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AN INTEGRATED APPROACH FOR ERP CONSULTANT ANTHOLOG

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Abstract— ERP systems offer reasonable adoptability and high levels of mobility to the requirements of establishments and challenging market scenario. ERP systems are so interrelated and central to business processes, that acquiring an effective and smooth consulting process has become its measure of success. The present study deals with the selection of suitable and capable consultant. Initially, different categories of criteria for consultant selection have been identified. Further, Kano's classification model has been utilized to sort and categorize criteria into two groups i.e. qualifying criteria and winning criteria. Based on literature review, views of experts from areas of academics, and stakeholder of industries, criteria for consultant selection were selected. For the purpose, a survey was carried out to identify the criteria of consultant selection and the weight assignment through questionnaire. Thereafter, Fuzzy-AHP method is used to find out the relative importance of the criteria and to estimate their respective weights. These in turn facilitate to identify the preferences based on the requirements of the client organization for selection of consultants to assure success of ERP system.

Keywords— Consultant Selection; ERP; Fuzzification; Analytic Hierarchy Process; Kano Model

I.Introduction

ERP systems are distinguished as enterprise-wide information systems. These systems combine information and all functional processes in firms that adopt these [1]. Studies have revealed that ERP is a system that has highly integrated information and its implementation is tremendously complex. ERP systems can be regarded as the backbone of the information systems in organizations [2]. Various Post-ERP implementation experiences have often been frustrating for client organizations with wasted time, effort, and money [3]. The implementation period of ERP software may be related to the complexity and size of the client organization.

Software implementers need to play an important role, not only in technical terms, but also in political and managerial terms, to help the organization in adjusting their perceptions and expectations of ERP systems and its implementations. To meet out the requirement, it is essential to make certain user support, as well as grasp and make most of knowledge from software suppliers and consultants to achieve success in ERP implementations [4]. Wu and Wang [5] have identified the significance of system providers and consultants as key indicators of success for ERP implementation. To reduce time horizon and bring down the cost, many companies look for the help from consultants for ERP project implementation. Therefore, the selection of ERP consultant turns out to be critical to accomplish the implementation goal [6].

ERP Consultant is a contract worker engaged to implement, upgrade or maintain ERP systems. Consultant's competence refers to a consultant's capability to perform diverse tasks in the adopted enterprise, which may include: problems solving, offering related and desired knowledge, mobilizing different skills, assisting in design, and deriving worth from an ERP package [7]. Therefore, competent consultants are required throughout the implementation process. These consultants itself are seen as one of the important critical success factors of ERP implementation [8]. Competent consultants are properly trained in ERP implementation methodologies and have real system development experience.

II. Decision Criteria

In the ERP consulting process, an expert consultant can facilitate communication and conflict management and help in improving ERP system quality [4]. The nature of the organization is likely to affect the choice and the importance weights of the consultant assessment criteria. For example, the public enterprises may place a greater importance to design approach, while the private sector may have more concern with the consultants' charges. Similarly, the organization size may affect the criteria weights, as the organizations' objectives are also influenced by the size of organizations [6].

To screen ERP consultant, clients can examine every competing firm based on its previous ERP implementation experience, its financial state, the recognition of its individual consultants by the ERP supplier, and its implementation knowledge in the client's industry [9]. While scrutinizing the literature and of the experts and decision makers from academic intellectuals, production & material management and finance, a group of nine criteria has been selected for consideration for consultant selection problem in the present work. They are listed as, ERP implementation experience, Consultancy fee, Business process knowledge, Firms reputation, Financial Position, ERP implementation in similar industry, Target date

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adherence, Client focus and online support, and Vendor certification of its individual consultants. The consultant fee in the study is measured by the ratio of the fee of cheapest consultant to the fee quoted by a consultant under evaluation.

III. Criteria Classification

In the present study a two phase consultant selection process has been proposed as depicted in Figure1. Initially, the shortlisted consultants have been ranked on the basis of selected basic criteria that are essential for an assignment. Thereafter, depending on need, some top ranked consultants are then evaluated on the criteria for order winners.

