An Analysis and selection of ERP vendor using Fuzzy approach

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***Abstract*- These Enterprise Resource Planning (ERP) this term has gained gigantic importance, this big and gigantic software runs almost each and every department of the organization. As organizations majorly depend upon ERP the major problem is identification and selection of the most suitable ERP for ones organization. The Key problem is predicting ERP success. ERP success majorly depends upon ERP effectiveness and ERP effectiveness in turn depends upon the appropriate Package selection. The ERP Vendor selection problem is a multi objective problem involving both qualitative and quantitative factors. These factors and their interdependencies make the problem highly complex one. Multi-attribute decision making (MADM) is devoted to solving the most desirable alternative selection problem according to multiple attributes. This paper used 3 decision makers who are weighted on specific criteria. These decision makers rate the factors responsible for ERP effectiveness, the survey values are further incorporated and aggregated using MIN MAX Avg principal and the output is finally De-fuzzified using Max membership principal**

Index terms- Enterprise Resource Planning, Multi Criteria Decision Making, Fuzzy Numbers

I. INTRODUCTION

Enterprise Resource Planning Systems (ERP) are very big and complex software package that runs almost each and every department and it would not be much if I say each and every aspect of an organization[1]. In the near recent years ERP has gained massive importance. One of the key strategic problems in ERP is "Measuring the success of ERP", ERP success depends upon ERP selection which majorly depends is ERP effectiveness. This is because there is a vital need to find out efficient ways for continuous assessment of ERP and to identify shortcomings of the system and eventually improve system performance. The quality of ERP systems is closely related to the user satisfaction, but having said that measuring human's satisfaction is intermingled by uncertainty and vagueness [2].Therefore ordinary statistical analysis does not stand efficient in this context. This motivated us to use fuzzy logic methods in assessing the effectiveness of ERP.

II. LITERATURE REVIEW

A. ERP

ERP systems have received a substantial attention from both academia and practice. Many research articles dealing with ERP systems have been published, covering various topics and issues. Moreover, a number of ERP literature reviews have been conducted. These reviews provide overviews of existing ERP literature from a general point of view. Since ERP literature is a broad topic, we focused our review on ERP in MNC that would provide a more detailed analysis and deeper understanding of this domain.

MNC have been recognized as fundamentally different environments compared to Small and Medium size enterprises[5]. In relation to ERP effectiveness, organizational size plays an important role[7]. The literature states that, we could not come across any research done on Effectiveness of ERP in MNC in context to Baroda dis, as the majority of the ERP studies are based on findings form issues related to ERP implementation [8]. Up to our knowledge, there are no existing literature reviews covering Effectiveness of ERP in MNC of Baroda District. The objective of this research is to present a comprehensive review of literature on ERP in MNCs in order to illustrate the status of research in this area, and to assist researchers in pinning down the current research gaps.

B. Fuzzy

Fuzzy sets have a great progress in every scientific research area. It found many application areas in both theoretical and practical studies from engineering area to arts and humanities, from computer science to health sciences, and from life sciences to physical sciences.

Intuitionistic Fuzzy Sets, Hesitant Fuzzy Sets, Type N Fuzzy Sets, Multi Fuzzy Sets, Nonstationary fuzzy sets.

A fuzzy set is a class of objects whose memberships are not precisely defined [14]. Fuzzy sets provide a better representation of reality than the classical mathematical binary representation.

Let us have a fixed universe E. Let A be a subset of E. Let us construct the set

$$A^* = \{\langle x, \mu_A(x), \nu_A(x)\rangle \mid x \in E\}$$

where $0 \leq \mu_A(x) + \nu_A(x) \leq 1$. We will call the set A* intuitionistic fuzzy set (IFS).

