



Survey Article

A Survey of MCDM-Based Software Engineering Method

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ABSTRACT

Multi-criteria decision making (MCDM) is an operation research subfield (OR). Decision-making is primarily a process involving various actors, including individuals, groups of individuals, institutions, and the state. As a discipline, multi-criteria decision-making is relatively new. Many researchers have devoted their time to developing new MCDM models and techniques since the 1950s and 1960s, when the foundations of modern multi-criteria decision-making methods were laid. Research and development in the area have intensified recently and appear to be developing tremendously. Few attempts have been made to systematically convey the theoretical foundations and advancements of multi-criteria decision-making systems, despite the widespread and intense development. The framework for evaluating judgments and the methodological options are still up for debate. In this paper reviews of MCDM/MADM technologies will be included describing their scenarios. Making a decision that is more appropriate than others to solve a particular problem is the goal of decision-making (DM), so this study presents a review of the advantages and disadvantages of different decision-making techniques, specifically in the field of software engineering.

1. INTRODUCTION

The goal of decision-making (DM) is to make a decision that is more appropriate than others to solve a particular problem. And this is done by studying potential predictions and then choosing from them [1]. These predictions are analyzed either using statistical, quantitative or survey analyses and then coming up with a decision that gives the best decision. Multi-criteria decision making or in abbreviation MCDM focuses on giving an ideal result when sufficient data is available by entering and setting priorities. It is one of the important factors that must be taken into consideration while increasing the chances of alternatives. What makes the system more complex is the presence of abundant participation and contribution of stakeholders in the system. Alternatives from a specific group There are several classifications not only MCDM, Multi-attribute The decision-making based on MADM has a great role in helping to choose alternatives and the theory of multiple attribute utility which is an abbreviation can be written as "MAUT" can be used smoothly to get the analysis of preference This theory and UAT can works correctly with the trait independence, the last one use the MAUT with the linear and regression. Multiple Objective Decision-Making MODM is used with continuous solutions when there are two or more two criteria. The modern method of multi-criteria decision making provides a platform for the decision-maker to find

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a solution close to reality, determining the decision or giving a decision that is close to reality depends on the type of application or engineering software that is used to solve the problem and the topic for which a decision is to be found. Nowadays, engineering software has developed greatly and become more complex. Therefore, applying decision-making to this type has become very necessary to solve the complexity of today's problems [2, 3].

