

COTS Evaluation Using Desmet Methodology & Analytic Hierarchy Process (AHP)

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Abstract. Diversity on COTS selection is causing that certain companies spend large amount of time and effort evaluating those COTS for integration within their custom made systems. This evaluation is most of the times based on de-facto rules and techniques that unfortunately may lead the company in choosing the worse or not the best component for its system. This research gives an interpretation on how to evaluate COTS making use of two different methodologies for software selection and decision making respectively. The purpose is to present how the DESMET methodology along with the AHP methodology can be combined in such a way that COTS selection would be easier and more accurate than before. This new evaluation approach will make COTS selection less human dependable and more straight forward, providing with the mean for ranking the different alternatives in a numerical way so deciding becomes more empirical base and less human base.

1 Introduction

As software development phase for any kind of system (including embedded systems) is becoming less artistic and more industrial, companies now realize that developing a whole system from scratch is completely worthless, and in most of the cases a black hole financially spoken. Software Industry as well as embedded systems industry are becoming customers of others software developers that build the software components for them.

Therefore, this new way of building systems arises another problem. Which component should I use? Which component will fit better into my system? Which component should I trust the most? Building component-based systems implies the integration of several commercial components named COTS (Commercial Off-The-Shelf) and make them work together as one unique system. Although, it may not seem a big trouble, the task of evaluating several COTS for a certain system may not be a trivial task, and should be treated seriously if we want to get a good result.

In response to this the European Software Institute under the MOOSE (Software engineering methodologies for embedded systems) project (ITEA) has studied several

evaluations models and decision making techniques in the market, and have come up with a new approach of COTS evaluation based on the DESMET and AHP methodologies.

2 COTS Evaluation Foundations

This new approach for COTS evaluation is based in two different methodologies that cover different objectives.

2.1 Desmet Methodology

The DESMET methodology was the result of a collaborative project in the United Kingdom in the last decade. This project identified a number of evaluation methods as well as formal experiments to evaluate software engineering methods and tools within a particular organization. The main steps are:

1. Define scope of evaluation
2. Select evaluation method & procedure
3. Set roles & responsibilities
4. Specify assumptions & constraints
5. Specify timescales & effort
6. Analyze & interpret results
7. Present results to decision makers

The main objective of the DESMET methodology is to help an organization to plan and execute an evaluation program in order to find the most suitable method or tool for its software development in each case.

2.2 Analytic Hierarchy Process (AHP)

The AHP is one of the best known decision making process to help people into the hard task of making the best decision out of a set of possible options. Therefore, AHP is considered a multi-criteria decision making process that balances both quantitative and qualitative aspects.

AHP was developed by Dr. Thomas L. Saaty in 1980 while he was a professor at the Wharton School of Business, and has been widely used since then by several companies such as the US Department of Defense, US Air Force, Boeing and several governments. The main steps are:

1. Identify final objectives
2. Identify alternatives
3. Evaluate key trade-offs among objectives & alternative solutions
4. Agree on final solutions.
5. An important note from these two methodologies is that they are not intended to use for COTS evaluation.

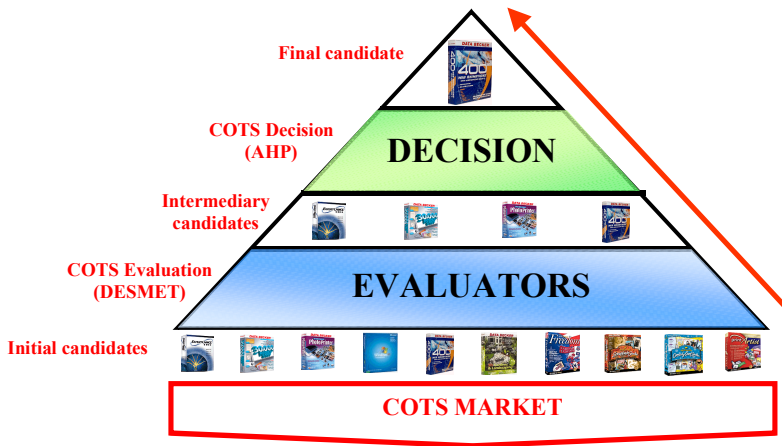


Fig. 1. Hierarchical COTS evaluation process

3 Process for Evaluating COTS in Depth

Although these two methodologies (DESMET & AHP) are not thought to be used for COTS evaluation, we are going to demonstrate how they can be successfully combined and adapted to work with COTS components.

Figure 1 illustrates the combination of these two methodologies in a hierarchical pyramid.

As we can see from Fig. 1., two basic groups of people is involved in an evaluation process.

Technical group, involved mostly in the preliminary research, evaluation and selection of several candidates from the market. As a result of this research, we come up with the first set of possible candidates, which is a narrow group of COTS more oriented to our project requirements.

