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Original Article

Effectiveness of Fuzzy Logic Multiple Attribute Decision Making Approach in Six Sigma Methodology in Software Industry

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Abstract – *Six Sigma is a methodology for enhancing software development systems and functional greatness in the software industry. Decision on serious variables chosen in software analysis steps is frequently very critical. It places a fundamental aim in the proper implementation of six sigma software projects, software productivity improvement in the software industry. In the software, environment involves inexact software uncertainty and vague software data. From a case study direction, this article demonstrates a planned approach for choosing of software serious factor of software development breakdown section (failure in software project) at a software company using six sigma methodology and fuzzy logic techniques faced Multi properties decision-making model. the above steps we have taken six criteria attribute for choosing of software serious factor for software development breakdown. In this section, the average time before software failure is considered to be a key identifying criterion. In this article, we have computed the weights related to criteria through different techniques such as fuzzy logic TOPSIS method, fuzzy logic VIKOR method, AHP (Analytical Hierarchy Process) approach etc. Software serious factor for breakdown ranking or prioritizing. Our outcomes are very powerful in accordance with the perception of software production and software maintenance selection of the software industry.*

Keywords - *Fuzzy Logic, Six Sigma Methodology, Software Breakdown Criteria, Multiple Attribute Decision Making, Software Industry.*

I. INTRODUCTION

Software industries are continuously facing resistance to settling into the ever-changing technological environment. Six Sigma methodology has been identified for many years as a very good strategy and has helped many software industries to highlight this challenge. This is one of the most important and popular software development in the field of software process improvement. Software industries have been earned maximum profit using this six sigma methodology. Six Sigma methodology has very good potential to minimize breakdown costs, performance improvement, revenue growth, resources empowerment, and strengthen focus. Six Sigma methodology has a more commanding strategy that employs a regimented approach to undertake software process variability using the application of statistical and non-statistical methods, tools and techniques in a suitable way.

This six sigma methodology teaches everyone in the software organization to become more effective and efficient. Software developers and software team leaders must be aware that successful execution of six sigma methodology requires not only technical understanding but also behavioural awareness. Various small, medium, large scale industries are not aware of the six sigma methodology, and many of them have the proper resources to implement six sigma software projects. Six Sigma methodology is a software process improvement strategy that consists of several phases logically interrelated with each other acronym DAMIC methodology (Define, Measure Analysis Improve and Control) is used for continuous improvement in any system or process. Six Sigma methodology is the strategy of achieving key improvements in the process by applying DMAIC methodology through the elimination of causes. Software development units can put into action such a strategy to enhance the software production process.

A. Important criteria evaluation

We have been identified six important software criteria for evaluation of the 13 serious breakdown factors in software development. These are based on the discussion with various technical champions, experts, system operators, software project managers, software maintenance experts and studies conducted by various researchers.

Table 1.

Software Important factors	Symbol
Software Maintenance	S1
Software Safety	S2
Software mean time before failure	S3
Software Cost	S4

Green Effect	S5
Repair Time	S6

II. TECHNIQUES IN SOFTWARE DEVELOPMENTS

The present research emphasises on finding critical software factors place an important role in breakdown time in software development to enhance their availability and to improve the software industry profit using the AHP approach, fuzzy VIKOR method, and fuzzy TOPSIS methods to sum up the outcomes.

A. Analytical Hierarchy Process (AHP) Approach

The analytical Hierarchy Process is a decision-making model and provides a supporting structure to cope with multiple criteria situations involving intuitive, rational, qualitative and quantitative aspects. It has been one of the most popularly used methods for the most powerful decision found especially suitable for software project planning at a strategic level.

AHP is a three-level process that consists of identifying and organising decision objectives, criteria constraints and alternatives into a hierarchy. This requires the decision-maker to develop a hierarchical framework of the software critical factors in the given problem to provide judgements about the relative importance of each of these factors and ultimately to specify a preference for each decision alternative with respect to each software factor. AHP is used as a supporting structure to formulate the evaluation of software trade-offs between the conflicting selections criteria associated with the various software suppliers offers. The comparison is based on six sigma champions opinion few inconsistencies may occur in the software system. The inconsistency of the software system can be checked by the consistency ratio.

