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Improved Technique by Integrating AHP-TOPSIS for Prioritization

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Abstract

Requirements prioritization is used to minimize risk during development of the software project, so that the most important requirements are implemented first. There are many prioritization techniques are available to prioritize the requirements, but the problem relies on choosing an appropriate technique that are suitable for people to prioritize medium to large numbers of requirements. Value Based Requirement Prioritization (VBRP) is one of the most widely used technique in the industry since it yields an accurate result and requires less sum of instance. To execute VBRP, the method of arrange Preference by Similarity to Ideal Solution (TOPSIS) is used as a framework. The project may contain hundreds or even thousands of requirements. Generally, all the requirements do not contain equal user satisfaction. The requirement prioritization is the process of managing the relative importance and urgency of different requirement based on the multi-criteria decision making method. In this project multi-criteria decision making techniques through the integration of Real-code population –based incremental learning (RPBIL) algorithm with AHP and TOPSIS. In which the weights of each criteria are calculated by analytical hierarchical process (AHP) and the final ranking is achieved by Technique For Order Preference By Similarity To An Ideal Solution (TOPSIS) by combination of population-based incremental learning (PBIL) algorithm.

Keywords: *Multi-Criteria Decision Making Method, Analytic Hierarchy Process (AHP), Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), Real-code Population-Based Incremental Learning(RPBIL).*

1. INTRODUCTION

In the software growth process, making decisions among a number of or many options is very common. Projects are oftenfaced with many constraints such as budgets, time to market and person income. The projects contain more supplies than they implemented in one product release, stakeholders need to make decisions on which supplies is to be implemented first.

Even project may contain hundreds or even thousands of chuck. Usually, not all the requirements affect user's satisfaction equally. Further, it is often not obvious which requirement strongly affects user's satisfaction among hundreds or thousands of chuck. When only one team member is involved in the project, it is easy to make decisions among them, because it needs only one stakeholder's opinion. When more than one Stakeholder is involved in the project, it could be harder to make decision. Because the different stakeholders have different perspectives.

Requirements prioritization is an approach that can uncover the most important requirements to maximize the stakeholder's satisfaction [8].So that the requirements prioritization has been recognized as one of the most important decision making processes in the software development process.

Multi-Criteria Decision making (MCDM) is the study of identifying and choosing alternatives based on the values and preferences of the decision maker. In which the decision making by the technique AHP and TOPSIS method. The Analytical Hierarchy Process is a multi-criteria decision-making technique that uses a pair wise comparison matrix to compute the relative value of requirements with respect to one another [15]. The basic idea of AHP is to calculate the priorities of requirements by comparing all unique pairs of requirements to estimate their relative importance and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) method is basic principle is that the chosen alternative should have the shortest distance from the ideal solution and the farthest distance from the negative-ideal solution.

2 RELATED WORKS

2.1Multi Criteria Decision Making (MCDM)

Multi Criteria Decision Making (MCDM) provides strong decision making in domains where selection of best alternative is highly complex. MCDM method helps to choose the best alternatives where many criteria have come into existence, the best one can be obtained by analyzing the different scope for the criteria, weights for the criteria and the choose the optimum ones using any multi criteria decision making techniques.

2.2TECHNIQUES OF PRIORITIZATION

Several techniques used to prioritize requirements. In which the multi-criteria decision technique is categorized based on nominal, ordinal and ratio scale.

2.2.1Nominal Scale

For nominal scale methods, requirements are assigned to different priority. And the groups, with all requirements in one priority group being of equal priority.

- Numerical assignment

Numerical assignment is mentioned by a number of studies [6,10].It is a simple requirements prioritization technique based on grouping requirements into different priority groups. The number of priority groups can vary, but three is common. For example, requirements can be grouped as “critical”, “standard”, and “optional”. The results of numerical assignment are on a nominal scale. All requirements contained in one priority group represent equal priority. No further information shows that one requirement is of higher or lower priority than another requirement within one priority group.