In the publications on IFS authors mainly deal with the concept of intuitionistic fuzzy set A* rather then with fixed set A. Mathematically, a more precise definition of the IFS is the following:

$$A^* = \{\langle x, \mu_A(x), \nu_A(x)\rangle \mid x \in E \,\&\, 0 \leq \mu_A(x) + \nu_A(x) \leq 1\}$$

Functions $\mu_A : E \to [0,1]$ and $\nu_A : E \to [0,1]$ represent degree of membership (satisfaction) and non-membership (non-satisfaction.). Also defined is function $\pi_A : E \to [0,1]$ through $\pi(x) = 1 - \mu(x) - \nu(x)$, corresponding to the degree of uncertainty (indeterminacy, etc.)

III. Methodology

Weights of decision makers are calculated on the following criteria such that the it satisfies the Normalization condition:

$$\omega j \in [0,1]$$

And $\sum_{j=1}^{n} \omega j = 1$

Using Eigen values the weight of decision makers comes out to be

D1	0.5278
D2	0.3325
D3	0.1396

Table 1 Criteria of Evaluation of Decision makers

1	Experience
2	Technical Expertise
3	Numeracy
4	Administrative--Ethical skills and business sense
5	Personal Skills--Listening and Creativity/ Innovation

Table 2 Criteria of ERP effectiveness is broadly classified into following using Ifinedo and Nahar Model

ERP QUALITY		
	Information Quality	Timely Info
		Latest Info
	System Quality	Easy to learn
		Data Integration
		Reduce cycle time of process
	Vendor Quality	Satisfaction
		Adequate Technical support
ERP IMPACT		
	Organization Impact	Reduce Inventory Cost
		Objectives achieved in General
	Workgroup impact	Organizational wide cooperation
		Simplify the business process
	Individual Impact	Better Analysis and planning

Table 3 The Decision makers are asked to rate the criteria using the following linguistic scale –

MH	(0.6,0.7,0.8)
H	(0.8,0.9,1.0)
VH	(0.9,1.0,1.0)

Table 4 The result comes out to be

			D1	D2	D3
ERP QUALITY	Information Quality	Timely Info	VH	H	H
		Latest Info	H	VH	MH
	System Quality	Easy to learn	VH	VH	H

		Data Integration	VH	VH	VH
		Reduce cycle time of process	VH	VH	H
	Vendor Quality	Satisfaction	VH	VH	H
		Adequate Technical support	H	VH	VH
	Organizatio n Impact	Reduce Inventory Cost	H	M H	H
		Objectives achieved in General	VH	VH	VH
	Workgroup impact	Organizational wide cooperation	M H	H	H
ERP IMPACT		Simplify the business process	H	H	H
	Individual Impact	Flexible Integrated real time decision support	H	M H	H
		Better Analysis and planning	H	VH	H

After substituting with the fuzzy values we get

Criteria for Effectiveness	D1	D2	D3
Timely Info	(0.9,1.0,1.0)	(0.8,0.9,1.0)	(0.8,0.9,1.0)
Latest Info	(0.8,0.9,1.0)	(0.9,1.0,1.0)	(0.6,0.7,0.8)
Easy to learn	(0.9,1.0,1.0)	(0.9,1.0,1.0)	(0.8,0.9,1.0)
Data Integration	(0.9,1.0,1.0)	(0.9,1.0,1.0)	(0.9,1.0,1.0)
Reduce cycle time of process	(0.9,1.0,1.0)	(0.9,1.0,1.0)	(0.8,0.9,1.0)
Satisfaction	(0.9,1.0,1.0)	(0.9,1.0,1.0)	(0.8,0.9,1.0)
Adequate Technical support	(0.8,0.9,1.0)	(0.9,1.0,1.0)	(0.9,1.0,1.0)
Reduce Inventory Cost	(0.8,0.9,1.0)	(0.6,0.7,0.8)	(0.8,0.9,1.0)
Objectives achieved in General	(0.9,1.0,1.0)	(0.9,1.0,1.0)	(0.9,1.0,1.0)
Organizational wide cooperation	(0.6,0.7,0.8)	(0.8,0.9,1.0)	(0.8,0.9,1.0)
Simplify the business process	(0.8,0.9,1.0)	(0.8,0.9,1.0)	(0.8,0.9,1.0)

