REVIEW ON FUZZY SET THEORY FOR SOLVING VARIOUS MCDM PROBLEMS

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Abstract: Design concept evaluation is a critical stage in the product development which has significant impact on the downstream process in product development thus on success of new product. Design concept evaluation is widely recognized as a complex multi-criteria decision-making (MCDM) problem involving various decision criteria and large amount of data which are usually imprecise and subjective. This paper proposes a new decision-making method to evaluate product design concepts based on the distance be- tween interval vectors each alternative and positive and negative ideal reference vectors. Rank of design concepts is obtained by calculating interval-based relative closeness index for each alternative. In this method, to deal with uncertainty and vagueness of data in the primary phases of product design, performance of design concepts with respect to quantitative and qualitative criteria are concurrently evaluated using rough set and fuzzy set. The weights of criteria used in the evaluation are obtained using the extent analysis method on fuzzy AHP. In final, the conclusions of our method are represented and some future directions are proposed to improve the model.

Index Terms: interval rough SAW; sustainable supplier; procurement; MCDM

I. INTRODUCTION

Customers are constantly seeking products with higher quality, lower price, shorter delivery time and higher satisfaction. In a highly competitive environment, many companies have focused product development process to respond customers' growing needs. New product development (NPD) process is a set of all activities required, from identification of market opportunity, to delivery of a product (Ulrich & Eppinger, 2011). These stages mainly include customers' needs analysis, setting target specifications, concept generation, concept evaluation and selection, concept testing, and setting final specifications. The success of new products relies to a great extent on the performance of the product development team in dealing with these stages. A good design process should guarantee both the fulfilment of customer needs and business goals. Therefore, the evaluation of new product concept has long been recognized as one of the most critical decisions for the success of product development because of significant effects on the downstream development activities.

Although product architecture is normally set up during the early stages of the product development cycle, it influences decisions in the next processes in the domains of product, process and supply chain (Fix son, 2005). It is estimated that product and process design influences 80% of manufacturing costs, 50% of quality, 50% of order lead time, and 50% of business complexity (Child, Dietrich's, Sanders, & Wisniowski, 1991; Shehab & Abdalla, 2001). Design concept evaluation is a multi-criteria decision-making (MCDM) process which is recognized as an effective technique in solving the NPD selection problem. Each design concept evaluation problem should consider customer needs, factors involving in life cycle of product and business constraints. In the early design stages, the evaluation of design concepts is difficult to precisely express by crisp data because the available information is usually imprecise, incomplete or subjective. In many cases in design concept evaluation problem, quantitative criteria (e.g. cost) and qualitative criteria (e.g. aesthetic) are needed to be simultaneously considered. Therefore, an effective method for the evaluation of design concepts which considers various criteria as well as uncertainty and vagueness in information in the early stages of design process is very necessary. This paper develops a novel method to rank design concepts considering quantitative and qualitative criteria and uses theories of rough set and fuzzy set to deal with uncertainty and vagueness in the problem. The method develops an interval-based relative closeness index to rank design concepts based on distance be- tween performance of design concepts with respect to quantitative and qualitative criteria and positive and negative ideal reference vectors.

Fuzzy sets are generalizations of conventional set theory introduced by Zadeh as a mathematical way to represent vagueness in everyday life. A fuzzy set assigns to each possible individual in the universe of discourse, a value representing its grade of membership in the set [1]. It is

concerned with the degree to which events occur rather than the likelihood of their occurrence. Fuzzy logic is most successful in situations with very complex models, where understanding is strictly limited and where human reasoning, human perception, human decision making are inextricably involved. Fuzzy sets play an important role in human thinking, particularly in the domains of pattern recognition, communication of information, decision making and abstraction.

This present work describes the designing of improved version of fuzzy set theory and its application in MCDM problems. The basic concept related to fuzzy set theory and the process carried out in it was explained. Following that the concept and importance of decision making process in various approach was discussed. Some of the research work related to the use of fuzzy set theory in various application had been reviewed. In addition to it the stepwise procedure for the proposed methodology was explained. Finally, the expected outcome after implementation of the proposed system was discussed.