$$\text{Consistency ratio} = \frac{\text{software consistency index}}{\text{Software random consistency index}}$$

$$\text{Where software consistency index} = \frac{\lambda max - n}{n-1}$$

B. Fuzzy Logic Approach

This approach was introduced by Azar, 2011 to undertake the problem where there are no clear edges between the two software variables in multiple criteria decision making (MCDM), where the stress is likelihood rather than probability

C. Fuzzy VIKOR Approach

This fuzzy VIKOR approach is to determine the compromise solution for a set of alternatives,

This solution is a feasible solution. It is very closer to a real solution for multiple attribute decision-making problems. According to fuzzy VIKOR, techniques focuses on priority and selecting from a set of alternatives and evaluating compromise solution for a problem with conflicting criteria, which can help the decision-makers to reach a final decision. The fuzzy VIKOR procedure evaluates the weight of stability intervals for the obtained compromised solution with the input weights given by the experts.

D. Fuzzy TOPSIS Approach

Hwang and Yoon presented the TOPSIS method for order preference by similarity to an actual solution. This technique uses different waiting schemes and distance metrics to compare outputs of a different group of weights. Applied to a group of software criteria data, the basic principles of the TOPSIS method is that the chosen alternative should have the shortest distance from the real solution and the long distance from the real negative solution. The real solution is a solution that maximizes the profit software criteria and minimizes the software cost criteria. In other words, the real negative solution minimizes the software cost criteria and maximizes the software profit criteria. The most benefited alternatives are the one which is closest to the real solution and farthest from the real negative solution.

III. Methodology

This section predicted the software project breakdown in software development by using the following methods that are fuzzy VIKOR, Fuzzy TOPSIS, as shown in the following diagram.

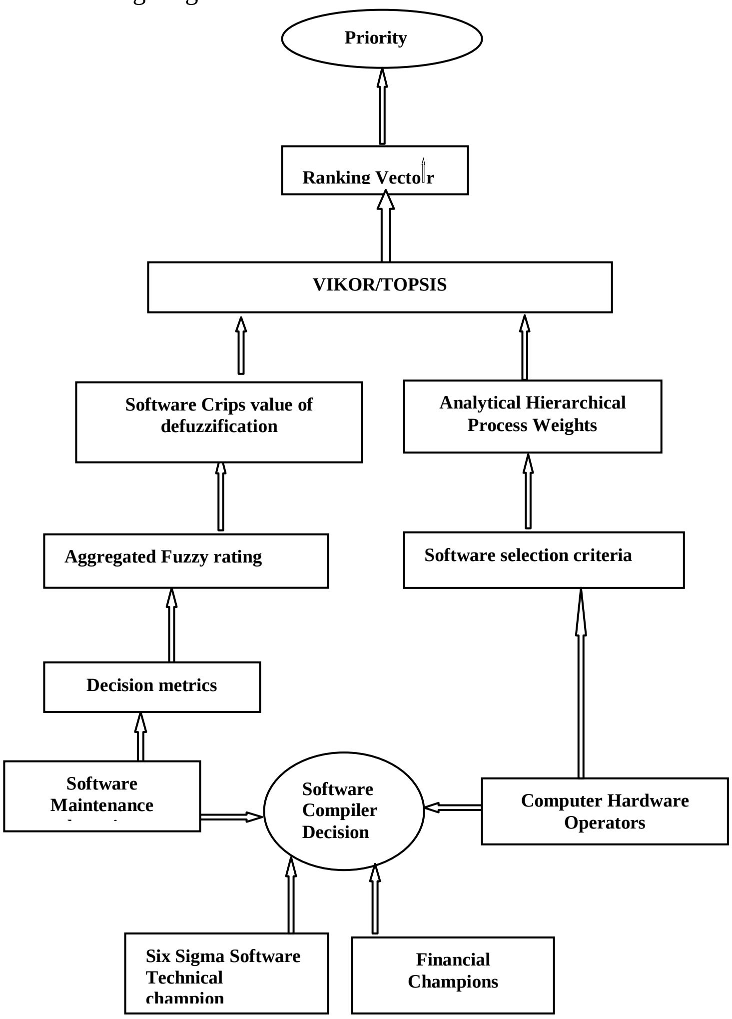

Fig. 1 Six Sigma Methodology Flow Chart

A. Procedure of VIKOR Approach

Step 1: Here, we use AHP Approach, compute AHP weights, Wj are calculated for all software breakdown variables or parameters

Step 2: Define Fuzzy logic linguistic terms

Step 3: Formation of decision Matrix

$$M=\begin{bmatrix} x11 & x12\ldots & x1p \\ x21 & x22\ldots & x2p \\ xq1 & xq2 & xqp \end{bmatrix}$$

Step 4: Defuzzification: This is to obtain the Crips values for each criterion corresponding to each alternative. This defuzzification is to provide the quantitative value for the linguistic parameters and fuzzy numbers.

