Involving Stakeholders in the Selection of a Project and Portfolio Management Tool

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Abstract
Contemporary Project and Portfolio Management (PPM) tools can support a wide range of an organization’s activities, offering a great number of functionalities, such as workgroup capabilities, support for time, resource and cost management, reporting features, risk and contract management facilities. This variety of features, along with the variation among each organization’s needs and the plethora of powerful tools in the market make the selection process among various PPM tools a difficult and complicated process. In this paper, we present a practical approach for this decision making problem which is based on the Analytic Hierarchy Process. The approach considers not only the judgment of tools, as it is expressed from expert opinions, but also the stakeholders’ (an organization’s members of personnel) preferences. We have applied the approach to evaluate a set of candidate PPM tools to support portfolio and project management requirements of the National Documentation Centre of Greece.

Keywords: Project and Portfolio Management Tools, Analytic Hierarchy Process

1. Introduction
The systematic use of an appropriate Project and Portfolio Management (PPM) software tool provides a lot of advantages for an organization that undertakes projects and/or portfolios of projects to implement organisational changes, business processes redesign and develop new products or services. A recent survey (Raymond and Bergeron, 2008) demonstrates that project managers are starting to realise the benefits obtained from PPM tools, in terms of increased productivity, effectiveness and efficiency of their managerial tasks. Other empirical studies (Liberatore and Pollack-Johnson, 2003) report that larger and more complex projects are pushing project managers to use PPM software more. In fact, contemporary PPM tools have embarked from single-user/single-project management
systems to distributed, multi-user, multi-functional software packages which offer integrated project management solutions, not limited to scope management, budget and planning control. Market analyses in the area (Wang, 2007; Light and Stang, 2008) present that modern PPM tools are trying to offer support for all knowledge areas described in the “Project Management Body of Knowledge” of the Project Management Institute (PMI, 2004) through covering an expansive view of the “integration management” knowledge area that includes investment analysis, alignment of strategic programs and support for business case creation. Current commercial PPM tools provide support for a range of organizations’ activities by offering a number of features such as time, resource and cost management, workgroup capabilities, reporting features, risk and contract management support.

This variety of features along with the variation among each organisation’s needs and the plethora of PPM tools in the market make the selection process of a PPM tool very difficult and complicated. The problem is often approached by ad hoc procedures based only on personal preferences or marketing information/hype and this may lead to a selection that does not precisely reflect the real organisation’s needs or, even worse, to an unsuitable tool selection. Consequently, empirical research shows that project managers often experience limitations when using a commercial project management software and may find it inadequate for managing complex projects (White and Fortune, 2002). Therefore, a well-established and systematic technique, especially from the multi-criteria decision making (MCDM) domain, can be useful to support a PPM tool selection process. Although there is no a generic methodology that can be adopted for selecting a software package of any type, literature reviews on evaluating software products suggest that users and decision makers can receive a lot of support, if they decide to adopt an MCDM method (Jadhav and Sonar, 2009). In particular, the findings of review studies (Vaidya and Kumar, 2006; Jadhav and Sonar, 2009) present that the Analytic Hierarchy Process (AHP) has been widely and successfully used in evaluating several types of software packages (e.g., MRP/ERP systems, simulation software, CAD/CASE tools, Knowledge Management tools etc.). The AHP method was introduced by Saaty (Saaty, 1980) and its primary objective is to classify a number of alternative decisions (e.g., a set of candidate software packages) by considering a given set of qualitative and/or quantitative criteria, according to pairwise comparisons/judgments provided by the decision makers. AHP is based on a hierarchical levelling of selection criteria, where the upper hierarchy level is the goal of the decision process, the next level defines the selection criteria which can be further subdivided into subcriteria at lower hierarchy levels and, finally, the bottom level presents the alternative decisions to be evaluated. Although AHP has been extensively used for the evaluation of various software products and tools, surprisingly little work has been done in the field of evaluating PPM tools (De Wit and Herroelen, 1990; Rushinek A. and Rushinek S., 1991; Maroto and Tornos; 1994). In this paper, we propose a practical application of the AHP for the evaluation of commercial PPM tools. The presented approach is based on an enriched set of selection criteria and it involves not only experts’ judgments but also the stakeholders’ (i.e. the organisation’s personnel) particular requirements from a PPM tool. The structure of this paper is as follows. Chapter 2 presents the relevant literature background on applications of AHP in SW package selection problems. Existing PPM evaluation frameworks are also critically discussed. Chapter 3 presents the detailed description of the proposed approach though examining its application in a real case study. Conclusions and extensions of the research work are addressed in chapter 4.
2. Literature Review
2.1 Multi-Criteria Decision Making & Applications of AHP in SW Package Selection

