Project Management Software Selection Using Analytic Hierarchy Process Method

Birgul Kutlu
Professor
Bogazici University
Department of Management Information Systems
Istanbul, Turkey

Aysun Bozanta

Esra Ates

Serpil Erdogan

Oya Gokay

Nurcan Kan

Bogazici University
Department of Management Information Systems
Istanbul, Turkey

Abstract

Today, project management software is essential for organizations to better manage their projects, reduce their costs, shorten schedules and be more responsive to customer demands. Software selection process is a critical issue for future growth and competitiveness of the company; moreover project management software selection also has a profound effect on the operation or control of the projects to be successful. The aim of this research is to focus on selection of project management software using Analytic Hierarchy Process (AHP) method. The selection criteria is specified by experts of mostly used 3 project management software packages, namely HP-PPM, MS-Project and Primavera. These criteria are evaluated by 5 project managers from different companies for these 3 project management tools. Results have specified that HP-PPM is the most appropriate tool among other two project tools in the scope of the interviewed companies.

Keywords: project management, software selection, analytic hierarchy process

1. Introduction

Project management is the process and activity of planning, organizing, motivating, and controlling resources, procedures and protocols to achieve specific goals in scientific or daily problems. Project management provides a framework to help accomplish goals for all organizations. One critical issue for project management is selection of proper project management software which has the capacity to help plan, organize, and manage resource pools and develop resource estimates. Following project steps are easier with the use of appropriate tools. Project management tools provide a large number of features that are customizable and can be tailored to meet the specific need of the organizations. However, the problem is that every company, even every project has different requirements. The more suitable tool that managers select, the more the projects will be executed successfully and their company may become more profitable.

Decision making in the field of software selection has become more complex due to a large number of software products in the market, ongoing improvements, information technology, and multiple and sometimes conflicting objectives (Zahedi et al., 2011).

Project management software is a term covering many types of software, including scheduling, cost control, budget management, resource allocation, collaboration, communication, quality management and documentation (Unesco Bangkok, 2008).

The choice of project management tool selection has a profound effect on the operation or control of the projects and their success. The reason for this matter lies in the complex and crucial nature of selecting project management tool for project managers.

The aim of this research is to select appropriate project management tool with the AHP methodology to meet expectations' of high level managers and to increase profitability of the company.

2. Methodology

2.1 Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP) is a structured technique for organizing and analyzing complex decisions that is developed by Saaty (1980). It is a method for ranking decision alternatives and selecting the best one when the decision maker has multiple criteria. It is based on the well-defined mathematical structure of consistent matrices and their associated right eigenvector's ability to generate true or approximate weights (Merkin, 1979).

There are seven steps for applying AHP (Saaty, 1980):

1. Define the problem and determine its goals.
2. Structure the hierarchy from the top through the intermediate levels and to the lowest level which usually contains the list of alternatives.
3. Construct a set of pair-wise comparison matrices (size n x n) for each of the lower levels with one matrix for each element in the level immediately above by using the relative scale management (Figure 1).
4. There are n*(n-1) judgments required to develop the set of matrices in step 3. Reciprocals are automatically assigned in each pair-wise comparison.
5. Hierarchical synthesis is used to weight the eigenvectors by the weights of the criteria and the sum is taken over all weighted eigenvector entries corresponding to those in the next lower level of hierarchy.
6. Having made all the pair-wise comparisons, the consistency is determined by the eigenvalue.
7. Steps 3-6 are performed for all levels in the hierarchy.

In AHP, preferences between alternatives are determined by making pair wise comparisons technique in which the decision maker examines two alternatives by considering one criterion and indicates a preference. Usually 1-9 scale (but sometimes 1-5 scale) is used for AHP. In the pair wise comparison matrix, the value 9 indicates that one factor is extremely more important than the other, and the value 1/9 indicates that one factor is extremely less important than the other, and the value 1 indicates equal importance (Sarkis and Talluri, 2004). Table 1 displays the pair-wise comparison scale used for this study.