Step 5: Evaluate of Ideal solution and negative ideal solution

$f^- = \{\min f_{ij}\}$

$f^+ = \{\max f_{ij}\}$

Step 6: Compute the utility S_i and regret R_i with respect to W_j using AHP

Step 7: Determine VIKOR index software breakdown factors with a minimum value of VIKOR index V_i is preferred

$$V_i = Q\left[\frac{S_i - S^+}{S^- - S^+}\right] + (1-Q)\left[\frac{R_i - R^+}{R^- - R^+}\right]$$

For all i= 1 to n

Step 8: Matrix Normalization as follows

$$R_{ij} = \frac{F_{ij}}{\sqrt{\sum_{i=1}^{m}(F_{ij})^2}}; \quad \forall_j$$

Step 9: Compute the decision matrix with normalization weight

$$Q_{ij} = [R_{ij}]_{m\times n} \times [W_j]_{n\times m} \text{primary diagonal}$$

Step 10: Determine the +ve ideal and –ve

The +ve ideal represented by Qj^+ and –ve ideal represented by Qj^-

Step 11: Compute positive ideal solution distance Di^+ and negative ideal solution distance Di^- is given by

$$d_i^+ = \left[\sum_{j=1}^{n}(Q_{ij} - Q_{ij}^+)^2\right]^{1/2}$$

i = 1 to m

$$d_i^- = \left[\sum_{j=1}^{n}(Q_{ij} - Q_{ij}^-)^2\right]^{1/2}$$

i = 1 to m

Step 12: Compute TOPSIS software priority index

$$S_i^+ = \frac{d_i^-}{[d_i^- + d_i^+]}$$

Software development breakdown factors with top rank index S_i^+ are preferred.

Table 2. Software Subjective weights of the determined software criteria calculated using AHP

Software Attributes / Impacts	S1	S2	S3	S4	S5	S6	Weights	Ranks
Software Maintenance(S1)	1.0000	5.0000	0.1100	0.1400	5.0000	0.1400	0.0757	4
Software Secure(S2)	0.2000	1.0000	0.1100	0.1400	3.0000	0.1400	0.0372	5
Mean Time before Failure(S3)	9.0000	9.0000	1.0000	9.0000	9.0000	0.9000	0.9000	1
Software Cost(S4)	7.0000	7.0000	0.1100	1.0000	7.0000	0.7000	0.2171	2
Green Effect(S5)	0.2000	0.3300	0.1100	0.1400	1.0000	0.1400	0.239	6
Software Repair Time (S6)	7.0000	7.0000	0.1100	0.1400	7.0000	1.0000	0.1463	3

Table 3. Fuzzy Linguistics parameters & corresponding fuzzy values

Fuzzy Linguistics parameter	Fuzzy values
Perfectly Good (AG)	(0.8000 0.9000 1.0000 1.0000)
Very Good (VG)	(0.7000 0.8000 0.8000 0.9000)
Good (G)	(0.5000 0.6000 0.7000 0.8000)
Perfectly Average (AA)	(0.4000 0.5000 0.5000 0.6000)
Below Average (BA)	(0.2000 0.3000 0.4000 0.5000)
Very Poor (VP)	(0.1000 0.2000 0.2000 0.3000)
Perfectly Poor (AP)	(0.0000 0.0000 0.1000 0.2000)

Table 4. Software Critical Breakdown Factor for Development

Software Critical Breakdown Factors	Symbols
Cooperation Architecture	CBF1
Final deadline revisions	CBF2
Competence performing assignment	CBF3
Existence of testing conductor	CBF4
Existence of overall Schedule	CBF5
Existence of overall testing plan	CBF6
Performance of estimation and prognosis efforts	CBF7
Integration Testing	CBF8
Project Manager	CBF9
Quality of delivery	CBF10
Implementation efficiency	CBF11
Area of delivery	CBF12
Project type	CBF13

Table 5. Linguistics decision matrix of software factors for software breakdown for all management software development breakdown factors criteria in software systems