An MCDM method (like AHP) overcomes some limitations of a conventional weighting scoring method (WSM). On one hand, in a WSM, criteria weights and rating scales are assigned arbitrary and real numbers are produced as final results. So, final comparative values are often realized to represent the true difference between the decision alternatives, rather than their relative ranking. Also, assigning representative criteria weights can be a very difficult task, when the number of criteria becomes large (Kontio, 1996). On the other hand, among the main advantages of applying the AHP method are (Jadhav and Sonar, 2009): i) it is capable to provide a hierarchical decomposition of a decision problem that helps in better understanding of the overall decision making process, ii) it handles both quantitative and qualitative criteria, iii) it is based on a relative, pairwise comparison of all decision elements; instead of arbitrarily defining a percentage score and a weight for each decision element, AHP allows the decision maker to focus on the comparison of two criteria/alternatives, at a time, thus it decreases the possibility of defining ratings based only on personal perceptions of the evaluators or other external influences, iv) AHP is applicable to both individual and group-based decision making (by considering the geometric mean of comparison values), v) it enables consistency checks upon pairwise decision judgments, vi) it enables sensitivity analysis to examine the effects of changing values of criteria weights on the final ranking of the decision alternatives, vii) the method applicability and its extended features (e.g., sensitivity analysis) are supported by software tools (e.g., Expert Choice (www.expertchoice.com), Super Decisions (www.superdecisions.com)), although pairwise comparisons and calculations can be also implemented in a spreadsheet application software.

All the above advantages have influenced the wide application of AHP to multi criteria decision making problems, in many different sectors, including project management and software engineering project management. As far as project management is concerned, Al Harbi (Al Harbi, 2001) presented a filed survey of applications of AHP, focusing, in particular, on the selection problem of the best contractor to undertake a construction project. The described case study uses a group decision making approach that involves characteristics of candidate contractors as well as project priorities defined by the project owner. Two representative examples of software engineering project management problems gained a lot of attention to be supported by AHP are i) prioritizing software requirements and ii) selecting component off the self systems (COTS). In both problems AHP has been used to compare respectively software requirements (Karlsson and Ryan, 1997) or COTS products (Kontio, 1996; Lozano-Tello and Gomez Perez, 2002) by taking into account the relative importance between value and cost of each requirement/COTS product.

The application of AHP has been reported in many other case studies related to software package selection problems. The reader is referred, for example, to (Ahmad and Laplante, 2007) where the authors propose the use of AHP to evaluate three imaging software packages by combining seven types of subjective data (software complexity metrics) and experts’ opinions. Their approach helps in deciding an imaging software when there are contradictory complexity metrics (quantitative data) for each software, by incorporating experts’ judgments and relying on their experience within the subject. Another example is the application of AHP in the selection of a suitable Knowledge Management (KM) tool (Ngai and Chan, 2005). The authors list various candidate decision criteria and sub-criteria for justifying this selection process but, in their case study, they actually show the use of only three major criteria (cost, functionality and vendor) to evaluate three alternative KM tools. Considering additional criteria or sub-criteria, often leads to a combinatorial
explosion of the number of individual pairwise comparisons, thus, making AHP application very time and cost ineffective (Maiden and Ncube, 1998). A similar problem appears in a recent approach that follows AHP for the selection of an ERP (Enterprise Resource Planning) system (Karaarslan and Gundogar, 2008). The authors suggest eight selection criteria (seven of them correspond to different modules of an ERP system and the ninth criterion covers the general system functionality) and a very detailed list of sub-criteria for the evaluation of two ERP systems. The evaluators in the presented case study were asked to rate explicitly (with a point from 0 to 5) each sub-criterion, an approach that improved the practical application of the decision making method.

