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Evaluation of Information Technology Portfolio Management Software using a Fuzzy Logic Algorithm

Iman Nourbakhsh*[1] Akram Rabiee[2] Salman cheraghi[3] Hamid Khajooei[4]
1. Graduate of Industrial Management, University of Yazd
2. Graduate of Industrial Management, University of Isfahan
3. Graduate ofAccounting, University of Isfahan
4. Graduate student of Information Technology Management
*E-mail of the corresponding author: nourbakhshiman@yahoo.com

Abstract
There are many Information Technology Portfolio Management Software (ITPM) and one of the important problems in this field is how to choose an ITPM that will be the most effective one and that will satisfy the requirements. In order to help in the solution of this problem, the authors have introduced a computer program to aid in the selection of an ITPM. The introduced system can easily be used over and it is basically a support system used to evaluate ITPM s by using a flexible and smart algorithm derived from fuzzy logic values. The paper describes the ITPM and the steps of the ITPM evaluation system. All things about the concept of the program are describe and only a programmer need to change this to a software evaluation.
Keywords: Information Technology, Portfolio Management, Fuzzy Logic Algorithm, EvaluationSoftware

1. Introduction

Information technology refers to all forms of technology applied to processing, storing, and transmitting information in electronic form [1]. Information technology, in its narrow definition, refers to the technological side of an information system. It includes the hardware, software, databases, networks, and other electronic devices. It can be viewed as a subsystem of an information system. Sometimes, though, the term information technology is also used interchangeably with information system [2].

Recently, information technology (IT) has moved beyond the implementation of IT applications to an age of IT-enabled change. The trend towards increasing use of IT continues and the challenge remains how to better manage IT projects in order to maximize their economic benefits. Part of that challenge can be tackled by ‘‘doing projects right’’ and part by ‘‘doing the right projects’’ [3].

Information technology (IT) is at a critical juncture in today’s business climate. The pressure of managing and optimizing IT investments across multiple business units/divisions in alignment with key business drivers and their associated risks, cost, value, performance in light of limited resources (people, funding, facilities, etc.) and a demanding legal and regulatory environment is a challenge for all companies. The measurement for return on IT investments has shrunken from yearly to quarterly to monthly. The increasing velocity in the pace of change and innovation is requiring a corresponding increase in the ability to adopt structure, discipline, and rigor in delivering value and meeting customer needs; a Darwinian shakeout is happening in front of our very eyes. Information technology can be either a strategic enabler that adds value, drives growth and transforms a business or a source of distracting noise that results in increased costs just to maintain the status quo [4].

2. Project and project management

A projectis a temporary endeavor undertaken to accomplish a unique purpose [5].Project managementis the application of knowledge, skills, tools, and techniques to project activities in order to meet or exceed stakeholder needs and expectations from a project [6].Project management exists in a broader context that includes program management, portfolio management and project management office. Frequently,there is a hierarchy of strategic plan, portfolio, program, project and subproject, in which a program consisting of several associated projects will contribute to the achievement of a strategic plan [7].

3. Project Portfolio management

A portfolio is a collection of project or programs and other work that are grouped together to facilitate effective management of that work to meet strategic business objectives. The project or programs in portfolio may not necessarily be interdependent or directly related. Funding and support can be assigned on the basis of risk/reward categories, specific lines of business, or general types of project, such as infrastructure and internal process improvement. Organizations manage their portfolios based on specific goals. The field of portfolio management owes its origins to a seminal paper written in 1952, in which Harry Markowitz [7] laid down the basis for the Modern Portfolio Theory (MPT). MPT allows to determine the specific mix of investments generating the highest return for a given level of risk[3].one goal of portfolio management is to maximize the value of portfolio by careful examination of candidate projects and programs for inclusion in the portfolio and the timely exclusion of project not meeting the portfolio strategic objectives. Other goals are to balance the portfolio among incremental and radical investment and for efficient use of resources. Senior managers or senior management teams typically take on the responsibility of portfolio management for an organization[7].

While Project Management concentrates primarily on the former, Project Portfolio Management, hereafter referred to as PPM, is focused on the latter. Contrary to Project Management, which focuses on single project, and Programmed Management, which concerns the management of a set of projects that are related by sharing a common objective or client, or that are related through interdependencies or common resources, PPM considers the entire portfolio of projects a company is engaged in, in order to make decisions in terms of which projects are to be given priority, and which projects are to be added to or removed from the portfolio[3].Project Portfolio Management calls for the integration of two important functions within the firm. These are the Operations function and the Projects function [8].