Fig.1 Outline of consultant selection process

IV. Theory of Attractive Quality (Kano's Model)

The customer is generally not able to precisely specify the desired attributes of a product in the actual purchasing situation. Therefore, logical support is necessary to identify the relevant customer requirements unambiguously. A method that is capable to recognize the focal point of the customer requirements is Kano model. Kano has presented the theory of attractive quality. A two-dimensional model of quality attributes has been presented on the basis of theoretical foundations. Further, a method has been illustrated to use this theory in practice [10]. This theory proposes five dimensions of perceived quality (i.e., must be, one-dimensional, attractive, indifferent and reverse quality). Kano et al. [10] have considered quality through a two dimensional view. Authors have proposed a theoretical approach and a graphical representation. Physical fulfillment and user satisfaction have been represented as two axes of graph. The original Kano model has been illustrated in Figure 2. The theory of attractive quality proposes five different quality elements as follows [10]:

1. Must-be requirements: Customers will feel extremely dissatisfied if this attribute is not provided. Customers will accept only if this attribute is provided.
2. One-dimensional requirements: Customers satisfaction is a linear function of the attribute performance. If attribute performance is high then the customer satisfaction is high and vice-versa.
3. The attractive requirements: Customers will be extremely satisfied if the attribute is provided; otherwise they will accept the product without dissatisfaction.
4. Indifference requirements: There is no effect on customer satisfaction no matter whether this attribute is provided or not.
5. Reversal requirements: Customer will be satisfied if this attribute is not provided; otherwise, they will be dissatisfied.
6. Questionable requirements: This indicates that either the customer misunderstood the question, or the question was phrased incorrectly, or an illogical response was answered.

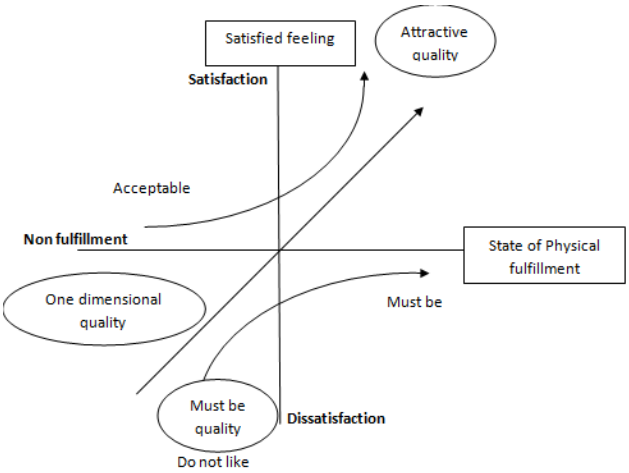

Fig.2 The original Kano's Model (Kano et al., 1996)

IV. The Methodology

The Kano's model was initially proposed for product development and has introduced a unique way to find out customer's requirements in detail by giving different categories to different requirements. While assessing customer's requirements, it considers the problem description from the customer's perspective with functional and dysfunctional aspects. The methodology has been capable to systematically categorize the requirements into different types. In the proposed consultant selection problem there is a requirement of categorization of criteria for two distinct phases i.e. order qualifying and order winning. As mentioned earlier the order qualification criteria are essential and are vital for evaluation of a consultant where as order winning criteria are attractive (desirable) to be considered. The present research utilizes the analogy that customer's point of view is decision maker's point of view where the dimensions are the criteria of consultant selection. These criteria are categorized by using the Kano's method. After classification the criteria that categorized under 'must be' and 'one dimensional' are considered as order qualification criteria as these are mandatory for assessment of consultants. The criteria that categorized as 'attractive' are used for order winning phase. These criteria have less importance as compared to order qualifying criteria but have a positive impact on consultant's quality.

Step 1: First of all the needs are established through personal interviews with stake holders and/or decision makers. Then, requirements are decided based on the

recognized needs. Thereafter, a set of attributes is determined to fulfill the requirements. To incorporate the functional and dysfunctional form of question related to these attributes a questionnaire is then designed. A sample question used in a questionnaire of present study is shown in Figure 4.3.

Step 2: Kano et al. [10] have proposed a methodology to evaluate questionnaire and find an outcome by combination of answers of functional form and dysfunctional form of different questions.