Table 6 After multiplying with the weights of decision makers we get the following table

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Criteria for Effectiveness	D1*Weight of D1	D2*Weight of D2	D3*Weigh t of D3
Timely Info	(0.4750, 0.5278, 0.5278)	(0.2660, 0.2993, 0.3325)	(0.1117, 0.1256, 0.1396)
Latest Info	(0.4222, 0.4750, 0.5278)	(0.2993, 0.3325, 0.3325)	(0.0838, 0.0977, 0.1117)
Easy to learn	(0.4750, 0.5278, 0.5278)	(0.2993, 0.3325, 0.3325)	(0.1117, 0.1256, 0.1396)
Data Integration	(0.4750, 0.5278, 0.5278)	(0.2993, 0.3325, 0.3325)	(0.1256, 0.1396, 0.1396)
Reduce cycle time of process	(0.4750, 0.5278, 0.5278)	(0.2993, 0.3325, 0.3325)	(0.1117, 0.1256, 0.1396)
Satisfaction	(0.4750, 0.5278, 0.5278)	(0.2993, 0.3325, 0.3325)	(0.1117, 0.1256, 0.1396)
Adequate Technical support	(0.4222, 0.4750, 0.5278)	(0.2993, 0.3325, 0.3325)	(0.1256, 0.1396, 0.1396)
Reduce Inventory Cost	(0.4222, 0.4750, 0.5278)	(0.1995, 0.2328, 0.2660)	(0.1117, 0.1256, 0.1396)
Objectives achieved in General	(0.4750, 0.5278, 0.5278)	(0.2993, 0.3325, 0.3325)	(0.1256, 0.1396, 0.1396)
Organizational wide cooperation	(0.3167, 0.3695, 0.4222)	(0.2660, 0.2993, 0.3325)	(0.1117, 0.1256, 0.1396)
Simplify the business process	(0.4222, 0.4750, 0.5278)	(0.2660, 0.2993, 0.3325)	(0.1117, 0.1256, 0.1396)
Flexible Integrated real time decision support	(0.3729, 0.4195, 0.4661)	(0.2246, 0.2620, 0.2994)	(0.1277, 0.1436, 0.1596)
Better Analysis and planning	(0.3729, 0.4195 ,0.4661)	(0.3369, 0.3743, 0.3743)	(0.1277, 0.1436, 0.1596)

Table 7 Now, the aggregate fuzzy weights $j\ w \sim$ of each criterion can be calculated as follows;

$$\tilde{w}_j = (w_{j1}, w_{j2}, w_{j3})$$

where;

$$w_{j1} = \min_k \{w_{jk1}\}$$

$$w_{j2} = \frac{1}{k}\sum_{k=1}^{k} w_{jk2}$$

$$w_{j3} = \max_k \{w_{jk3}\}$$

k = number of decision makers = 3

Criteria for Effectiveness	AGGREGATE D1D2D3
Timely Info	(0.1117, 0.3176, 0.5278)
Latest Info	(0.0838, 0.3017, 0.5278)
Easy to learn	(0.1117, 0.3286, 0.5278)
Data Integration	(0.1256, 0.3333, 0.5278)
Reduce cycle time of process	(0.1117,0.3300, 0.5278)
Satisfaction	(0.1117, 0.3286, 0.5278)
Adequate Technical support	(0.1256, 0.3157, 0.5278)
Reduce Inventory Cost	(0.1117, 0.2778, 0.5278)
Objectives achieved in General	(0.1256, 0.3333, 0.5278)
Organizational wide cooperation	(0.1117, 0.2648, 0.4222)
Simplify the business process	(0.1117, 0.3000, 0.4222)
Flexible Integrated real time decision support	(0.1277, 0.2750, 0.4661)
Better Analysis and planning	(0.1277, 0.3125, 0.4661)

Table 8The actual survey values are taken as follows:

Criteria for Effectiveness	Survey Value
Timely Info	0.634
Latest Info	0.501
Easy to learn	0.577
Data Integration	0.624
Reduce cycle time of process	0.631
Satisfaction	0.651
Adequate Technical support	0.55
Reduce Inventory Cost	0.51
Objectives achieved in General	0.701
Organizational wide cooperation	0.672
Simplify the business process	0.534
Flexible Integrated real time decision support	0.651
Better Analysis and planning	0.573

Table 9 The actual values are fuzzified

Criteria for Effectiveness	Survey Value	Converted into Fuzzy
Timely Info	0.634	(0.534, 0.634, 0.734)
Latest Info	0.501	(0.401, 0.501, 0.601)
Easy to learn	0.577	(0.477, 0.577, 0.677)
Data Integration	0.624	(0.524, 0.624, 0.724)
Reduce cycle time of process	0.631	(0.531, 0.631, 0.731)
Satisfaction	0.651	(0.551, 0.651, 0.751)
Adequate Technical support	0.55	(0.45, 0.55,0.65)
Reduce Inventory Cost	0.51	(0.41,0.51,0.61)
Objectives achieved in General	0.701	(0.601, 0.701, 0.801)
Organizational wide cooperation	0.672	(0.572, 0.672, 0.772)
Simplify the business process	0.53	(0.43, 0.53, 0.63)
Flexible Integrated real time decision support	0.651	(0.551, 0.651, 0.751)
Better Analysis and planning	0.573	(0.473, 0.573, 0.673)

Table 10 In this step we incorporate the survey values with the weightage

Timely Info	(0.059,0.2013,0.3874)
Latest Info	(0.033, 0.1511,0.3172)
Easy to learn	(0.0532,0.1896, 0.3821)
Data Integration	(0.0658,0.2079,0.3821)
Reduce cycle time of process	(0.593,0.2082, 0.3858)
Satisfaction	(0.0644, 0.2139, 0.3963)
Adequate Technical support	(0.0565, 0.1736, 0.3430)
Reduce Inventory Cost	(0.0457, 0.1416, 0.3219)
Objectives achieved in General	(0.0754, 0.2336, 0.4227)

Organizational wide cooperation	(0.0638, 0.1779, 0.3259)
Simplify the business process	(0.0480, 0.159, 0.2659)

Table 11 Using the Min Average and Max principal again we get

Criteria for Effectiveness	
Timely Info	(0.033, 0.1762, 0.3874)
Latest Info	
Easy to learn	(0.0532, 0.2019, 0.3858)
Data Integration	
Reduce cycle time of process	
Satisfaction	(0.0565, 0.01937, 0.3963)
Adequate Technical support	
Reduce Inventory Cost	
Objectives achieved in General	(0.0457, 0.1876, 0.3219)
Organizational wide cooperation	
Simplify the business process	(0.0480, 0.1684, 0.3259)
Flexible Integrated real time decision support	
Better Analysis and planning	(0.0604, 0.1790, 0.3500)

Table 12 Now we apply the Max member Principal also known as height principal to get the Defuzzified output

Criteria for Effectiveness	Defuzzification
Timely Info	0.1762
Latest Info	
Easy to learn	0.3858
Data Integration	
Reduce cycle time of process	
Satisfaction	0.3963
Adequate Technical support	
Reduce Inventory Cost	0.3219
Objectives achieved in General	
Organizational wide cooperation	0.3259
Simplify the business process	
Flexible Integrated real time decision support	0.179
Better Analysis and planning	

Table 13

IV CONCLUSION

This paper proposes a multiple criteria decision model in fuzzy environment for ERP selection problem. This is considered as one of the critical decision making process where multiple criteria are involved. The de-fuzzified output thus obtained can be further given as input to be processed using Matlab or similar tool with a set of rules to get the ERP Quality and ERP Impact. ERP Quality and ERP Impact values thus obtained can be further processed with the set of rules to obtained the de-fuzzified ERP effectiveness.

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