4. Information technology portfolio management

IT portfolio management is the next best thinga proven, rational, and practical value revenue generation and cost reduction approach that works, enabling companies to create and maintain a sharp focus while having visibility and control of their investments across their organizations [9].

IT portfolio management provides a sound and proven business approach to optimizing investments in information technology. The goal of an IT portfolio is to deliver measurable business value tangible and intangible while aligning and improving the business and IT strategy[9].

MPT was initially developed for financial investments, in 1981, McFarlan provided the basis for the modern field of PPM for IT projects. According to McFarlan, management should also employ a risk based approach to the selection and management of IT project portfolios. He observed that risk unbalanced portfolios could lead an organization to suffer operational disruptions, or leave gaps for competitors to step in. In the mid-1990s, the field of PPM received increasing attention. In 1994, a GAO report described a successful company that used portfolio investment techniques to manage its IT projects. The organization developed a set of criteria to evaluate benefits, costs and risks and thus determined the best mix of projects for obtaining a better balance between maintenance and strategic initiatives. As a result, in three years, the organization reported a 14-fold increase in the return on investment from IT projects. In 1998, Thorp published the ‘‘Information Paradox’’, putting PPM in a broader framework called ‘‘Benefits Realization’’. According to the author, PPM techniques are fundamental for getting value from IT projects. In a recent publication, Jeffery andLeliveld report the results of a survey with 130 senior executives, 90% of whom were CIOs. The survey identified, among other things, that 25% of the respondents could be defined as optimally applying Information Technology Portfolio Management (ITPM), 45% as having or adopting it and 78% as planning to have or to keep it [10].

There are excellent IT portfolio management software products. Many IT portfolio management efforts have been hugely successful with simple office automation tools (e.g., Microsoft Excel). As the process and size of the IT portfolio grow and different views of the portfolio are required to support different stakeholders, simple office automation tools falter. Fund Manager, BetterInvesting Portfolio Manager, Microsoft Money Premium, Portfolio Analyzer, PowerSteering, Deltek PPM and EVM Products , Dynamics SL, Epicor for Service Enterprises, JOVACO Project Suite, NetSuite, OpenAir Professional Services Automation (PSA) Solution, SAP Business ByDesign, Team Headquarters, project-open, Portfolio Director and Quicken Premier are some of this software [11,12].

Software selection is dependent on functional requirements (i.e., what is required to support the objectives and corresponding tasks and deliverables of the process), the resources available including funding and people/skills, and the magnitude of the IT portfolio. In general, the three categories of IT portfolio management solutions are:

1) General IT portfolio management solutions
2) Project/discovery portfolio management solutions
3) Asset portfolio management solutions [9].

A proven methodology serves as the primary framework in this section for evaluating IT portfolio management software solutions. As shown in Exhibit 1, the approach consists of a category of functional capabilities followed by two dimensions: presence (ability to deliver value to the customer) and performance (ability to provide value to the customer). These categories and criteria must be used in the context of the company’s specific business environment, requirements, strategies, and priorities. They vary in importance across companies and among industries [9].