Table 1: Pair-Wise Comparison Scale for AHP Preferences

Numerical rating	Verbal judgments of preferences
9	Extremely preferred
8	Very strongly to extremely
7	Very strongly preferred
6	Strongly to very strongly
5	Strongly preferred
4	Moderately to strongly
3	Moderately preferred
2	Equally to moderately
1	Equally preferred

Figure 1: Pair Wise Comparison Matrix

$$A = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \\ . \\ C_n \end{array} \begin{array}{c} \begin{array}{cccccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 & . & C_n \end{array} \\ \begin{bmatrix} 1 & a_{12} & a_{13} & a_{14} & a_{15} & a_{16} & . & a_{1n} \\ a_{21} & 1 & a_{23} & a_{24} & a_{25} & a_{26} & . & a_{2n} \\ a_{31} & a_{32} & 1 & a_{34} & a_{35} & a_{36} & . & a_{3n} \\ a_{41} & a_{42} & a_{43} & 1 & a_{45} & a_{46} & . & a_{4n} \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 & a_{56} & . & a_{5n} \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & 1 & . & a_{6n} \\ . & . & . & . & . & . & 1 & . \\ a_{n1} & a_{n2} & a_{n3} & a_{n4} & a_{21} & a_{21} & . & 1 \end{bmatrix} \end{array}$$

In Figure 1:

n = criteria number to be evaluated
C_i = i^{th} criteria,
A_{ij} = importance of i^{th} criteria according to j^{th} criteria

The next stage is to calculate λ_{max} so as to lead to the Consistency Index and the Consistency Ratio.

Consider $[A_x = \lambda_{max} * x]$ where x is the Eigenvector.

ThenConsistency Ratio (CR) is calculated to measure how consistent the judgments have been relative to large samples of purely random judgments. If CR is greater than 0.1 the judgments are untrustworthy because they are too close for comfort to randomness and the exercise is valueless or must be repeated.

2.2Implementation of AHP

In this part, application of each step of AHP will be explained in detail.

2.2.1 Problem Statement

Decision making in the field of software selection has become more complex due to a large number of software products in the market, ongoing improvements, information technology, and multiple and sometimes conflicting objectives (Zahedi et al., 2011). For instance, project managers coming from different backgrounds are prone to choose different tools according to their prior experiences without considering companies real requirements. This may result in wrong decision as well as loss of money, time and effort.

The choice of project management tool selection has a profound effect on the operation or control of the projects to be more successful. The reason for this matter lies in the complex and crucial nature of selecting project management tool for project managers. The aim of this project is to select appropriate project management software with AHP methodology to meet expectations' of high level managers and to increase profitability of the company.

2.2.2 Constructing the Structure of AHP

Defining criteria is one of the most critical steps of constructing AHP model since the decision of users shapes around these pre-determined criteria. In order to define the most appropriate criteria, first the literature is searched comprehensively and then experts that use project management tools from different sectors are interviewed. Criteria affecting selection of project management software are specified by literature and interviews performed with experts (Table 2).

Table 2: Project Management Tool Selection Criteria Literature List

Criteria Groups	References
Cost	(Eliat et al., 2008), (Farzaneh et al., 2013), (Jadhav & Sonar, 2008), (Zahedi et al., 2011)
User Friendliness	(Farzaneh et al., 2013), (Jadhav & Sonar, 2008), (Silva et al., 2013), (Zahedi et al., 2011)
Tool Maturity	(Eliat et al., 2008), (Farzaneh et al., 2013), (Jadhav & Sonar, 2008), (Silva et al., 2013), (Zahedi et al., 2011)
Vendor/Consultant	(Eliat et al., 2008), (Farzaneh et al., 2013), (Jadhav & Sonar, 2008), (Kamal M. Al-Subhi Al-Harbi, 2001), (Silva et al., 2013), (Zahedi et al., 2011)

Some other criteria are also found such as application development cost, acquire and test hardware, suitability with programming, language, browser compatibility from the literature. However, these criteria are excluded sincethe system is not being developedand the aim is to buy one. If the application will be developed in house, these criteria will also be crucial.

In order to implement AHP methodology and to perform the calculation accurately, real values of all criteria for each tool are needed. Therefore, appointments are arranged with executives from 3 mainly used project management software companies; HP (HP-PPM, 2014), Microsoft (MS-Project, 2014) and Oracle (Primavera, 2014). The executives are requested to specifyscores for each criterion of the 3 tools. Table 3 shows the values for each criterion. In order to state the strength of each tool according to different criteria, executives have given scores to project management tools for each main and sub criterion between 1 and 10.