There are two additional difficulties related with the practical application of AHP. First, when determining “crisp” comparative values, any uncertainties on judgments of decision makers cannot be easily handled (Saaty, 1980). A possible solution for this limitation is to use a combination of AHP with fuzzy logic (Chang, 1996). In (Cebeci, 2009), for example, a combined fuzzy logic - AHP based approach is proposed to select the most suitable ERP system for a textile manufacturing company. However, the complexity of fuzzy logic approaches raises difficulties for their practical application. A second difficulty in AHP application appears when there are dependencies among the selection criteria. In such a case, the Analytic Network Process (ANP) can be used, an AHP extension that handles both intra- and inter-dependencies among clusters of selection criteria (Saaty, 1996). The application of the method is, however, very time and cost effective, since it requires a great number of pairwise comparisons. For example, a case study of ANP use in selecting among three ERP systems, with respect to twelve selection criteria organised into system and vendor related clusters, concludes that considering all possible interactions among criteria requires additional time and effort (Percin, 2008).

Although AHP has been extensively used for the evaluation of various software products, surprisingly little work has been done in the field of evaluating PPM software tools with AHP or even by using its extensions, such as ANP. In the late past, there were some research papers aimed to compare PPM tools through the evaluation of some quality features, such as user friendliness, documentation and resource allocation (De Wit and Herroelen, 1990) or conventional technical tool characteristics, such as scheduling and resource management capabilities (Rushinek A. and Rushinek S., 1991; Maroto and Tormos; 1994), but there is lack of a comparative approach that considers both experts’ judgments and PPM users’ requirements in an actual organizational context. In addition, PPM tools of today no longer emphasise only on scheduling and resource management. They are systems that support the life-cycle management of a project or a portfolio of projects. Therefore, the selection of an appropriate PPM tool is a complex process that requires systematic support. Searching the relevant literature, we could find no relevant research work on applying an MCDM method, like AHP, in project management tools selection. The only exception seems to be the work of (Ahmad and Laplante, 2006) which propose an approach based on AHP for the selection of software project management tools. Their work, however, is rather limited to software project management tools and they consider an indicative set of twelve general selection criteria, without to properly justify their selection. The authors specify that their intention is “not to create a definitive set of features, but rather a representative one to illustrate the selection process”. Our proposal follows a more practical, group-based approach applied in an actual context of an organisation required support for selecting an appropriate PPM tool to fulfil specific management requirements. Therefore, our first intention was to perform the selection process by considering not only the experts’ opinions but also the users’ requirements from a PPM tool. In addition, the selection criteria are specified according to a comprehensive, functional oriented evaluation framework (NASA PMTWG, 2004). The result is a detailed
set of features for each of the selection criteria. Our goal, therefore, is to examine the
candidate PPM tools according to a detailed, functional-based list of requirements/features,
instead of just exercising general selection criteria (sets of features).

2.2 PPM Tools Evaluation Frameworks
The selection process of a PPM tool can be supported by referencing to published survey
results. In the past, for example, PMI had published an extensive survey (PMI, 1999) that
compared more than 200 different tools in dimensions like scheduling, cost management,
risk management, resource management, communication management and process
management. However, such detailed comparisons focus rather on technical factors which
represent vendors’ perspectives and they should be always utilised with care by
considering specific project management needs within the context of individual
organisations. Support in setting up a PPM tool can be also gained by considering the
users’ perceptions from a PPM tool usage. This requires the application of a technology
acceptance model to provide some empirical evidence on the relationships that exist, for
example, between a tool’s usefulness and its ease of use (Davis, 1989). A representative
evaluation approach of this approach is the one presented in (Ali and Money, 2005). This work
surveyed 497 PPM tool users and the result was a general index for measuring the
effectiveness of PPM tools according to four, user-oriented, dimensions (information
quality, functionality, ease of use, performance impact). However, the theoretical
background of such an index lacks the mathematical formality of an MCDM approach.
Formal mathematical support can be found useful in cases that selection criteria contradict
each another and perspective PPM tool users are actually expressing their preferences and
not their actual knowledge on potential benefits derived from a PPM tool.