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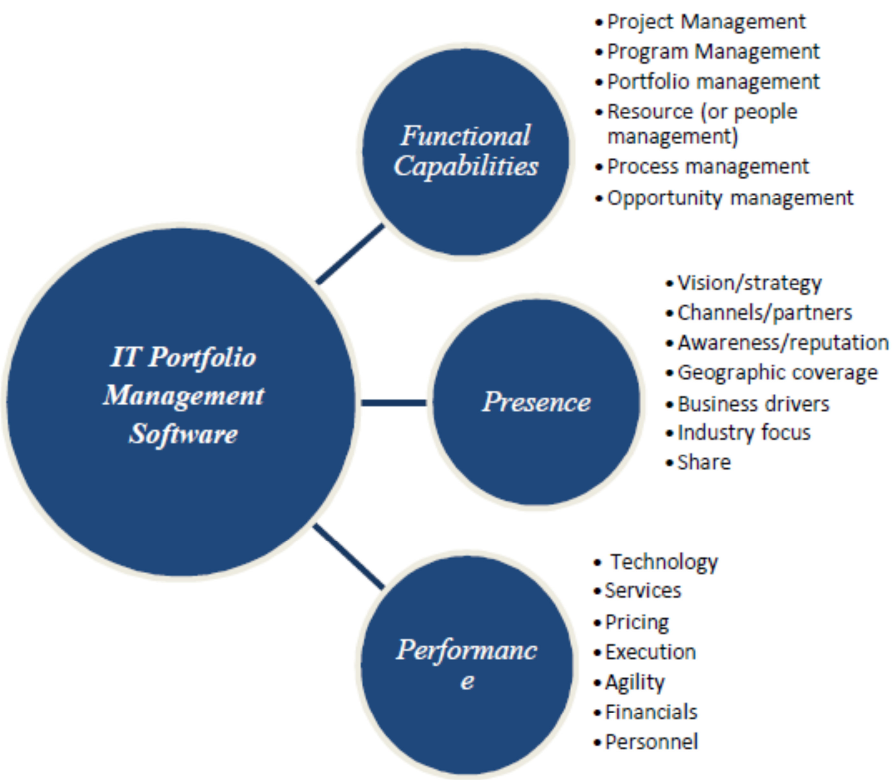

Figure1. Features and aspect of IT portfolio management software

Logically, the evaluation operation consists of a number of sequential steps and one should follow these steps to get the correct results. Some of these steps may require the evaluator to enter the fuzzy values. The final aim of the evaluation process is to get a result that refers to the most suitable ITPM satisfying the specified requirements. In any evaluation operation, the user should assign ratings to each feature to be used in the evaluation process. The following is a list of the steps necessary for a complete evaluation operation:

1) The user firstly should specify the features to be used in the evaluation process.
2) Then, the number of ITPM s to be included in the evaluation process is specified.
3) Now, the user should weigh each feature included in the features' group and this weight should depend on the degree of importance.
4) The system ranks each feature and this ranking process gives a degree of efficiency and performance.
5) The system multiplies each weight by the corresponding rank for all ITPMs.
6) Each multiplication result coming out of the same ITPM are added.
7) Each result that came out of the previous step is divided by the number of features entered in the first step. The group of results forms the group of grades for all ITPM s included in the evaluation process.
8) The system applies a maximization algorithm to find the maximum grade of all results. Consequently, the ITPM which gets the maximum value will be the required one.

This algorithm described here it can be applied equally to the evaluation of any other kind of information system [13].

5. Evaluation Method

5.1. Multi-attribute decision making method

Decision making is a process of selecting a particular option from a set of possibilities, so as to best satisfy the aims or goals of the decision maker (Efstathiou and Mamdani[14] and Rajkovic et al. [15]). One of the approaches to decision support, which is widely used in practice, is multi-attribute decision making (Keeney and Raiffa[16] and Chankong and Haimes[17]). The basic principle (see Table 1) is a decomposition of the decision problem into smaller,less complex sub problems[18].Every multi-attribute decision making problem has a group of criteria and alternatives. Consider that we have m criteria and n alternatives. Let C1. Cm refer to the group of criteria and A1,. . . , An refer to the group alternatives. The decision making table (Table 1) shows the standard of multi-attribute decision making methodology [19]. In this table, each row represents a criterion and each column describes the degree of performance of each alternative. The score aij describes the performance of alternative Aj for criterion Ci. A higher score value means a better performance. As shown in the table, the weights w1. . . wm are assigned to the criteria. For example, weight wi represents the importance of criteria Ci in the decision and it is always positive. Usually, weights represent the opinion of a single decision maker. On the other hand, the values x1, . . . ,xn are assigned to the alternatives in the decision and they are the final ranking values of the alternatives. Usually, higher ranking value means a better performance of the alternative, so the alternative with the highest ranking value is the best of all the alternatives. In addition to some monetary and elementary methods, the multi-attribute decision making methods are based on the Multi-attribute Utility Theory (MAUT) and Outranking Methods [19].