II. LITERATURE REVIEW

Chung-Hsing Yeh et al. had built up another way to deal with supportable arranging of e-squander reusing exercises for meeting the best manageability interests of an e-reusing organization. A fluffy multi rules dynamic calculation was created to assess elective reusing exercises of an e-squander reusing work as far as their corporate maintainability execution on recognized manageability models under the ecological, monetary, and social measurements. A progression of ideal weighting models are created to decide the ideal loads for the three manageability measurements and their related standards. In light of an e-reusing organization's emotional manageability inclinations, the ideal loads mirror the best corporate maintainability execution of the e-squander items prepared by the organization under its present operational settings. The methodology speaks to a unique commitment to the methodological advancement of weighting the three corporate manageability measurements for arranging choices. Practically speaking, it furnishes e-reusing organizations with a proactive system for consolidating the idea of corporate supportability into their normal arranging choices.

Santoso Wibowo et al, had structured a multi-measures collective choice creation approach for viably assessing the exhibition of e-squander reusing programs under vulnerability in an association. Intuitionistic fluffy numbers were utilized for sufficiently speaking to the emotional and uncertain appraisals of the chiefs in assessing the overall significance of assessment rules and the exhibition of individual e-squander reusing programs as for singular measures in a given circumstance. An intuitive fluffy multi-models dynamic calculation was created for encouraging accord working in a cooperative choice creation condition to guarantee that all the enthusiasm of individual leaders had been suitably considered in assessing elective e-squander reusing programs as for their corporate supportability execution. The created calculation was then joined into a multi-rules choice emotionally supportive network for making the general execution assessment process successfully and easy to utilize.

Hasan Dalman et al had created fluffy based methodology for settling multi objective multi thing strong transportation issue. A multi-objective multi-thing strong transportation issue (MOMISTP) with boundaries, e.g., transportation costs, supplies, and requests, as trapezoidal fluffy factors was defined. In this MOMISTP, there were impediments on certain things and transports with the goal that some unique things can't be conveyed by methods for some extraordinary movements. With the utilization of the closest stretch estimation of trapezoidal fluffy numbers, a span programming model was built for the fluffy MOMISTP and afterward this model was transformed into its deterministic structure. At that point, another span fluffy programming approach was created to acquire the ideal arrangement of the issue.

P. Senthil Kumar et al., had created fluffy and intuitionistic fluffy set related calculation for taking care of enhancement based issue. At that point, with the assistance of the created calculation the ideal arrangement of the fresh, fluffy and intuitionistic fluffy improvement issues are resolved. Another hypothesis identified with type-2 fluffy/type-2 intuitionistic fluffy enhancement issues was created and demonstrated. Some new and solid outcomes identified with type-2 fluffy/type-2 intuitionistic fluffy streamlining issues were introduced. To outline the technique, some genuine numerical models were introduced. Created article furnishes seven completely worked models with screen captures of yield synopses from the product utilized in the calculations for better understanding. The benefits of created approach when contrasted with other existing work were additionally determined. Detail examinations of the near investigation also the conversation were given. To show the benefits of the proposed approach, prevalence examination was talked about. Examination investigation and the upsides of the created administrators were likewise talked about.

Milagros Isabel Cova et al., had contemplated the way toward building a fluffy set scale so as to esteem laborers support and their learning through a specialized improvement venture in metallurgical plants. The procedure begins with a down to earth question which originates from laborers. Investment was organized in three subsets: support in arranging, in structuring and in actualizing the improvement venture. These three subsets were collected in a worldwide cooperation set.

Learning was organized in two subsets: individual and gathering learning as fluffy derivation framework Mandami type. Investment (causal condition) comprises a subset of accomplished learning (the result), an adequate yet a bit much condition for the result. This subset connection was profoundly reliable offering help for the announcement "participatory activities empower significant learning" among laborers and association.

Harish Garg et al. had presented fluffy based method for taking care of issue identified with unwavering quality in enhancement issue. In structuring period of frameworks, plan boundaries, for example, segment reliabilities and cost were regularly under vulnerabilities. In this current work boundaries are considered as loose regarding triangular span information. The questionable multi-target enhancement model was changed over into deterministic multi-target model including left, focus and right span capacities. A clashing nature between the targets was settled with the assistance of intuitionistic fluffy programming procedure by thinking about direct just as the nonlinear level of enrollment and non-participation capacities. The resultants max–min issue had been illuminated with molecule swarm streamlining (PSO) and contrasted their outcomes and hereditary calculation (GA). At long last, a numerical case was introduced to show the presentation of the created approach.