To reach a more detailed list of selection criteria, evaluators may utilise criteria offered by
a conceptual reference model for PPM tools, like, for example, the RefModePM model
(Ahlemann, 2009). A conceptual reference model provides a holistic approach for a PPM
tool selection process since it handles the problem from a business process reengineering
perspective. A conceptual reference model can be followed, first of all, to categorise all perspective
PPM tool users (i.e., members of an organisation personnel), then to define the
organisation’s project management processes and, finally, to provide descriptions for the
organisation’s project data. RefModePM is mainly a process oriented framework that
classifies project management processes within a project-based organisation into twelve
general functional areas, which, in a broad sense, follow the phases of a project life cycle:
Project Idea Generation, Project Idea Evaluation, Portfolio Controlling, Program Planning,
Project Controlling, Program Controlling, Portfolio Controlling, Program Termination,
Project Termination, Personal Information Management and Team Collaboration. Each of
these functional areas is further subdivided into process steps which form the selection
criteria for a candidate PPM tool.

Apart from the RefModePM, to decide upon PPM tools selection criteria, we have
considered another evaluation framework that is proposed by the NASA PPM Tools
Working Group (NASA PMTWG, 2004). This framework (NASAPM) is more functional
oriented. It lists explicitly a number of technical / performance / reporting requirements to
be used as selection criteria, where each requirement is further analyzed into a set of
functional features. The following nine evaluation criteria, adopted mainly from the
NASAPM evaluation framework, have been used in our selection process: C1) Open
Database Connectivity & Architecture - Workgroup & Networking Capabilities, C2) Ease
of Use, C3) Project Scheduling Support - Definition of Project Task / Field Features, C4)
Baselining - Tracking Project Progress & Calendar Features, C5) Resource & Cost

Each criterion includes a set of functional features. For example, criterion C3 (Project Scheduling Support - Definition of Project Task / Field Features) summarises eighteen functional features, namely: i) Perform basic scheduling/PERT functionality, ii) Allow variable scaling for task duration, iii) Perform full Critical Path Method (CPM) functionality, including capability of showing multiple critical paths in output reports, iv) Allow users to designate logical relationships (i.e., SS, SF, FF, FT), v) Allow users to customize tables and views, vi) Allow users to create project templates, vii) Generates an Organizational Breakdown Structure (OBS) and a Work Breakdown Structure (WBS) or allow user to impose a WBS, viii) Allow users to assign positive or negative lag/lead times on logical relationships, ix) Perform resource levelling and smoothing, x) Have the capability of "de-linking" percent complete from remaining duration, xi) Allow users to define and assign constraints to tasks – milestones, xii) Allow users to specify tasks or milestones to be rolled-up, xiii) Allow users to define fields for each project/task/resource, xiv) Roll-up multiple projects into a master schedule, xv) Define a task with the duration being automatically calculated based upon its dependency with another task (hammock task), xvi) Incorporate a large comment/notes field for entry of soft information, xvii) Define task start/end dates as fixed, resource-driven or effort-driven, xviii) Allow users to create a read-only version of project (fields, tables, resources, calendars).

In total, for the nine, listed above, evaluation criteria, a total number of 105 functional features have been identified to be evaluated.