Step 3: A table of frequencies is then constructed on completing the evaluation table. For each criterion the frequencies of each category is counted. The element with greatest frequency is said to be the category of that requirement. In addition, if the outcomes for two requirements have the same frequency, the categorization that would have the greatest influence on the service or product should be chosen. The precedence order should follow: M > O > A > I.

If "ERP Implementation experience" is considered as a criteria of consultant selection. How would you feel	1. like 2. acceptable 3. no feeling 4. must be 5. do not like
If "ERP Implementation experience" is not considered as a criteria of consultant selection. How would you feel	1. like 2. acceptable 3. no feeling 4. must be 5. do not like

Fig. 3 A modified Kano questionnaire

A. Customer Satisfaction Coefficient

Berger et al. [11] have proposed customer satisfaction (CS) coefficient that shows the amount of increase in satisfaction if a service / product requirement is met or the amount of decrease in satisfaction if a service / product requirement is not met. The CS coefficient is indicator strength of a product feature that may influence customer satisfaction or customer dissatisfaction in an instance of its "no fulfilment". The CS coefficients can be calculated for by following formulas:

$$\textit{Satisfaction Index (SI)}=\frac{(A+O)}{(A+O+M+I)}$$

$$\textit{Dissatisfaction Index (DI)}=-\frac{(A+O)}{(A+O+M+I)}$$

The range of a positive CS coefficient in value from zero to one; the effect is higher on satisfaction of customer when its value is nearer to one. Similarly the negative satisfaction of customer operates, and a zero value indicates that this feature does not bring about dissatisfaction. This is helpful to recognize feature influence on the satisfaction of customer and set preferences of product or service design.

B. Application of Kano's Model for Criteria Classification

In order to assess the significance of the consultant selection criteria for the manufacturing industry having production house in India, a comprehensive set of dysfunctional and functional forms of questions regarding consultant selection criteria are included in a questionnaire. The experts were asked to answer both the forms of questions related to each criterion along with the weight of that criterion on a five point Likert scale. Out of 90 questionnaires a total of 68 responses have been received and results are shown in Table 1. The results show that the ERP implementation experience, criteria consultancy fee, ERP implementation in similar industry, business process knowledge and client focus and online support are classified in must be or one dimensional category and these will be considered as order qualifying criteria. The criteria firms reputation, financial Position, target date adherence and vendor certification of its individual consultants are attractive criteria, they are therefore considered as order winning criteria for further analysis.

V. Criteria Prioritization

It is obvious that the consultant selection among prospective candidates has quantitative and qualitative aspects. Majority of the criteria are qualitative in nature. These criteria often can be represented only by subjective judgment of decision maker in linguistic terms. In view of wide applications of Fuzzy Analytic hierarchy process (FAHP) and its ability to deal with vague data linguistics nature, it has been used to prioritize the different criteria and to calculate the relative weights of criteria.

Fuzzy set theory has been integrated with AHP by several researchers to consider the vagueness, uncertainty and many of the other limitations as depicted by Cheng et al. [12]. In this approach, the triangular fuzzy numbers are used for pair-wise comparison of fuzzy AHP. The extent

TABLE I Kano' classification for consultant selection criteria

Category Criteria	A	M	O	R	Q	I	Total	Kano category	SI	DI
Consultancy fee	19	27	13	0	1	8	68	**M**	0.48	-0.60
ERP implementation experience	14	25	17	0	1	11	68	**M**	0.46	-0.63

ERP implementation in similar industry	6	31	22	0	0	9	68	**M**	0.41	-0.78
Firms reputation	29	13	11	0	2	13	68	**A**	0.61	-0.36
Financial Position	31	11	14	0	0	12	68	**A**	0.66	-0.37
Business process knowledge	18	27	12	0	1	10	68	**M**	0.45	-0.58
Target date adherence	30	19	8	0	2	9	68	**A**	0.58	-0.41
Client focus and online support	19	11	31	0	0	7	68	**O**	0.74	-0.62
Vendor certification of its individual consultants	23	18	13	0	4	10	68	**A**	0.56	-0.48

analysis method has been used to demonstrate with the help of an example. Any production cycle evaluated by this technique yields a fuzzy set. The results of the analysis can lastly be defuzzified by developing the surface center of gravity of any fuzzy set, and the production cycles alternatives can be ranked in terms of the objective set.