2. REVIEW OF LITERATURE

For many different applications, many decision support methods have been implemented on these different applications, which were greatly beneficial in decision-making. Decision-making methods were not new, as they appeared since 1960, and work continued to apply decision-making to various applications, and a large number of requests to make decisions led to the emergence of what is known as MCDM, depending on what people need today to make decisions, decision-making techniques can be used to arrive at a solution, either by using linear/non-linear programming, or techniques of discrete optimization. Abbas Marandi, et al. (2017). The aim of their studies was submitting a study about multiple criteria decision-making techniques and their applications, in several different fields such as clean energy engineering software, environment, knowledge management software, soft computing engineering software, and other matters. The data of their research were 393 articles and these samples were taken from 2000-to 2014, those articles were published in 120 journals. The research method was dividing the articles into 15 groups depending on several things like the research type, date of publication, the authors, and the tools used. The results indicated that researchers published more articles in 2013 than in the rest of the years also, the *European Journal of Operational Research* was classified by researchers as the journal, which included 70 publications related to this study, and thus it is considered one of the important journals, the results also stated that the hybrid MCDM in integrated and AHP with the individual tools were rated as the 1st and 2nd methods in use [4]. Vaidya, OS& Kumar, (2019). The aim of the research was a conducted survey on AHP technology focused on engineering software, e-commerce, and government sectors, as well as clean energy management and other things. The data of the research was many highly reputable papers and research papers have been published in high-ranked journals. The research method was taking the selected papers and classifying them according to the field, year of publication, and country of origin. The result of the research was to make a reference for the AHP program to help the researchers in their work in a concise manner [5]. Achimugu, et al. (2020). The aim of the research published many details about the review and study of the literature whose purpose is to determine the priorities of engineering software requirements based on the help of MCDM. The data of the research was fifty-three studies that related to the subject of the research were selected. The research method was divided into the fifty-three papers that were selected as follows: 30 studies dealing with the possible effects of male hypogonadism, 9 studies related to examining risk factors, and finally 14 studies about possible diseases that may accompany the main disease. The result of the research indicated that men who suffer in old age or obesity, and perhaps the general weakness in the physical structure, in fact, they are more likely to get this disease, and this injury may be a syndrome for them for life [6]. Vicent, et al. (2019). The aim of the research was to develop proposed methods for decision-making in a bridge design engineering software, as well as to review the different methods of decision-making for each stage of bridge construction. The data of the research exceeded seventy studies or research papers that are specialized in this field or related to decision-making in software engineering. In the research method when researchers apply the research method noted that a large number of them (more than 20 research) make decisions using the AHP method, and the rest depend on the vague AHP method, and thus this AHP is considered one of the basic and dependent methods of decision-making, in fact, it is used for decision-making with many applications, such as choosing a decision in engineering software, the tools that used with those engineering software, models and evaluation for this software, as well as project management and systems monitoring. The result of the research was just a brief description of the methods that were used [7]. Jusoh, et al, (2014). The aim of the research was to use AHP technology to make a decision to choose open-source engineering software this choice was based on unsupported criteria by the stakeholders, also made a proposal about the adoption of QSS and the criteria for decision methods. The data of the research was open-source software toolkit (MyOSST) v1.0. The research method was applying AHP to the selection process to make the users take a decision about QSS products. The result of the research was that the tool that has been proposed to help users make a decision has the ability to seamlessly identify QSS-type products [8]. Srivastava and Ray (2019). The aim of the research was based on the Fuzzy Analytical Hierarchy Process (FAHP), which it was used to make a comparison between the automated functional and regression testing tools as well as compare what was produced by experts from CMM institutions that hold level number five. The data of the research was the automated functional and regression testing tools. The research method was applying a new category from the fuzzy aggregator's group. The result of the research was found that FAHP had the ability to assist the program's project manager and the software checker in diagnosing and evaluating competitors of software testing tools and this will have the ability to give information to providers or vendors of software testing to improve the quality of their products [9]. Weial (2022). The aim of the research was to submit a proposal for a new method, which is to combine AHP with a fuzzy assessing the risks of e-commerce transactions. The