3. Description of the Case Study

This section presents the application of an AHP-based PPM tool selection process within the context of a real project that took place in 2008 with the overall goal to analyse the project management requirements of the Hellenic National Documentation Centre (NDC) (www.ekt.gr). NDC is a national institute responsible for providing documentation and information support on science research and technology issues. Since its establishment, in 1980, NDC has been involved in a number of projects, funded by national and EU operational programmes. The institute operates the National Science and Technology Digital Library, develops digital content (such as the National Archive of PhD theses), supports networking of Hellenic University Libraries and operates as national contact point for some EU funded R&D programmes like “Ideas”, “Cooperation” and “Capacities”. In NDC there is no currently an integrated portfolio/project management infrastructure. A team of 16 employees (users) with project management responsibilities undertake and manage the institute projects. Each of these employees utilises a stand-alone PPM tool according to his/her own personal preferences/experience. In order to increase project management effectiveness and productivity, NDC has recently decided to adopt a collaborative PPM tool. Responding to a corresponding call for tenders, the Technological Research Center of Thessaly (www.trc-thessaly.gr) has been approved to act as the technical consultant for this project. Three evaluators (experts) from TRC, with an average of five years experience in PPM tools usage, were involved in this project, aiming to identify NDC requirements from a PPM tool and select an appropriate tool that will cover these requirements.

3.1 First project steps

Three joint meeting between the users and the experts group were conducted to agree upon selection criteria and candidate PPM tools. In the first meeting, experts presented to the users group the details of RefMode™ and NASA™ tools evaluation frameworks. The
users expressed that their requirements from a PPM tool were more consistent with the functional oriented criteria included in the NASA\textsuperscript{PM} evaluation framework. Therefore, the final agreement was to base the selection process upon the technical/performance/reporting requirements listed in the NASA\textsuperscript{PM} framework. In the second meeting, the users were asked to provide answers to a detailed questionnaire with the aim to identify the specific project management responsibilities of each user. Through analysing their answers, two teams of users were identified: Team I that consisted of eleven project managers involved in planning, executing and monitoring of single projects and Team II that included five project officers, responsible for strategic management, contract management, multi-project coordination and planning the institute project portfolios. In the third meeting, a discussion took place upon possible candidate PPM tools to be evaluated. Though there is a large number of available PPM tools, both experts and users were queried to express their opinions on ten PPM tools which in market survey results (Light and Stang, 2008) are characterised as leaders and challengers in this segment of enterprise software market. Five from these tools were excluded mainly for two reasons: first, since they do not have presence in the national market and, second, because experts were not familiar with their usage. This first-level screening resulted in a list of five powerful, widespread PPM tools with portfolio management and workgroup capabilities and strong presence (i.e., technical/training support) in the national market. For project confidentiality reasons, we will refer to these PPM tools as A, B, C, D and E.

3.2 Experts’ assessment of PPM tools

The previous step resulted in the identification of 5 candidate PPM tools and 9 selection criteria which, in turn, include 105 (in total) sub-criteria (functional features) to be analysed. The hierarchical structure of the decision/selection problem is depicted in Figure 1. To evaluate the candidate tools in a manageable and reliable way, each of the 3 experts/evaluators repeatedly applied two methods providing, respectively, score assignments and pairwise comparisons. Such an approach presents some methodological similarities with OTSO, a methodology for reusable COTS evaluation which also makes a combined use of AHP and scoring methods (Kontio, 1996). However, the main difference in our approach is that the AHP based ranking of tools is actually utilised to reconsider the judgment based on assigning scores. In particular, we have adopted an ordinal scoring scale, similar to the one proposed by RefMode\textsuperscript{PM}. The three experts individually evaluated each tool by providing a score value on each one of the 105 functional features and they utilised a “2-stars” score (0-stars: no functionality, 1-star: adequate functionality, 2-stars: advanced functionality). The result was an aggregate total score for each tool, in each one of the nine selection criteria. For example, according to criterion C3, an aggregate score of tool A equal to 21/36 means that the evaluator perceived that tool A scores 21 in total of 36 stars (C3 includes 18 features * 2 (maximum number of stars) = 36 stars).