In the present work, a fuzzy AHP has been proposed for industrial applications from feasible and practical view points. This process involves the fuzzy interval mathematics with triangular fuzzy numbers and confidence index α with interval mean approach. The procedure has been segregated into five steps: planning, fuzzyfication, fuzzy operations, defuzzification and analysis & confirmation

VI. Application of FAHP Model

A. Hierachy Structure

In previous section the criteria for two phases of consultant selection have been categorized. The criteria are prioritized and structured to use FAHP for both the phases' separately. Initially, hierarchy models for order qualifying and order winning phase were developed. Further interviews were conducted with the experts from areas of academics, finance and production & material management to review the hierarchy of model that is feasible for application in ERP consultant selection problem. A description brochure of criteria was also submitted to the experts to check whether these descriptions in the model hierarchy were understandable or not. After revising both the hierarchy and descriptions of criteria, finally hierarchy models of both the phases were developed (Figure 4).

B. Fuzzy Comparison Matrices

Fuzzy comparison matrices were constructed for different enablers that were precipitated during development of hierarchical structure. The comparison matrix was to be developed with triangular fuzzy numbers. For the purpose, the experts were requested to evaluate the relative importance of the criteria based on triangular fuzzy numbers with the intension to: (i) weight the judgments of the different criteria. (ii) understand the views regarding applicability of FAHP and (iii) receive their suggestions in general.

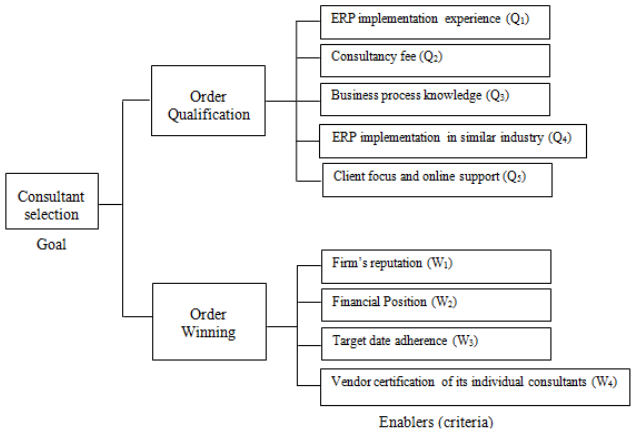

Fig. 4 The hierarchial structure model for consultant selection

These experts were also requested to express the relative importance of each dimension by pair-wise comparison. Their judgments for hierarchy model were analyzed using consistency ratio and the process of judging the comparison of matrix was continued till CR reached the value that is less than 0.1. Fuzzy comparison matrixes and there consistency ratio for criterions are shown in Tables 3 and 4.

C. Defining Lower and Upper limit of Fuzzy through Interval of Confidence

The discussion with experts yielded the relative importance of different strategies. The triangular membership function

TABLE III Fuzzy comparison matrix of Order qualifying criteria for consultant selection

Order Qualifying	ERP implementation experience	Consultancy fee	Business process knowledge	ERP implementation in similar industry	Client focus and online support

ERP implementation experience	1	5^{-1}	5^{-1}	3^{-1}	7^{-1}
Consultancy fee	5^{-1}	1	1^{-1}	3^{-1}	3^{-1}
Business process knowledge	5^{-1}	1^{-1}	1	3^{-1}	3^{-1}
ERP implementation in similar industry	3^{-1}	3^{-1}	3^{-1}	1	5^{-1}
Client focus and online support	7^{-1}	3^{-1}	3^{-1}	5^{-1}	1
λmax = 5.2922 & CR=0.0652					

TABLE IV Fuzzy comparison matrix of Order winning criteria for consultant selection

Order Winning	Firm's reputation	Financial Position	Target date adherence	Vendor certification of its individual consultants
Firm's reputation	1	5^{-1}	3^{-1}	7^{-1}
Financial Position	5^{-1}	1	3^{-1}	3^{-1}
Target date adherence	3^{-1}	3^{-1}	1	5^{-1}
Vendor certification of its individual consultants	7^{-1}	3^{-1}	5^{-1}	1
λmax = 4.2128 & CR= 0.0788)				

and α-cuts used to convert the subjective judgments of the experts into fuzzy judgments. After that a degree of optimism for the experts was estimated by the index of optimism μ. Individual fuzzy comparison matrices based on triangular membership function and α –cuts were initially formulated. The lower limit and upper limit of the fuzzy numbers with respect to α, were defined as follows by using equation. 4.