data of the research was C2C which is one of the types of Internet service providers in China also it is considered one of the e-commerce transactions. The research method was analyzing a huge amount of C2C model data in China and also the researchers have implemented FAHP in matters related to software electronic commerce as well as analyzing the extent of the security and privacy risks of this type of software transaction. The result of the research was, the researchers have led to the fact that this electronic system, represented by C2C, is a clear system for users because the information in it is inconsistent, as well as the risk of occurrence in it is great, so its evaluation has become very important [10]. Challa, et al (2019). The aim of the research was the measurement of software quality and its quantitative evaluation of software companies. The data of the research was ISO/IEC 9126, McCall's model, and Boehm's Model. The research method was making many attempts to find software quality standards using the forms ISO-IEC, McCall, and Boehm depending on the technology of FAHP. The result of the research was found the unpredictable nature of software quality so they recommended the use of the ambiguous fuzzy-multi-criteria approach [11]. Sarfaraj et al. (2021). the aim of the research was to present a fuzzy analytical hierarchy and use it to solve a problem MCDA also worked on fuzzy logic and linked it to the well-known method AHP. The data of the research was AHP technology with Fuzzy. The research method was used of AHP with fuzzy to diagnose the appropriate web for the development platform and the proposed model was taking many things into account such as cheap compatibility and cost to choose the best engineering software. The result of the research was considered the best platform for the web is a database query and PHP language compared to others [12]. Sumeet and Yawinder, et al (2020). The aim of the research was to use different applications of engineering software through which the application of MCDM and FAHP can be used. The research method was to use FAHP to choose high-quality engineering software. These problems addressed the establishment of choosing the appropriate decision for engineering software, such as finding or finding a web development platform, and what the factors of the prosperity and quality are. About their result researchers said "it is possible to rely on the FAHP theory as the best way to make a sound decision in choosing engineering software applications" and the Fuzzy-AHP can be well implemented in the field of software engineering [13]. Sahaaya, et al (2019). The aim of the research was to suggest a web-supported decision support model based on ELECTRE to specify the prioritization. The data of the research was the ELECTRE which is considered a decision-making model. The research method was used the ELECTRE method, which is a method that depends on the priorities of requirements, also this method depends on the decision-making analysis and it has many criteria for managing the system requirements the researchers here took 100 points from several stakeholders these samples were all entered into the aforementioned system. The result of the research was the researchers found in the system the results showed that it was clear that the system is characterized by the cost of implementation and the number of working hours, But the problem here is that the researchers chose a few points, so the researchers recommended in their future work that these points should be increased to give a clearer picture of the choice of decision [14]. Vanessa and Silva et al. (2019). The aim of the research was to rely on the multi-criteria to build the SMARTER method which is considered one of the useful ways for the decision support for small software that serves the small and medium enterprises. The research method that used is the researchers used this method simple multi-attribute rating technique exploiting ranks whose name can be abbreviated "SMARTER", their research was targeting small and medium software giving them a decision to make them fit the market requirements they used common forms such as DSDM crystal and XP2 the results were arranged according to the values that have multiple attributes. The result of the research was arranged in an easier and more effective way, depending on the cost however, they noticed that this leads to a lack of information that gives a more accurate choice. As for the future work of these researchers, they have suggested using a numerical factor that provides better selection results that substitute for the usual methods [15]. Javed and Khan, et al. (2017). The aim of the research was to propose a new methodology that can prioritize dependent and independent requirements based on the ANP algorithm. The data of the research were analyzed of different techniques. The research method that used is the researchers used the well-known engineering program MATLAB to simulate, and they determined the requirements for the ANP algorithm. The result of the research is the researchers said that it ANP algorithm is considered one of the best algorithms suitable for setting priorities, and this is due to its consistent results, and its results, as is known, depending on the scale ratio. And in their future work, they said that the use of this algorithm in the industry gives more flexibility to determine priorities during the development phase of engineering programs [16]. Hadeel and Elsherbeiny, et al (2017). The aim of the research was is to use statistical analysis to prioritize requirements for large-scale software. The data of the research was the some of the statistical engineering software analysis. The research method was used the statistical engineering software analysis to determine or prioritize system requirements, which in turn include a large number of stakeholders this study was conducted on 75 stakeholders and submitted 48 requests, 10 projects, and 104 specific requests the classification was done using three methods, the rate ranged from zero to five RateP, RankP, and PointP respectively. The result was the statistical packages are an accurate way to get results in addition to being easy to use [17].

3. THE METHODS OF MCDM

3.1 Analytical Hierarchical system (AHP)

became proposed by way of Thomas Saaty 18 .In 1980, to decompose problems right into a hierarchical shape and a pairwise assessment is finished over the options to decide on the preferences. AHP unearths wide programs in many fields of complex, real international challenges comprising a wide variety of alternatives. The issue is assigning the weights to the options ended in fuzzy good judgment implementation, resulting in a fuzzy AHP technique [19]. In place of evaluating values, fuzzy common sense resulted in the intermediate values which made an assessment of alternatives less difficult. Altogether AHP works at the idea of impartial standards.

3.2 Elimination and preference Translating a set of rules (ELECTRE)

family includes ELECTRE I, II, III, IV, IS, and TRI methods which seem comparable but range in the way decision hassle is solved. The ELECTRE turned into delivered by means of Benayoun, Roy, and Sussman in 1968[20]. The method became later evolved by means of Bernard Roy (Roy, 1996). ELECTRE III is considered to be greater efficient in ranking evaluation. This method specifically relies upon the assessment of the concordance index and discordance index. Ascending and descending pre-order is finished after which the alternative ranking is evaluated [21].