Table 3: Criteria Values

Criteria	HP-PPM	MS-Project	Primavera
Cost for User			
Hardware Infrastructure	1	1	1
Implementation	1	3	2
Maintenance	1	2	2
Software License	6	5	7
User Friendliness			
Multidimensional reporting	9	9	8
User responsiveness	8	6	7
Tool Maturity			
Platform variety	1	10	9
Maintainability	6	9	9
Functionality (speed, capacity)	7	8	8
Documentation quality	9	7	7
Customization	5	6	8
Upgrade ability	6	9	2
Vendor and Consultant Support			
Demo and pilot test opportunity	7	10	8
Online help, training, tutorial	9	5	8
Technical support	9	6	9
Vendor reputation	9	10	9
Experience and knowledge	8	10	9

2.2.3 Constructing Pairwise Comparison Matrices

After the criteria are determined and the values of each tool for each criterion are assigned, AHP template is formed using Microsoft Excel.In this template, there are 5 comparison matrices consisting of one for main criteria and one for sub criteria of each main criterion. Main criteria matrix consists of cost, user friendliness, tool maturity, and vendor/consultant support variables. First sub criteria matrix consists of the sub criteria of cost which are hardware infrastructure, implementation, maintenance, and software license costs.

Second sub criteria matrix consists of multidimensional reporting and user responsiveness which are the sub criteria of user friendliness. Third main criteria matrix contains platform variety, maintainability, functionality, documentation quality, customization, upgrade ability that form tool maturity. The elements of final sub criteria matrix are demo and pilot test opportunity, online help, training and tutorial, technical support, vendor reputation, and, experience and knowledge which are the sub criteria of vendor and consultant support.

2.2.4 Judgments of the Experts

In order to analyze which tool is appropriate for the businesses according to the priorities of the companies, AHP methodology is implemented through interviews. Experts, using project management software, from different sectors are interviewed:

- HP-PPM: 2 companies from telecommunications sector
- MS-Project: 1 company from aircraft maintenance and 1 company from information/communication services sector
- Primavera: 1 company from construction sector

The experts state which criterion is more important than other when using project management tool by giving weights differing from 1/9 to 9. They repeat pairwise comparison for main criteria and each sub criteria matrices.

2.2.5 Calculating Eigen Vectors

In order to find the ranking of matrices, namely the Eigen vector,the column entries are normalized by dividing each entry by the sum of the column. Then the overall row averages are taken. Eigen vector, in other words priority vector, represents the ranking of criteria.

2.2.6 Consistency Check

In order to check the consistency of the judgments, system checks the Consistency Ratio. AHP assumes that the users are rational decision makers which mean if A is preferred to B and B is preferred to C, then A is preferred to C. For this purpose, Consistency Ratio is checked and if it is greater than 0.1, then the judgments are unreliable and must be repeated (Saaty, 1980).

The formula of Consistency Index (CI) as follows:

$$CI = (\lambda max - n)/(n-1)$$

Where n is the order of matrix and also can be extracted from following equation:

$$\mathrm{AX} = \lambda max\, \mathrm{X}$$

After calculating Consistency Index, final step is calculating Consistency Ratio which has to be less than 0.1. Table 4 shows the average consistency indices derived from Saaty's book (1980).

Table 4: Average Consistency Indices

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

In Table 4, the first row shows the order of matrix that is used in pairwise comparison and second row shows the average consistency indices derived from a sample of randomly selected reciprocal matrices of AHP method. The formula of Consistency Ratio is as follows:

$$CR = CI \,/\, averageCI$$

Then consistency ratio is checked to be less than 0.1.

$$CR < 0.1$$

If the consistency ratio doesn't ensure required value then experts repeated the pairwise comparison.

2.2.7 Iteration of the Previous Steps

All previous steps are repeated for all criteria matrices and satisfactory consistency ratios are tried to be obtained. After that, priority matrices that show the ranking of criteria are formed.

The last step is taking matrix multiplication of the Eigen vectors and the values of alternatives which are given by experts based on pre-determined criteria. The results give the ranking of alternatives and the best alternative takes the highest score.

3. Results

After interviews with 5 experts from different sectors namely telecommunication, aircraft maintenance, construction, and information services, calculations were completed using AHP template prepared with Excel and the results are presented in Table 5. As it can be seen from Table 5, scores are not very far away from each other. Based on the pairwise criteria comparisons of two experts from communication sectors who are currently using HP-PPM as project management tool, HP-PPM was determined as the most appropriate tool for their demands. An expert, who is currently using MS-Project, from aircraft maintenance sector applied pairwise criteria comparison based on the needs of the projects that he executed and it is determined that HP-PPM is the most appropriate tool for his needs. Moreover, another expert who is also using MS-Project currently applied AHP and both HP-PPM and Primavera were found to be the most suitable tools having equal scores. Finally, after calculations that were made based on the pairwise criteria comparison of expert who is currently using Primavera from construction sector, HP-PPM was determined as the most appropriate tool for the needs of the expert.