$$1_\alpha = [1, 3-2\alpha], \quad 1_\alpha^{-1} = \left[\frac{1}{3-2\alpha}, 1\right]$$
$$3_\alpha = [1+2\alpha, 5-2\alpha] \quad 3_\alpha^{-1} = \left[\frac{1}{5-2\alpha}, \frac{1}{1+2\alpha}\right]$$
$$5_\alpha = [3+2\alpha, 7-2\alpha] \quad 5_\alpha^{-1} = \left[\frac{1}{7-2\alpha}, \frac{1}{3+2\alpha}\right]$$
$$7_\alpha = [5+2\alpha, 9-2\alpha], \quad 7_\alpha^{-1} = \left[\frac{1}{9-2\alpha}, \frac{1}{5+2\alpha}\right]$$
$$9_\alpha = [7+2\alpha, 11-2\alpha], \quad 9_\alpha^{-1} = \left[\frac{1}{11-2\alpha}, \frac{1}{7+2\alpha}\right]$$

For α = 0.5, above expression will yield the fuzzy comparison matrices (Table 3 and 4). For illustration the resulted Table: 3 and 4 both respectively converted and shown below:

$$FCM_q(\alpha = 0.5) = \begin{bmatrix} 1 & [4,6] & [4,6] & [2,4] & [6,8] \\ \left[\frac{1}{6},\frac{1}{4}\right] & 1 & [1,2] & \left[\frac{1}{4},\frac{1}{2}\right] & [2,4] \\ \left[\frac{1}{6},\frac{1}{4}\right] & \left[\frac{1}{2},1\right] & 1 & \left[\frac{1}{4},\frac{1}{2}\right] & [2,4] \\ \left[\frac{1}{4},\frac{1}{2}\right] & [2,4] & [2,4] & 1 & [4,6] \\ \left[\frac{1}{8},\frac{1}{6}\right] & \left[\frac{1}{4},\frac{1}{2}\right] & \left[\frac{1}{4},\frac{1}{2}\right] & \left[\frac{1}{6},\frac{1}{4}\right] & 1 \end{bmatrix}$$

$$FCM_W(\alpha = 0.5) = \begin{bmatrix} 1 & [4,6] & [2,4] & [6,8] \\ \left[\frac{1}{6},\frac{1}{4}\right] & 1 & \left[\frac{1}{4},\frac{1}{2}\right] & [2,4] \\ \left[\frac{1}{4},\frac{1}{2}\right] & [2,4] & 1 & [4,6] \\ \left[\frac{1}{8},\frac{1}{6}\right] & \left[\frac{1}{4},\frac{1}{2}\right] & \left[\frac{1}{6},\frac{1}{4}\right] & 1 \end{bmatrix}$$

D. Estimating the degree of optimization

Degree of satisfaction for the judgment matrices is estimated by the index of optimism μ. The larger value of the index μ indicates the higher degree of optimism. The index of optimism is a linear convex combination defined by Equation 7. The following crisp judgment matrix can be obtained after setting the index of optimism, μ, in order to estimate the degree of satisfaction. Here μ =0.5 are used to transform fuzzy group comparison matrices into group crisp comparison matrices, from which the importance

weights were obtained. For example, group crisp comparison matrix (GCCM) is obtained as shown below after using μ =0.5 (in Equation 5).

$$GCCM_q\ (\alpha = 0.5\ and\ \mu = 0.5) = \begin{bmatrix} 1 & 5 & 5 & 3 & 7 \\ 0.2083 & 1 & 1.5 & 0.375 & 3 \\ 0.2083 & 0.75 & 1 & 0.375 & 3 \\ 0.375 & 3 & 3 & 1 & 5 \\ 0.1458 & 0.375 & 0.375 & 0.2083 & 1 \end{bmatrix}$$

$$GCCM_w\ (\alpha = 0.5\ and\ \mu = 0.5) = \begin{bmatrix} 1 & 5 & 3 & 7 \\ 0.2083 & 1 & 0.375 & 3 \\ 0.375 & 3 & 1 & 5 \\ 0.1458 & 0.375 & 0.2083 & 1 \end{bmatrix}$$