Business group, involved in the final decision making process. This group of people must evaluate the intermediary candidates proposed by the technical group and proposed a final candidate to the ultimate responsible for deciding.

The two big processes represented in Fig. 1. (COTS evaluation and COTS Decision) correspond directly to the DESMET and AHP processes and with each group of participants respectively. Therefore, the final COTS evaluation process presented in this paper is composed of seven different steps within two main processes:

COTS Evaluation Process (DESMET)

1. Set roles & responsibilities
2. Set time scale & effort
3. Define scope and candidates
4. Specify assumptions & constraints
5. Select an evaluation method
6. Evaluate and present results

COTS Decision Process (AHP)

7. Identify selection criteria
8. Evaluate final candidates
9. Agree on final decision

3.1 Set Roles & Responsibilities

Specific roles and responsibilities must be set up when initializing an evaluation process. This is one of the most important steps within the entire evaluation. The success of the results obtained depends greatly on the evaluators chosen, because they are the persons who search, test and definitely work with the components. At least three different roles must be defined:

COTS Assessor: This is the person in charge of the whole COTS evaluation process. Its main responsibilities are:

- Lead COTS Evaluation
- Select evaluation team
- Specify system requirements
- Set time & effort needed
- Review evaluation report
- Chose final candidates

Evaluation Team: This team is formed by a group of technical people whose main objective is running the different sub-tasks of COTS evaluation:

- Collect COTS users requirements
- Define COTS features
- Chose initial alternatives
- Select evaluation method
- Carry out the evaluation
- Prepare evaluation report to the COTS Assessor.

COTS Users: These are the final users of the COTS. They are also called COTS integrators because their main task is to integrate the selected COTS into their own system. Although the evaluation team could be also the COTS users as well, it is recommended to have different groups of people within these two roles in order to be more objective when selecting the COTS. Their main tasks are:

- Identify COTS requirements
- Proposed initial alternatives/candidates
- Review COTS features
- Review evaluation report

3.2 Set Time Scale & Effort

One of the first tasks of the COTS assessor is to determine the time scale of the whole process and the effort we'll take us to perform the evaluation. One task earlier is to establish which actions should be taken, who should participate and the time limit for

each of these tasks. Once we have all this information, then we can outline a preliminary planning which could be modified later on.

Some information the planning should have is:

- Tasks to perform
- Milestones
- Due dates
- Staff involved
- Effort required
- Final reports

3.3 Define Scope and Candidates

Here the COTS assessor along with the COTS users must define together the scope of the evaluation as well as the possible candidates we initially must take into account. One of the aspects that will influence in the final selection of the initial candidates is the type of COTS based system we are building:

- COTS integrated system: COTS plus self development code
- COTS solution system: System based only on COTS.

Another important issue within this step is to define the specific domain the COTS will have to cover and the characteristics of the required COTS. Finally we should to come up with a short list of possible candidates that will be examined and compared later on. Depending the domain and the requirements of the system, the initial candidate list might be too long to evaluate all COTS, so an initial screening selection could be performed in those cases. The final candidates list must contain the most representative list of COTS for the specified domain.

3.4 Specify Assumptions & Constraints

Specifying any special assumptions or constraints from either the system or the COTS candidates will help us to predict future drawbacks from the chosen solution. Therefore, it is essential to spend some time thinking on the types of things we should take into account when selecting the initial candidates such as:

- Limited budget assigned
- Required infrastructure & support
- Required training
- Required environment for validation
- Trial version availability
- IPR issues
- Open source.

3.5 Select an Evaluation Method

According to the DESMET Methodology we can select among three different types of evaluation that can be applied to COTS selection process. These types of evaluation are:

- Quantitative: Measure the benefits of using each COTS in a quantitative way.
- Qualitative: Assess features and characteristics of each COTS.
- Hybrid: This type of evaluation is a combination of the two, Quantitative and Qualitative

The DESMET Methodology also defines several ways of organizing the evaluation depending on the type and quantity of resources do we have. These ways of performing the organization are:

- Screening assessment: Initial pre-evaluation of the COTS through sources like Internet and COTS vendors profiles.
- Formal experiment: Set up an experiment in-situ to test several COTS.
- Case Study: Read related information from other people that have already implemented such COTS in their systems.
- Survey: Get different opinions from people that may have used the same COTS for integration.
- Expert Analysis: Get a formal opinion of either an internal or external expert in the pre-selected COTS.
- Benchmarking: Study and investigate other companies' best practices regarding COTS integration to adapt the same ideas and improve our performance.

3.6 Evaluate and Present Results

Finally we have to perform the evaluation throughout all the pre-selected COTS according to the timescale, roles, effort and evaluation type from the previous steps. As a main result of this task we will obtain the final group of candidates for the decision makers.