		X_1	.	.	.	X_n
		A_1	.	.	.	A_n
W_1	C_1	a_{11}	.	.	.	a_{m1}
.	.	.	.	.	.	.
.	.	.	.	a_{ij}	.	.
.	.	.	.	.	.	.
W_m	C_m	a_{m1}	.	.	.	a_{mn}

Table1. Concept of multi-attribute decision making

5.2. Linear weighted attribute model

The five models proposed by Anderson [20] for software selection are divided to two sets: compensatory and non-compensatory models. One of them is the Linear Weighted Attribute Model. In this model, each attribute used is given a performance rating, or weight. These weights are assigned to the attributes which represent the compensatory nature of this model. The other variable is the rank. It is the frequency degree of a specific attribute of one element from the evaluation members. The final score is defined as in this Eq.:

$$S_i = \sum_{i=1}^{n} (W_j R_{ij})$$

where Si is the score of element i, Wj is the weight assigned to criterion j, and Rij is the rank of i for criterion j. Thus, the final score for a package is the sum of the weighted performance scores. One of the most important models proposed by Anderson is Elimination by Aspects (EBA). This model ranks the attributes by the importance in descending order, and sets a minimum value to each attribute. Packages that do not conform to the minimum of the first attribute are eliminated; the remainder is tested against the second attribute's minimum, and so on. In this case, the Linear Weighted Attribute Model equation will give us the score of the ith system included in the evaluation operation. It results in the summation operation of multiplying the weights group by the corresponding ranks of the ith system. In fact, it is required to get an independent grade, or general score, for each LMS in the evaluation operation overall its features group. That is, the score should be common for all attributes in the operation, therefore, the result coming out of applying the Linear Weighing Attribute Model should be divided by the total number of attributers, or features included in the evaluation process. This is described by this Eq.:

$$G_i = \sum_{i=1}^{n} \left(\frac{W_j R_{ij}}{\text{n}} \right)$$

where n is the number of attributes.

As stated before, this equation gives us the general score of the ith ITPM in the evaluation operation of all attributes. This equation should be applied to each system included in the operation where the total number of systems is (m), see this Eq.:

$$G_i = \left(\sum_{i=1}^{n} \left(\frac{W_j R_{ij}}{\mathrm{n}} \right) \right)_{\mathrm{i=1}}^{\mathrm{m}}$$

where m is the number of ITPM's.

Applying the Linear Weighted Attribute Model equation to all systems in the evaluation operation, we get a group of scores for all systems. After applying the maximum method to the scoresthe system which takes the maximum score will be the one that we seek. The final equation for the evaluation operation becomes as in this Eq.:

$$\mathrm{MAX} \left[\sum_{j=1}^{n} \left(\frac{W_j R_{ij}}{\mathrm{n}} \right) \right]_{\mathrm{i=1}}^{\mathrm{m}}$$

where m is the number of ITPM s in the evaluation operation, n is the number of features in the evaluation operation, i, j are counters.

This section describes how the Linear Attribute Model equation was applied to the ITPM evaluation process. Here, we will call the attributes as the group features, and the evaluation elements or the alternatives as the ITPM s group which are included in the evaluation operation. The algorithm can be summarized by looking at Table 2 and recent Eq.

Assume we have these variables:

Group of features: F1, F2, . . . ,Fn
Group of LMSs: ITPM 1, ITPM 2, . . . , ITPM m
Weights values: W1, . . . ,Wn
Ranks values: R11, . . . ,Rmn

The following points should be observed before the algorithm is implemented:

1) The number of features (m) should be given integer data types.
2) The number of ITPM s (n) should also be given integer data types.
3) The weighing of features should use the fuzzy values from ''Zero" to ''One", where ''One" symbolizes the most important feature, and ''Zero" symbolizes the unimportant feature.
4) Ranking each feature of each ITPM should also use the fuzzy values from ''Zero" to ''One", where ''One" when the system is given a full mark on a specific feature, and ''Zero" when this feature is not included in this system [13].