Computing s/w criteria(s/w attributes Impact)	CBF1	CBF2	CBF3	CBF4	CBF5	CBF6	CBF7	CBF8	CBF9	CBF10	CBF11	CBF12	CBF13
S1	EP	HP	BA	EP	A	EP	EP	HP	HP	HP	H	BA	H
S2	HP	BA	HP	BA	BA	EP	HP	BA	EP	BA	H	AA	AA
S3	EP	HP	BA	HP	AA	EP	EP	HP	HP	HP	H	AA	AA
S4	EH	EH	H	EH	AA	EH	EH	H	EH	H	BA	AA	EH
S5	EH	EH	AA	EH	BA	EH	EH	EH	H	H	HP	H	H
S6	EH	EH	H	EH	EH	EH	EH	EH	EH	H	HP	H	EP

Table 6. Evaluated Crip numbers for indicated fuzzy grades

A computing of software Criteria	Software Development breakdown factors(Alternatives)												
	CBF1	**CBF2**	**CBF3**	**CBF4**	**CBF5**	**CBF6**	**CBF7**	**CBF8**	**CBF9**	**CBF10**	**CBF11**	**CBF12**	**CBF13**
Software Maintenance S1	0.0670	0.2111	0.3700	0.0670	0.3700	0.2111	0.0670	0.2111	0.2111	0.2111	0.6700	0.3700	0.8262
Secure Software S2	0.4000	0.4000	0.2111	0.3700	0.3700	0.2111	0.2111	0.3700	0.0670	0.3700	0.6700	0.5222	0.5222
Meantime before failure S3	0.2000	0.2111	0.3700	0.2111	0.5222	0.2111	0.2111	0.2111	0.2111	0.21111	0.6700	0.5222	0.5222
S/w cost S4	0.9390	0.8222	0.6700	0.8262	0.5222	0.8262	0.9399	0.8262	0.9399	0.6700	0.3700	0.5222	0.2111
Green effect S5	0.9700	0.8222	0.5222	0.8262	0.3700	0.6700	0.8262	0.8262	0.6700	0.8262	0.2111	0.6700	0.8262
S/w Repair time S6	0.9399	0.9399	0.6700	0.9399	0.8262	0.9399	0.9399	0.9399	0.9399	0.8262	0.2111	0.6700	0.0670

Table 7. Evaluation VIKOR & TOPSIS priority (Ranking)

Compute S/w Criteria	Software Development breakdown factors in (Alternatives)												
	CBF1	**CBF2**	**CBF3**	**CBF4**	**CBF5**	**CBF6**	**CBF7**	**CBF8**	**CBF9**	**CBF10**	**CBF11**	**CBF12**	**CBF13**
VIKOR Priority Index	0.0000	0.0890	0.3000	0.0790	0.5111	0.0970	0.0530	0.0890	0.0530	0.1220	0.7500	0.513	0.564
VIKOR Ranks	1.0000	7.0000	9.0000	4.0000	10.0000	5.0000	2.0000	6.0000	3.0000	8.0000	13.0000	11.0000	12.0000
TOPSIS Rank	1.0000	7.0000	9.0000	4.0000	10.0000	5.0000	2.0000	6.0000	3.0000	8.0000	13.0000	11.0000	12.0000
TOPSIS priority Index	0.9878	0.9780	0.6916	0.8916	0.3600	0.8900	0.9811	0.8905	0.9964	0.8934	0.0162	0.2892	0.0563

IV. CONCLUSION

Fuzzy logic multiple properties of the decision-making method is used for the selection of software critical factors in software development breakdown factors in a software company. AHP method is used to compute weights of all properties for the selection of the failure variables. Mean time before failure is found to be the many critical and green effect has least serious properties. The next highest rank of software serious breakdown factors in software development systems are computed with the help of fuzzy logic TOPSIS and fuzzy logic VIKOR approach with AHP weights. This research explores the feasibility of fuzzy TOPSIS and fuzzy VIKOR techniques. In software development, Six Sigma analysis steps for the selection of the software development breakdown variables. The important features of this research are identified as follows:

1. The research is used to show the importance of the "Analysis Phase" for the successful execution of Six Sigma software projects
2. The research was also used to prove that the multiple fuzzy attributes decision-making approach can be further improved to achieve a better Six Sigma rating.

In multiple attribute decision making, the research has successfully explored the power of producing effectiveness of TOPSIS, AHP and VIKOR.

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