Each expert was also asked to follow the AHP method and make pairwise comparisons between candidate tools, according to each one of the nine selection criteria (i.e., tool A was compared versus tool B versus tool C versus tool D versus tool E on each of the nine criteria). Judgments followed the linear nine-point scale of AHP (Saaty, 1980) to specify the relative performance of tools (i.e., 1: equal performance, 3: weak performance, 5: strong performance, 7: demonstrated performance, 9: absolute performance, 2 - 4 - 6 - 8: intermediate values of performance). Thus, each time, an expert performed a total number of 90=(5*(5-1)/2)*9 pairwise comparisons and a 5x5 comparison table was derived for each one of the 9 criteria. After applying the steps of the AHP method (i.e., normalization of expert judgments, computation of priority vectors and calculation of consistency
indices/consistency ratios), a 5x9 priority matrix was calculated (a matrix that consists of 9 priority vectors) for the 5 candidate PPM tools. All experts repeatedly applied the above two methods in case that a consistency ratio (CR) of pairwise comparisons was observed to be more than 10% (i.e., the recommended acceptable CR by AHP method) or in case that there were differences between the tools’ prioritisation according to AHP and the tools’ ranking provided by the score-based evaluation. In particular, if a CR value was observed to be larger than 10%, the expert was requested to review his pairwise comparisons in order to reach a better level of consistency in the comparative judgment. A consistent tools’ priority matrix was then compared to the corresponding ranking of tools on each criterion resulted by the scoring method. If any differences were observed in the relative ranking of tools using the two analysis methods, the expert was asked to reconsider scores’ assignments. Thus, scores’ assignments and AHP-like pairwise comparisons were repeatedly applied, until all 3 experts reached a final consensus that revealed a consistent ranking of tools according to the identified selection criteria.

The average total scores, as they were given by the 3 experts, for each tool in each criterion are presented in Table 1. Standard deviations were calculated to show how the scores are “spread out” from the average values. In all cases, the standard deviation observed was never greater than 0.9. Thus, Table 1 shows the degree to which each tool meets every criterion by taking into account average scores. For instance, concerning criterion C1, B tool “gathered”, on average, from all experts 17 stars on 28. The values of Table 1 were normalised (i.e., in scale [0..1]) by dividing each score by its column total. Normalising the scores ensures that all criteria are equally weighted, thereby preventing one criterion from dominating the others because of its inherent numerical values. The normalised comparison matrix is presented in Table 2. This table depicts the final priority matrix of all PPM tools according to all experts’ judgments.
3.3 Users’ evaluation of selection criteria

To analyse the users’ requirements from a PPM tool, we designed and disseminated to 16 members of the NDC personnel an AHP-structured questionnaire, asking from them to comparatively evaluate the nine selection criteria. Each of the 16 users was requested to perform 36 pair wise comparisons, each one in the form presented in Figure 2.

<table>
<thead>
<tr>
<th></th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
<th>C6</th>
<th>C7</th>
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<th>C9</th>
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<tbody>
<tr>
<td>A</td>
<td>21/28</td>
<td>5/20</td>
<td>13/24</td>
<td>13/22</td>
<td>9/14</td>
<td>20/42</td>
<td>3/12</td>
<td>7/12</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>17/28</td>
<td>13/20</td>
<td>23/36</td>
<td>14/24</td>
<td>13/22</td>
<td>8/14</td>
<td>23/42</td>
<td>4/12</td>
<td>7/12</td>
</tr>
<tr>
<td>C</td>
<td>24/28</td>
<td>12/20</td>
<td>22/36</td>
<td>8/24</td>
<td>14/22</td>
<td>10/14</td>
<td>10/42</td>
<td>6/12</td>
<td>6/12</td>
</tr>
<tr>
<td>D</td>
<td>19/28</td>
<td>10/20</td>
<td>23/36</td>
<td>13/24</td>
<td>14/22</td>
<td>10/14</td>
<td>21/42</td>
<td>4/12</td>
<td>6/12</td>
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<tr>
<td>E</td>
<td>22/28</td>
<td>10/20</td>
<td>23/36</td>
<td>12/24</td>
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Table 1. PPM tools evaluation matrix from experts’ judgments

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<td>0,1702</td>
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<td>0,1667</td>
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</tr>
<tr>
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<td>0,1333</td>
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<tr>
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<td>0,2000</td>
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<td>0,2371</td>
<td>0,2917</td>
<td>0,1875</td>
</tr>
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Table 2. PPM tools priority matrix