Ding-Hong Peng et al. had introduced a summed up reluctant fluffy synergetic weighted separation (GHFSWD) measure, which depends on the summed up reluctant fluffy weighted separation (GHFWD) measure and the summed up reluctant fluffy arranged weighted separation (GHFOWD) measure. Separation and likeness measures for reluctant fluffy sets and explored some alluring properties and unique cases. The GHFSWD measure not just sums up both the GHFWD and GHFOWD quantifies just as the basic reluctant fluffy separation measures, yet in addition mirrors the significance degrees of both the given individual separations and their arranged positions. At that point, in light of the characterized ideas of positive perfect reluctant fluffy set and negative perfect reluctant fluffy set, it used created approach to be specific GHFSWD measure to build up a strategy for numerous standards dynamic with reluctant fluffy data. The technique was adaptable in light of the fact that it permits leaders to furnish inclination with aversion and decide distinctive choice outcomes by picking diverse choice procedures.

Huchang Liao et al. had built up a technique to settle the multi-measures dynamic (MCDM) issue inside the setting of reluctant fluffy etymological term set in which the models struggle with one another. To do as such, the ideas of perfect answers for a HFL-MCDM issue had been presented. Moreover, so as to speak to the closeness of one answer for the perfect one, such a reluctant fluffy etymological measures, for example, the reluctant fluffy phonetic gathering utility measure, the reluctant fluffy semantic individual lament measure, and the reluctant fluffy semantic trade off measure was created. In view of these measures, a reluctant fluffy semantic VIKOR (HFL-VIKOR) strategy was presented, which was roused by the conventional VIKOR technique. The general strategies for the HFL-VIKOR strategy were given. Some numerical models were given to show the points of interest and common sense of our technique. At long last, it makes a conversation on the benefits of the HFL-VIKOR technique and furthermore the future work.

Shu-Ping Wan et al, had built up another Atanassov's intuitionistic fluffy (An IF) programming strategy to explain heterogeneous multi property cooperative choice creation issues with An IF truth degrees in which there were a few kinds of quality qualities, for example, An IF sets (An IFSs), trapezoidal fluffy numbers, stretches, and genuine numbers. In this strategy, inclination relations in examinations of options with reluctance degrees were communicated by An IFSs. Thus, An IF bunch consistency and irregularity files were characterized based on inclination relations between options. To evaluate the fluffy perfect arrangement (IS) and loads, another An IF programming model was developed on the idea that the AIF bunch irregularity file ought to be limited and should be not bigger than the An IF bunch consistency record by some fixed An IFS. A viable technique was created to explain the new inferred model. The separations of the options in contrast to the fluffy IS were determined to decide their positioning request. Additionally, a few speculations or specializations of the determined model were examined. Appropriateness of the created strategy was delineated with a genuine provider choice model.

III. DESCRIPTION OF SYSTEM

Theories such as approximate reasoning theory, vague set theory, rough set theory, probability theory, soft set theory were developed in recent year for solving various MCDM problems. The problem such as effective selection of equipment used in various industry, designing concept evaluation, selection of appropriate location for suiting military airport and other essential buildings, effective solid transportation etc. comes under MCDM methods. The above mentioned technique was developed for solving this prevailing problem.

Recently, the fuzzy set theory was found to be an interesting area of research because of the existing numerous challenges. Fuzzy set theory was developed and utilized in various field of application for various purposes. Many sort of work consisting of vague data can be solved effectively using fuzzy set theory. Also some of the uncertainty problems can also be

solved with the assist of fuzzy set theory. On considering on these advantages the fuzzy set theory was proposed in this present work. The classical set theory can function only in definite boundary condition as well as can be utilized only for clear data. It does not provide effective result for vague information. The membership function in classical set theory will exist only in 0 and 1. To overcome all these drawback the fuzzy set theory was developed.

Fuzzy set theory can be effectively utilized in various uncertainty problem. The membership function in fuzzy set theory will exist between the interval 0 and 1. The selection of membership function is considered as vital in case of fuzzy set. The effective performance of fuzzy set theory can be achieved only on the basis of selection of membership function. In order to solve the drawback present in already existing fuzzy set theory as well as to improve the effectiveness of the theory for application in various problem solving approach the modified fuzzy set theory was developed and applied in problem solving approach.

IV. CONCLUSION

The aim of this paper is to propose a new method for the evaluation of design concepts by considering various criteria as well as uncertainty and vagueness in information. In this method, the quantitative criteria are evaluated with rough set theory (or rough number), qualitative criteria are assessed using fuzzy set theory (or linguistic terms), and the weight of criteria is evaluated using extent analysis method on fuzzy AHP. The proposed method is based on the distance between interval vector each alternative and the positive-ideal and negative-ideal reference vectors. An interval- based relative closeness index is proposed to rank design concepts.

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