Table 5: AHP Scores

Sector/Company	HP-PPM Score	MS-Project Score	Primavera Score	Current Software
Telecommunications/1	**0.35**	0.31	0.34	**HP-PPM**
Telecommunications/2	**0.34**	0.33	0.33	**HP-PPM**
Aircraft maintenance	**0.37**	0.29	0.34	MS-Project
Construction	**0.36**	0.31	0.33	Primavera
Information services	**0.35**	0.30	**0.35**	MS-Project

Sub-criteria based results can be summarized as follows:

- According to the sub criteria weights among tools, for all companies the weight of the cost criteria is the highest in HP-PPM tool.
- For the criteria of user friendliness, it has the highest weight in MS-Project according to the preferences of all companies.
- For all companies, HP-PPM is the best tool, Primavera is the second best tool and MS-Project is the third best tool for tool maturity criteria.
- For the company from aircraft maintenance sector, MS-Project is the best tool, Primavera is the second best tool and HP-PPM is the third best tool for vendor/consultant criteria. For the companies fromtelecommunication and construction sectors, MS-Project and Primavera are the best tools with equal weights for vendor/consultant criteria. For the company from information services, HP-PPM is the best tool for vendor/consultant criteria.

4. Conclusion

The selection of project management tool is a very critical decision that affects the efficiency and effectiveness of operations and also affects the control of the projects. The aim of this study is to focus on selection of project management software using AHP method.

The main steps completed in this study are as follows: Literature about project management is searched comprehensively and the most crucial criteria are extracted. Interviews with experts are conducted and criteria are determined for AHP by also taking into account the criteria from literature. Moreover, three mostly used project management software packages are elected as alternatives for AHP. After that, weights for these three alternatives are determined according to pre-determined criteria by interviewing experts. The model is developed in Excel. AHP is applied with five experts from different sectors and they made pairwise criteria comparisons based on their priorities. Finally, calculations are made and results are formed.

Results show that HP-PPM is the most appropriate tool for various businesses interviewed. Depending on AHP results, it can be asserted that interviewed companies from the telecommunication sector already have the best project management tool to manage and control their projects.As for the interviewed companies from aircraft maintenance, construction and information/communication services sector,the tools they are using are not appropriate for them.

Therefore, it can be concluded that they may benefit from changing their project management tool. Nonetheless, this project should be broadened by including other sectors and interviewing more companies from each sector to generalize the conclusions.

References

Eilat, H., Golany, B. & Shtub, A. (2008). R&D project evaluation: An integrated DEA and balanced scorecard approach. Omega: the international journal of management science, 36, 895-912.

Farzaneh, M., Vaani, I. & Sohrabi, B. (2013). A survey of influential factors in the implementation of enterprise resource planning system. International Journal of Enterprise Information Systems, 9(1), 76-96.

HP-PPM (2014). HP Project and Portfolio Management. [Online] Available: http://www8.hp.com/us/en/software-solutions/project-portfolio-management-it-portfolio-management/?jumpid=reg_r1002_usen_c-001_title_r0001 (October 20, 2014)

Jadhav, A.S. &Sonar, R.M. (2009). Evaluating and selecting software packages: A review. Information and Software Technology, 51(3), 555-563.

Kamal M. Al-Subhi Al-Harbi. (2001). Application of the AHP in project management. International Journal of Project Management, 19, 19-27.

Merkin, B.G. (1979). Group Choice. New York: John Wiley & Sons.

MS-Project. (2014). Deliver winning projects. [Online] Available:http://products.office.com/en-us/project/project-and-portfolio-management-software (October 20, 2014)

Primavera. (2008). Oracle-Primavera. [Online] Available: http://www.oracle.com/us/products/applications/primavera/057415.pdf (October 20, 2014)

Saaty, T.L. (1980). The analytic hierarchy process. New York: McGraw-Hill.

Sarkis, J., & Talluri, S. (2004). Evaluating and selecting e-commerce software and systems for a supply chain. European Journal of Operational Research, 159, 318-329.

Silva, J., Fernandes, J., Gonçalves, J. & Cunha, M. (2013). Criteria for ERP selection using AHP approach, 8th Iberian Conference on Information Systems and Technologies (CISTI), 1-6.

UnescoBangkok. (2008). Using project management software in education. [Online] Available: http://www.unescobkk.org/education/ict/online-resources/databases/ict-in-education-database/item/article/using-project-management-software-in-education (October 20, 2014)

Zahedi,M.R., Yousefi,S. & Cheshberah,M. (2011). A fuzzy quality function deployment approach to enterprise resource planning software selection. Asian Journal of Scientific Research, 4(2), 114-128.