It is expected that the questionnaires will be used by an experienced assessor who has detailed knowledge of the AMES method and has a working knowledge of the domain in which an organisation operates.

It is imperative that the assessor selects suitable people/groups from whom to elicit information. If the wrong people are consulted then the information obtained will provide a false picture of an organisation’s capability to perform application management. It is necessary to have full management commitment for the assessment process as they will provide the opportunity to interview the required personnel. Ideally the people who should be interviewed are the practitioners in the field of maintenance, i.e. business unit managers (senior management), project managers and the software engineers.

An initial assessment has to be made first. This assessment provides the baseline for any future improvement. It provides a ‘snap shot’ of an organisation’s current capabilities and will show the areas where improvement is required/desirable. After an initial assessment has been made, the assessor is able to tailor the questionnaires to be more focused for the next assessment of that organisation. The information obtained will focus any process improvement programme in the area of application management that an organisation decides to implement. By repeating the assessment process after a given time period (e.g. between three to six months) it is possible to determine the effectiveness of any process improvement.

7 Improvement Programme

After an assessment has been made of an organisation’s capability to perform application management it may be necessary to instigate a process improvement programme. The improvement programme will address the areas that have been
highlighted as being weak. The details of the improvement programme will vary
from situation to situation. However, any process improvement programme will
be based upon the adoption of the AMES model and its associated methods and
tools.

For any improvement programme to be effective it is essential that the
following issues are addressed:

- good project management techniques are followed,
- project management is as much a senior management function,
  as it is leadership and control of project resources
- all projects contain risks which need to be identified in esti-
  mates, plans, appraisals and control decisions.

To facilitate the improvement programme, the concept of a task-force can
be used. The task-force contains suitably qualified personnel with the necessary
support functions so that they can ‘attack’ the problems identified. It is essential
that the people involved in the change should know why the change is necessary.
Furthermore, good communication throughout the task-force is required.

Before process improvement can begin, it is necessary to have a definition
of the objectives that need to be achieved within a defined time frame.
Furthermore, it is necessary to select the people who will perform the tasks (i.e.
the task-force itself). A design phase can then begin. This allows the task-force
to assess the best method by which the required objectives of the process
improvement can be solved. During this phase it is necessary to have regular
communication and reviews to ensure objectives are meant. After a design has
been formulated, then it can be implemented. Implementation requires regular
reviews to assess progress against objectives and changing needs. After
completion, another review is advisable to establish lessons learned for future
projects.

Once an area has been identified as requiring improvement, by adopting
the structure for process improvement described above, the appropriate section
of the AMES model can be applied, e.g. strategy definition. The AMES model
defines the tasks that need to be achieved in order to satisfy the required
improvements. After applying the AMES model it is then necessary to re-assess
that area to ensure that improvement has occurred. By collecting metrics
information, a baseline of the existing process has been established, this can then
be used to assess the improvement that has taken place once AMES has been
implemented. If no improvement is noted then further analysis of the problems
will be required in order to identify the root cause. It is possible that other issues
outside the scope of the AMES model have an affect, e.g. change in business
focus, redundancy of workforce etc.

8 Initial Results

A number of initial results have been obtained from practitioners in the field of
application management. These results have been obtained from the industrial
partners of the AMES consortium. It is widely agreed that it is both desirable and
necessary to have a means by which an assessment can be made of an organisation's ability to perform application management. The method reported here provides an initial attempt at solving this problem. However, assessment is only the first step in having complete control over the application management process.

The assessment method defined in this paper has addressed the first objective and to some extent the third and forth as presented in the introduction, i.e. a method to determine the current situation, methods for improvement and methods to ensure any improvement is secure. We have defined a means by which a detailed assessment can be made of an organisation’s ability to perform application management. In developing the evaluation method we have identified some of the issues that need to be addressed in order to satisfy the third and forth objectives, i.e. methods for sustained process improvement. It is assumed that any methods employed in order to define the goals of a company and an improvement programme, with respect to application management, will be tailored by each company to meet their own needs and skills. Hence the second, third and forth objectives are really under the control of each company.

At present the AMES assessment method is being used internally to assess the development of tools as part of the project. It is intended to apply the AMES assessment method more broadly, once it has been thoroughly evaluated within the AMES consortium.

9 Conclusions

The CMM developments do provide a method by which a software process can be assessed. However, in order to develop an effective appraisal method for application management, it has been necessary to define our own assessment frameworks and questionnaires. These have been based on the CMM key practices, i.e. commitment, ability, activities, measurement and analysis, and verification; but taking the key process areas defined in the AMES model.

The evaluation frameworks and subsequent questionnaires offer a flexible approach to the evaluation of application management. The evaluation frameworks described, provide a basic structure for the appraisal of applications management. Furthermore, they allow additional key process areas and goals to be added as they are identified as more experience of application management is gained. This allows the evaluation questionnaires to be tailored to meet the needs of a given type of domain.

Any improvement programme that is implemented will need information obtained during the evaluation of an organisation. The actual methods by which improvement is brought about will depend on the organisation and its general management and specifically project formalisation and control techniques. It is necessary to have tight control on the improvement programme to help ensure it meets the required objectives.
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References