All users provided consistent comparisons, except from one user in Team I that provided answers with a fairly high CR(=0.202). The decision was to include only results from participants having CR of 0.15 or less, following closely the Saaty’s recommendation of 0.10. Thus, the final sample of users consisted of 10 users in Team I (10 project managers) and 5 users in Team II (5 project officers). The average CR for all 15 users was equal to 0.109. The individual responses were aggregated by computing the geometrical mean for each comparison as follows. Suppose that each of the $K$ respondents ($K = 15$ users in both teams, $K = 10$ users in Team I, $K = 5$ users in Team II) makes a pairwise comparison $a_{ij}^k$ ($1$, $2$, $\ldots$, $9$) for criteria $i$ and $j$. Then, the aggregate comparison index for factors $i$ and $j$ is computed as the $k^{th}$ order root of the product of all individual responses:

$$a_{ij} = \sqrt[k]{\prod_{k=1}^{K} a_{ij}^k}$$

Application of AHP to aggregated comparisons derived from all users (a), Team I users (b) and Team II users (c) resulted in the final prioritisation (weighting) of the selection criteria, as shown in Figures 3(a), 3(b) and 3(c), respectively. Agreement in weights’ prioritisation of Team I (Figure 3(b)) with the overall weights’ prioritisation (Figure 3(a)) was analysed by Spearman’s Rank Correlation procedure. A positive (strong) relationship was found between these two rankings, i.e., the rank (Spearman) correlation coefficient was found equal to 0.60. There was also a positive relationship between the weights’ prioritisation of
Team II (Figure 3(c)) and the overall weights’ prioritisation (Figure 3(a)). In this case, the Spearman correlation coefficient was equal to 0.55. Thus, it appears that generally there existed an agreement between the ranking of some criteria (for each of the teams) and the overall criteria ranking, however this positive relationship is no statistically significant (at a 5% confidence level). For example, the ranking of criteria C1, C4, C5, C6, C7, C8 according to Team I users coincides with the overall ranking. The same is true for the ranking of criteria C2, C3, C5, C6, C8 according to Team II. This ranking also coincides with the final ranking. Therefore, we can conclude that the overall weighting of criteria depicted a compromised consensus for the perceptions of both teams.

Comparison of criteria weights according to Team I (Figure(b)) with criteria weights according to Team II (Figure(c)) reveals that there is a weak negative (no statistically significant) relationship between them (the Spearman correlation coefficient is equal to -0.15, at a confidence level equal to 5%). Thus, it seems that the two teams rated differently the selection criteria. For project managers (Team I members), the most important criteria for selecting a PPM tool were C1 (Open Database Connectivity & Architecture - Workgroup & Networking Capabilities), C5 (Resource & Cost Management Features), C2 (Ease of Use) and C8 (Support for Supplier & Contract Management). The less important criterion for project managers was C6 (Risk Management Features). On the other hand, project officers (Team II members) classified criteria C9 (Portfolio Management Features), C8 (Support for Supplier & Contract Management) and C5 (Resource & Cost Management Features) as the most important factors when selecting a PPM tool, while C2 (Ease of Use) and C6 (Risk Management Features) were rated as less important factors. Surprisingly, both teams rated “Risk Management Features” (C6) as not so important. The reason was investigated through an informal discussion where members from both teams expressed that they were not familiar with probabilistic/simulation based risk analysis techniques provided by some contemporary PPM tools.

3.4 Final PPM tools evaluation

Table 3 presents the ranking vectors for the 5 candidate PPM tools. Rates in column (a) are calculated by multiplying the PPM tools priority matrix (Table 2) with the Team I criteria weighting vector (values presented in Figure 3(b)). Respectively, rates in column (b) are calculated by multiplying the PPM tools priority matrix (Table 2) with the Team II criteria weighting vector (values in Figure 3(c)). Values in column (d) are derived by multiplying the tools priority matrix (Table 2) with the criteria weighting vector, as it was given by all users (values in Figure 3(a)). Finally, column (c) depicts the average scores of tools, as they were provided by all experts (i.e., these are the average numbers in each row of Table 2).