- MoScoW

MoScoW is a kind of numerical assignment and it is mentioned by DSDM Consortium [2,3].MoScoW currently incorporates into the software development methodology DSDM (Dynamic Systems Development Method). The idea of MoScoW is that it groups all requirements into four priority groups “MUST have”, “SHOULD have”, “COULD have”, and “WON’T have”[8].

• “MUST have” means that requirements in this 9group must be contained in the project. Failure to deliver these requirements means the entire project would be a failure.

• “SHOULD have” means that the project would be nice if it contains the requirements in this group.

• “COULD have” also means that the project would be nice if it contains these requirements. But these requirements aren’t more important than the requirements in the “SHOULD have” group.

• “WON’T have” is like a “wish list”. It means that the requirements in this group are good requirements but they will not be implemented in the current stage. They may be implemented in the next release.

The results of MoScoW are on a nominal scale. All requirements contained in one priority group represent equal priority. No further information shows one requirement is of higher or lower priority than another requirement within one priority group.

2.2.2 ORDINAL SCALE

Ordinal scale methods result in an ordered list of requirements.

- Simple ranking

Ranking elements is quite intuitive for most people as it can happen in people’s lives. Berander and Andrews [3,6] mention simple ranking is that n requirements are simply ranked from 1…n, with the most important requirement ranked 1 and the least important requirement ranked n [6]. This is a common requirements prioritization technique based on an ordinal scale.

- Binary search tree

The idea of the BST method for ranking requirements is that each node represents a requirement, all requirements placed in the left sub tree of a node are of lower priority than the node priority, and all requirements placed in the right sub tree of a node are of higher priority than the node priority [5]. When performing the binary search tree method, one requirement is chosen first as the top node. Then, select one unsorted requirement to compare with the top node. If that requirement is of lower priority than the top node, it searches the left subtree, but if that requirement is of higher priority than the top node, it searches the right subtree. The process is repeated until no further node needs to be compared and at that time the requirement can be inserted into the right position.

2.2.3 RATIO SCALE

The results of ratio scale methods can provide the relative difference between requirements.

- Hundred Dollar Method

Hundred dollar method (also called cumulative voting) which is mentioned by Berander and Andrews [3,6], is a simple method for prioritizing requirements. The idea behind hundred dollar method is that each stakeholder is asked to assume that he/she has $100 to distribute to the requirements. The result is presented on a ratio scale. The ratio scale result can provide the information on how much one requirement is more/less important than another one.

- AHP

The Analytical Hierarchy Process is a multi-criteria decision-making technique that uses a pair wise comparison matrix to compute the relative value of requirements with respect to one another [15]. The basic idea of AHP is to calculate the priorities of requirements by comparing all unique pairs of requirements to estimate their relative importance. In other words, the person performing the comparison has to decide which requirement is of more important

- TOPSIS

Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) method is presented in Chen and Hwang [13,14].The basic principle is that the chosen alternative should have the shortest distance from the ideal solution and the farthest distance from the negative-ideal solution.

3. PROBLEM DEFINITION

The technique which is used for selection under Multi- Criteria Decision Making (MCDM) approach is to reduce the amount of manual work done by the decision-makers to select an efficient and robust for the softwaredevelopment.MCDM approach refers to making preference decisions over the available alternatives using specified criteria. The aim of MCDM is

- To help decision- makers to choose the best alternatives.
- To sort out the alternatives that seems good among the set of available alternatives.
- To rank the alternatives in decreasing order of performance.

The task of selection is often assigned under pressure and evaluators may not have time or experience to plan selection process in detail. Hence, selecting based on user need is time-consuming. Thus, a need for an efficient approach was felt which will solve all the problems.

4. APPLIED METHODS

A. Analytical Hierarchy Process (AHP)

The Analytical Hierarchy Process is a powerful and flexible multi criteria decision making method that can be applicable in variety of decision making situation from simple to complex situation. It is specially used to quantify managerial judgment of the relative importance of each of several conflicting criteria used in decision making process. In this method a problem is put into a hierarchical structure as follows:

a) The overall objective of the decision.

b) Factors or criteria for the decision.
c) Sub factors under those factors.
d) Decision option.