It is also convenient to write a report for each COTS evaluation performed for future reference.

3.7 Identify Selection Criteria

The initial COTS candidates proposed in step 6 are the input to this step in which the business group or decision makers are involved. The main objective of this step is to identify the major aspects that will influence in the final decision. These aspects are called selection criteria and might be for instance:

- Financial aspects (COTS cost, Maintenance cost, upgrading cost, ...)
- Technical aspects (Reliability, safety, performance, requirements, quality, ...)
- Business aspects (COTS vendor recognition, COTS vendor properties, Historical records, ...)
- Legal aspects (Type of contract, license agreement, escrow, ...)

Choosing the right selection criteria is crucial for the final decision. So if COTS vendor recognition is not important for us, then we will not chose it; otherwise, if COTS maintenance is essential in this project then we will selected as criteria. Select only the most significant aspects to avoid complicated selection trees.

3.8 Evaluate Final Candidates

The entire process of evaluating the final candidates for selecting the best COTS to this project is divided into 5 sub-steps represented in Table 1.

Table 1. Sub-steps in evaluating the COTS candidates

EVALUATE FINAL CANDIDATES	
1. Ranking selection criteria	In this step we have to rank each of the chosen selection criteria among each other within a 9 value scale: 1 – Equal 3 – Moderate 5 – Strong 7 – Very Strong 9 – Extreme The final result will be a table called Pair-Wise comparison in which the overall weight for each criteria respect to each other is also calculated. Therefore, what we know so far is the percentage of importance of each criteria respect to each other in a scale from 0 to 1.
2. Ranking different candidates	In this step we have to do basically the same as we did when ranking the selection criteria. However, this time we must rank each set of candidates regarding each criteria. The tasks are the same and the result that we obtain is the percentage of importance of each candidate respect to each other and selection criteria.
3. Draw ranked hierarchy tree	In order to have a clear view of the values we have obtained so far, we must draw the final ranked hierarchy tree where all the calculated values are represented respectively. This tree will give us an overall view of the weights of each candidate under each criteria, and will allow us to depict which could be the „winner“. However, two more steps are needed to get to the final answer.
4. Final candidates ranking	In this step we do the product matrix between all the candidates weights found in sub-step 2 and the weights for each criteria from sub-step 1. The resulting values will represent the final ranking of all the candidates.
5. Cost / Benefits analysis	However, another further step is needed if we want to obtain a real and objective value of which candidate is most suitable for our system. To do this we must perform a cost / benefits analysis from the values obtained in sub-step 4 and the normalized cost of each COTS.

Finally, after several steps we know which COTS might be the most suitable and convenient for our purpose. Therefore, if we take a closest look into these previous 8 steps we see that there exist two main actions to perform in this kind of evaluations. The first action is to select a good candidate list by the technical group, and the second one is to define a good set of selection criteria by the business group. These two actions will influence greatly in the final results.

3.9 Agree on Final Decision

Now we arrive to the hardest part of the whole evaluation process. We have a nice list of COTS ranked in other of importance for our specific project. We also know which COTS is more suitable for our project and why, and we also have nice reports that describe is COTS in detailed. However, these are all numbers and business is more than numbers, it’s human knowledge too.

Therefore, in this last step we must agree or disagree on the values we obtained before. COTS selection, as any other selection, is always human dependable. Numbers only help us to easily discard and select the best COTS to evaluate, and give us an idea of which ones are better; however, we cannot base our final decision only on numbers. We have to discuss all together the final results and come up with the selected COTS.

4 Conclusion

The objective of this paper has been to present how two different well-known methodologies for selection and decision making (DESMET & AHP) can be combined together to perform a COTS evaluation process. We all know COTS usage implies some benefits and also some risks when integrating within our system. Therefore, once we have decided to use COTS in our systems, then we skip to the next problem, how do I know which COTS to use. So COTS evaluation is not only a requirement, but also help us to mitigate risks during integration.

Another important key factor of COTS evaluation is that COTS evaluation is always context dependent. It means that, an evaluation process must be carried out for a specific project and not for several different projects with distinct characteristics. So a good COTS for a certain project might not be so good for another project. Different evaluation processes must be performed in these cases.

As we have seen during the entire process, people from all levels in the company must be involved in such process in order to get a most realistic answer. In fact the most important steps within the whole evaluation, the initial candidates list and COTS criteria selection, are carried out by two different groups of people, the technical group and the business group.

Money is always an important aspect for everybody when acquiring a product. Therefore, it must be also taken into account separately also in this type of acquisition. Cost / benefits analysis will provide us with a more realistic answer within our environment.

Last but not least, COTS evaluation, as any other evaluation process is always human dependable, so numbers will only guide us to the final answer, but never will be used as a rule of thumb.

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