By taking into account both users’ and experts’ perspectives, although there are small differences among tools’ ratings, we can conclude that there is a general consensus for the “winners” (i.e., tools scoring rankings above 20%):

- tool E, a powerful environment offering integrated support for both enterprise resource planning and project management services
- tool B, a widespread project management tool that operates at an enterprise-level platform, offering portfolio and multi-user management capabilities.

It appears that there is also an agreement about the least promising tool that is tool A, an environment specialised mainly in IT service portfolio and financial management functionalities with low technical support responsiveness in the national market. As far as evaluation of Tool C is concerned, its main advantageous characteristic is the strong integration with database management applications (i.e., it received the highest score in criterion C1 “Open Database Connectivity & Architecture - Workgroup & Networking
Capabilities”). Therefore, Tool C is within the first rank rows for Team I users who considered C1 as the most important criterion. Finally, although experts rated tool D (i.e., tool D is another very widespread PPM tool with powerful project scheduling and resource levelling capabilities) at about 20%, the final tool ranking was below 20%. One reason for this is because one of the main tool advantages is the support for quantitative risk management techniques, a criterion (C6) that received a low weight from the majority of users.

![Figure 3: Prioritisation of the selection criteria according to users’ judgments](image)

Table 3. Final ranking of PPM tools

<table>
<thead>
<tr>
<th>PPM Tools</th>
<th>Ranking based on Team I criteria weighting (a)</th>
<th>Ranking based on Team II criteria weighting (b)</th>
<th>Ranking based on average scores of experts’ judgments (c)</th>
<th>Ranking based on users’ criteria weighting (d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>18.24% (5)</td>
<td>19.03% (5)</td>
<td>18.29% (5)</td>
<td>18.59% (5)</td>
</tr>
<tr>
<td>B</td>
<td>20.27% (3)</td>
<td>20.44% (2)</td>
<td>20.59% (2)</td>
<td>20.25% (2)</td>
</tr>
<tr>
<td>C</td>
<td>20.30% (2)</td>
<td>19.04% (4)</td>
<td>19.65% (4)</td>
<td>19.80% (4)</td>
</tr>
<tr>
<td>D</td>
<td>19.80% (4)</td>
<td>19.80% (3)</td>
<td>20.02% (3)</td>
<td>19.83% (3)</td>
</tr>
<tr>
<td>E</td>
<td>21.39% (1)</td>
<td>21.69% (1)</td>
<td>21.44% (1)</td>
<td>21.54% (1)</td>
</tr>
</tbody>
</table>

4. Conclusions

In this paper, through discussing a real case study, we demonstrated how group-based, multi criteria decision analysis can be applied to facilitate the selection problem of an appropriate Project and Portfolio Management (PPM) tool. The presented approach is based the Analytic Hierarchy Process (AHP) method. All problem stakeholders (i.e., both PPM tool experts and PPM tool users) have been actively involved in this process. This active participation has been proven to be helpful in deriving rankings of the candidate tools, according to a detailed set of functional features (selection criteria) offered by contemporary PPM tools, as well as, in assigning weights to criteria based on the stakeholders’ perceptions about the relative importance of these criteria on the
effectiveness of the organisation’s project management process. Using a combined score-based and AHP-based approach, experts have reached a consistent consensus for all tool performances on each criterion. When analysing the user requirements from a PPM tool, users have been classified into groups according to their strategic/operational level of involvement in the organization’s project management processes. Aggregate comparisons for each user group may lead to a different final ranking of the candidate tools, so the final decision has always to be made with care. Some limitations were also observed in the study. First, uncertainties in experts and users judgments were not formally handled. We believe that treating uncertainties (for example, by applying fuzzy-based AHP) would strengthen our approach in deriving more precise results. Second, dependencies among criteria were not considered. We believe that this can be handled by applying a more extended decision making technique (for example, the Analytic Network Process – ANP). However, the complexity of such possible extensions would require more training of all problem stakeholders in applying AHP-based, pairwise comparisons and systematic usage of a decision making software tool. All these issues constitute our future plans for improving the approach, as well as, we intend to validate it to other decision experiments.

References