The steps involved in AHP model are as follows:

Step-1: List the overall goal, criteria and decision alternatives.

Step-2: Develop a pair wise comparison matrix. Rate the relative importance between each pair of decision alternatives and this rate is based on Saaty's nine point scale[15].

Step-3: Develop a normalized matrix by dividing each number in a column in the pair wise comparison matrix by its column sum.

Step-4: Develop a priority vector. Average each row of the normalized matrix. The row average forms the priority vector of alternative preferences with respect to the particular criterion.

Step-5: Calculate the consistency ratio [CI, RI and CR]. Calculate the eigenvector or the relative weights and for each matrix of order n. Compute consistency ratio using, RI= Random Inconsistency = and

CR= The acceptable CR range varies according to the size of matrix. That is 0.05 for the 3 by 3 matrix, 0.08 for a 4 by 4 matrix and 0.1 for all larger matrices, n>=5.

Step-6: Develop the overall priority vector by multiplying normalized matrix of criteria with the priority matrix of decision alternatives which is formed with priority vectors of different criteria. With this priority values judgment can be taken. [3,7].

Table. 1: Saaty's 9-Point Scale of Pair-Wise Comparison

Scale	Compare factor of i and j
1	Equally Important
3	Weakly Important
5	Strongly Important
7	Very Strongly Important
8	Extremely Important
2,4,6,8	Intermediate value between adjacent scales

B. Technique For Order Preference By Similarity To An Ideal Solution (TOPSIS)

TOPSIS assumes that are m alternatives (options) and n attributes/criteria and have the score of each option with respect to each criterion. Let xij score of option i with respect to criterion j. We have a matrix $X = (x_{ij})$ m×n matrix. Let J be the set of benefit attributes or criteria (more is better) and J' be the set of negative attributes or criteria (less is better).

Step 1: Construct normalized decision matrix.

This step transforms various attribute dimensions into non-dimensional attributes, which allows comparisons across criteria.

Normalize scores or data as follows:

$r_{ij} = x_{ij} / (\Sigma x^2_{ij})$ for $i = 1, \ldots, m; j = 1, \ldots, n$

Step 2: Construct the weighted normalized decision matrix.

Assume we have a set of weights for each criteria w_j for $j = 1,\ldots n$. Multiply each column of the normalized decision matrix by its associated weight. An element of the new matrix is: $v_{ij} = w_j r_{ij.}$

Step 3: Determine the ideal and negative ideal solutions.

Step 4: Calculate the separation measures for each alternative.

The separation from the ideal alternative is:

$$S_i^* = [\Sigma (v_j^* - v_{ij})^2]^{½} \qquad i = 1, \ldots, m$$

Similarly, the separation from the negative ideal alternative is:

$$S'_i = [\Sigma (v_j' - v_{ij})^2]^{½} \qquad i = 1, \ldots, m$$

Step 5: Calculate the relative closeness to the ideal solution C_i^*

$C_i^* = S'_i / (S_i^* + S'_i)$, $0 < C_i^* < 1$

Select the option with C_i^* closest to 1.

CONCLUSION

Requirement selection decision becomes more important strategic decision in complex and competitive business life. Choosing the suitable requirement involves the evaluation of subjective and objective factors. The decision criteria in requirements are origin of quality, availability, cost, delivery requirements, and cost of conveyance, quality certificates and reliability. Using multi criteria decision techniques such as AHP and TOPSIS which provides a useful approach for requirement prioritization that select the best requirement.AHP and TOPSIS methods are combine to select the suitable requirement from the available alternatives. It is shown that final TOPSIS ranking is done by criteria weights .The TOPSIS is a successful MCDM method for ranking the alternatives. AHP-TOPSIS determines the appropriate requirement by providing the most customer satisfaction for the criteria identified in the software development.by the combination of RPBIL algorithm it shows the better performance among many technique.

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