3.3 VIKOR changed initially

advanced by Serafim Opricovic in 1979 and a utility was published in 1980 to clear up selection issues with conflicting criteria. The approach is based totally on aggregation and decision representation near a great answer as that in TOPSIS. In VIKOR linear normalization technique is used 21. Its miles a compromise ranking technique imparting most application for most of the people and the minimum software with minor alternatives for the individual [22].

3.4 Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS)

which was introduced by Hwang and Yoon in 198122 .is used along with AHP to increase the efficiency in decision making. TOPSIS is based on agregation and represents a decision close to an ideal solution. The method uses vector normalization to calculate the shortest distance from the positive ideal solution and the farthest distance from the negative ideal solution. Initial work with the Fuzzy TOPSIS method for group decision-making was implemented by Chen in 2000. In this work, decision makers use fuzzy sets to allot the semantic values to the alternatives [23].

3.5 Analytic network process (ANP) method

developed in 1996 allows the dependencies between the standards. Maximum of the troubles cannot be organized in hierarchical form due to the contribution from exclusive stages. ANP is represented with the aid of a network, with the cycles interconnected to the device. The important downside of ANP is uncertainty in human judgment which results in a deficiency in the assessment of essential criteria. Fuzzy ANP derives nearby weights using the fuzzy choice programming technique. This local weight paperwork first-rate matrix to attain worldwide weights for rating the options [24].

3.6 Wieger's method with fuzzy logic

is used for requirement prioritizing in the current paper. The technique relies upon on benefits, penalties, risks, and fees of every requirement. Weights are evaluated in phrases of the club characteristic. Implementation has completed the use of MATLAB for club characteristic and clothier inference rules to determine the concern based totally on the fuzzy common sense. It is considered to be greater appropriate for the actual-time implementation, as the degree of significance of necessities is very excessive for the duration of the improvement degree. The development within the MCDM techniques shows that fuzzy model of the techniques is greater appropriate because of the vagueness in the selections made by way of the stakeholders and the anomaly in the requirement [25]. Most of the work shows that fuzzy ideas can higher manage uncertainty during complicated selection making.

3.7 SMARTER (smart Exploiting Ranks) technique

, based totally on MAUT (multiple characteristic utility idea) which is specifically used for preference evaluation. This technique belongs to clever (easy multi-characteristic score method) proposed by means of Edwards and Barron, a family of compensatory methods. SMARTER makes use of Rank of Order Centroid (ROC), for elicitation of weights, which converts ranking standards into numerical weights. SMARTER is divided into distinctive steps; defining the aim and

spotting choice makers, standards placing, defining purpose opportunity, comparing standards and alternatives, evaluation of outstanding alternatives, calculating one-dimensional fee feature and in the end weight swing and ROC method implementation [26].

3.8 PROMETHEE: its complement Geometric analysis for the interactive resource (GAIA)

evolved in the early 1980s are majorly used to conquer alternate high-quality solutions to reap goals alternatively offering a proper decision. These methods help the developers in designing the framework for the process, analyzing the answer, and prioritizing the alternatives [27].

4. CONCLUSION

Decision assist methods are majorly used in lots of special regions along with electricity machines, enterprise sectors, software engineering, and so on. Recent tendencies show decision-making techniques have made researchers innovate new methods to acquire extra-equipped results. The observation highlights the application of multi-standards choice-making strategies in the one-of-a-kind levels of the software engineering life cycle. The latest survey shows most of the paintings with a mixture of to be had MCDM strategies to enhance on the performance of selection making. Universal work shows that the AHP and the bushy AHP are greater often used strategies. That is especially because of simplicity in information and simplicity of implementation, forming a sturdy base for decision-making strategies. Current paintings also indicate the implementation of TOPSIS, SMARTER, ELECTRE, PROMETHEE, and Fuzzy Wiegert's methods for specific utility in software program engineering. Most of those conventional strategies have obstacles while used for fixing real-world troubles. As a consequence, choice-making ought to take into account the complexity to cope with real run time structures. Future paintings indicate a hybrid model of choice-making technique, combining critical capabilities from current methods to boom the performance and consistency of the software program existence cycle model.

Conflicts Of Interest

No conflict of interest.

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