E. Eigen value and Eigen vector

Let GCCM(α=0.5 and μ=0.5)= A. Eigen value of the matrix A can be obtained by solving the characteristic equation of A, i.e. det (A-λI)=0.

for GCCMq,

$$\lambda_1 = 5.2922,\ \lambda_2 = -0.0035 + 0.7726i,\ \lambda_3 = -0.0035 - 0.7726i,$$
$$\lambda_4 = -0.1418 + 0.1549i,\ \lambda_5 = -0.1418 - 0.1549i$$

$$Normalized\ weight\ for\ qualifying\ criteria = (0.4886, 0.1155, 0.1014, 0.2461, 0.0483)$$

for GCCMw,

$$\lambda_1 = 4.2128,\ \lambda_2 = -0.0222 + 0.6353i,\ \lambda_3 = -0.0222 - 0.6353i,\ \lambda_4 = -0.1668,$$

$$Normalized\ weight\ for\ winning\ criteria = (0.5509, 0.1241, 0.2669, 0.0581)$$

F. Check the Consistency Property

If the consistency ratio (CR=CI/(RI)) is less than 0.1, then comparison are acceptable, otherwise not. If the consistency test is not passed, the original values in the pair wise comparison matrix must be revised by the decision maker. Here CR of the matrix A can be calculated as:

CR=CI/(RI) and CI=(λmax - n)/(n – 1)

For qualifying comparison matrix

λmax=5.2922, n=5 in matrix A then

$$CI = \frac{5.2922 - 5}{5 - 1} = 0.0731$$

For RI= 1.12 (from table 2) the value of

CR= CI/(RI) =0.0652.

For matrix A as, CR<0.1 so this comparison is acceptable.

For winning comparison matrix

λmax=4.2128, n=4 in matrix A then

CI= (4.2128 - 4)/(4 – 1)=0.0709.

For RI= 0.90 (from table 4.2) the value of

CR= CI/(RI) =0.0788.

For matrix A as, CR<0.1 so this comparison is also acceptable.

G. Final Score and Ranking

A structured questionnaire was framed to collect the responses from manufacturing industries. These questions were framed on a five point Likert scale. These questionnaires were mailed to different manufacturing industries throughout the country. These included industries involved in the manufacturing of electrical, electronics and telecommunication, etc. to evaluate the consultant selection criteria. Final score of various criteria are shown in Table 8 & 9. Ranking are provided according to their final score or relative weight.

TABLE V Prioritization of Order qualifying criteria

Criterion (Enablers)	Weight	Rank
ERP implementation experience	0.4886	**1**
Consultancy fee	0.1155	**3**
Business process knowledge	0.1014	**4**
ERP implementation in similar industry	0.2461	**2**
Client focus and online support	0.0483	**5**

TABLE VI Prioritization of Order winning criteria

Criterion (Enablers)	Weight	Rank
Firm's reputation	0.5509	**1**
Financial Position	0.1241	**3**
Target date adherence	0.2669	**2**
Vendor certification of its individual consultants	0.0581	**4**

VII. Conclusion

IV. Based on literature review, views of experts from areas of academics, and stakeholder of industries, criteria for consultant selection were selected. The criteria are then classified into two categories of requirements with the help of Kano's model. 'Consultancy fee', 'ERP implementation experience', 'ERP implementation in similar industry', 'business process knowledge' and 'client focus and online support' are identified as criteria for order qualifying whereas 'firm's reputation', 'financial Position', 'target date adherence' and 'vendor certification of its individual consultants' are distinguished as order winning criteria. It was found from the pair wise comparison of criteria for order qualification the criterion 'ERP implementation experience' to be of highest importance with 48.86 % followed by 'ERP implementation in similar industry' 24.61% (Table 5). For order winning phase, the criterion

'firm's reputation' and 'target date adherence' are the criteria of prime importance with weights of 55.09 % and 26.69 % respectively (Table 6).

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