Features group	F_1	F_2	. . .	F_j	. . .	F_n
Weights	W_1	W_2	. . .	W_j	. . .	W_n
ITPM$_1$ *ranks*	R_{11}	R_{12}	. . .	R_{1j}	. . .	R_{1n}
ITPM$_2$ *ranks*	R_{21}	R_{22}	. . .	R_{2j}	. . .	R_{2n}
.	.	.		.		.
ITPM$_i$ *ranks*	R_{i1}	R_{i2}	. . .	R_{ij}	. . .	R_{in}
.	.	.		.		.
ITPM$_m$ *ranks*	R_{m1}	R_{m2}	. . .	R_{mj}	. . .	R_{mn}

Table2. The representation of relations between weights and ranks in the decision making process

The evaluation process is explained below in detail (see Fig. 2):

1) User chooses the group of features to be included in the evaluation process. A total of 21 features are offered.
2) The system checks all of the ITPM s stored in its database. This step will return a group of systems depending on user's selected features. User's job here is to select the ITPM to be included in the evaluation operation.
3) This step is to weigh each feature inserted in the features group chosen in the first step. The weights given here will depend on the needs. The weighing method will use the values from 0 to 1. ''One" is for the most important feature, and ''Zero" is for an unimportant feature.
4) This step is to rank each feature with each ITPM depending on the features' description given by the

system. Here, ranks use the values from 0 to 1. ''One" when the system is given a full mark to its feature, and ''Zero" when the feature is not required.

5) This is the results step where all the mathematical evaluation operations are made and the system selects an ITPM.In addition to the best ITPM, the system provides information on:

a. The ITPM which scores the best grade.
b. Summary of all similar evaluation operations done before with the same group of features.
c. Full description of all ITPM s included in the process. Here, users can give their opinions and also see the opinions given earlier by other users.
d. The administrator's advice about the best ITPM.

Taking all results shown here into consideration, one can decide which ITPM suits best and satisfies the requirements. It is clear that these steps are very easy to the novice user and any special skills or specialized technical knowledge is not needed to use the system.

In future studies, researchers can develop a web base program for using this algorithm and doing the evaluation running on the Windows or Linux servers. The program database can update and include the last features of ITPM programs.

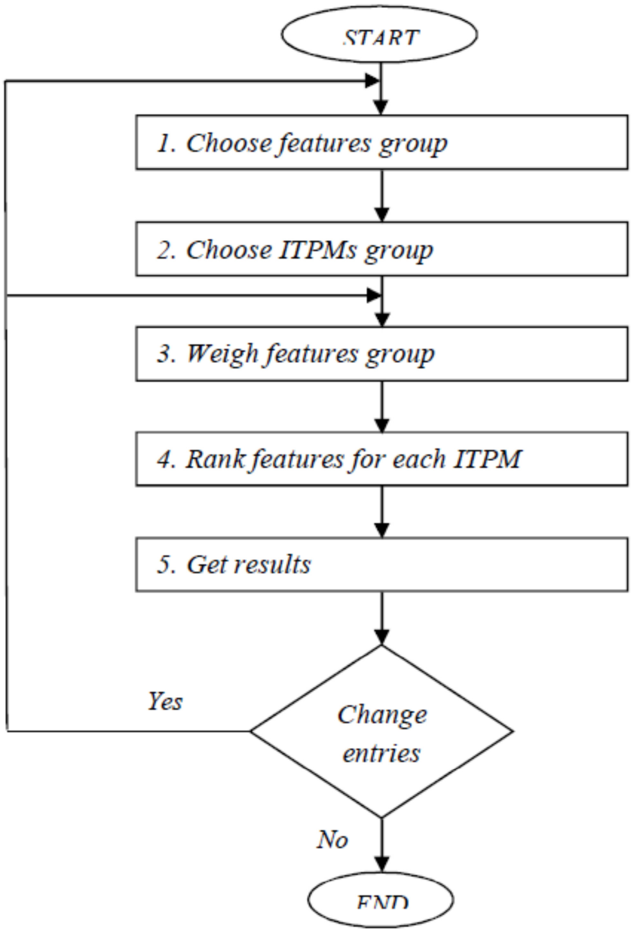

Figure2. The evaluation operation flowchart

6. Conclusion

The numbers of ITMP systems are increasing and there are now over 10 commercially available ITMP systems. It has now become an important task to choose the correct ITMP for distant purposes. This paper has described a Fuzzy logic algorithm that can be coded developed to use as a software evaluation of ITMPs and choose the best one satisfying the requirements. The software can also be used to make comparison of the various ITMPs before a selection is made. In summary, it would be more costly, more time consuming and more effort would be needed to evaluate ITMPs manually. In addition, in general it is easier to make mistakes with any kind of manual evaluation process. The fuzzy logic algorithm system that introduced by author on the other hand can carry out the evaluation process easily, efficiently, with little effort, instantly, and with no errors.

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