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Interrelations of Critical Failure Factors in ERP Implementation: An ISM-based Analysis

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Abstract. Some factors adversely impact the process and results of ERP implementation. The aim of this paper is to understand mutual influences of these factors. The Interpretive Structural Modeling (ISM) methodology has been used to evolve mutual relationships among these critical failure factors. It is observed that out of nine factors included in this study three factors namely 'poor understanding of business implications and requirements', 'poor data quality', and 'lack of top management support' have high driving power and therefore deserve serious attention in the process of ERP implementation. The study concludes with discussion and managerial implications.

Key words: ERP Implementation, Critical Failure Factors, Interpretive structural modeling

1. Introduction

Enterprise Resource Planning (ERP) system has received significant attention in the industries in the last two decades. However, not all ERP implementations have resulted in expected results. There are some factors which influence the success or failure of ERP implementation. We may call these factors as critical success factors (CSFs) or critical failure factors (CFFs). These factors not only affect the process of ERP implementation but may also influence each other. It is, therefore, important to understand their mutual relationships so that those factors which are at the root of some more factors (called driving factors) and those which are most influenced by the others (called driven factors) are identified. After this it is prudent for the management to accord appropriate attention to these factors which may result in successful ERP implementation.

Interpretive Structural Modeling (ISM) is a well-established methodology for identifying relationships among specific items, which define a problem or an issue (Sage, 1977). In this research, these factors have been analyzed using the ISM approach, which shows the interrelationships of the factors, their driving power, and the dependencies. In this study, nine Critical Failure Factors (CFFs) have been identified from literature and subjected for analysis of interrelationships. In accordance with the ISM methodology, experts' opinion was sought in developing the relationship matrix, which is later used in the development of ISM model. The main objectives of this paper are: (i) to identify the critical failure factors in the process of ERP implementation, (ii) to establish relationships among the identified factors using ISM, and (iii) to discuss the managerial implications of this research and suggest directions for future research. The remainder of this paper has been organized as follows. The next section discusses the identification of CFFs. This is followed by the use of ISM methodology and model development. The results of this research are followed by the discussion and conclusion.

2. CRITICAL FAILURE FACTORS in ERP IMPLEMENTATION

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In the last two decades many authors have done significant research on identifying critical factors in ERP implementation. Holland and Light (1999) have classified the success factors in two broad categories of strategic and tactical factors. Somers and Nelson (2001) proposed a comprehensive list of 22 critical success factors associated with ERP implementation. Umble et al. (2003) extended the research on CSF and came out with nine CSFs for ERP implementation. Shahin and Sulaiman (2009) had a comprehensive literature review for articles published during 1999-2008 and identified 17 CSFs.

Considering a large failure rates in ERP implementations some researchers such as Momoh et al (2010) attempted to find out the critical failure factors (CFFs) in ERP implementation. On the basis of a comprehensive literature review they propose 9 CFFs. Each of these critical factors was cited in the literature. Interestingly not only the CFFs were cited in the literature all the reference papers on which the compilation was build were also cited in the literature. This makes their efforts to compile the CFFs more authentic. The CFFs thus identified are used in this paper. These are shown in Table I.

Table I Critical Failure Factors and their citations

S. No.	Critical Failure Factors in the IT-enablement of a supply chain	Citations
1.	Lack of change management	12
2.	Excessive customization	13
3.	Dilemma of internal integration	08
4.	Poor understanding of business implication and requirements	07
5.	Poor data quality	09
6.	Lack of top management support	05
7.	Hidden cost	03
8.	Misalignment of IT with business	03
9.	Limited training	04

3. ISM Methodology and Model Development

ISM has been used to achieve the research objectives. ISM methodology helps to impose order and direction on the complexity of relationships among elements of a system (Sage, 1977). For complex problems, like the one under consideration, a number of factors may be affecting the ERP implementation. However, the direct and indirect relationships between these factors describe the situation far more accurately than the individual factor taken into isolation. Therefore, ISM develops insights into collective understandings of these relationships. The various steps involved in the ISM technique are:

(i) identification of elements, which are relevant to the problem or issues; this could be done by survey or any group problem solving technique,

(ii) establishing a contextual relationship between elements with respect to which pairs of elements would be examined,

(iii) developing a structural self-interaction matrix (SSIM) of elements, which indicates pair-wise relationship between elements of the system,

(iv) developing a reachability matrix from the SSIM, and checking the matrix for transitivity. Transitivity of the contextual relation is a basic assumption in ISM which states that if element A is related to B and B is related to C, then A is necessarily related to C,

(v) partitioning of the reachability matrix into different levels,

(vi) based on the relationships given above in the reachability matrix draw a directed graph (DIGRAPH), and remove the transitive links,

(vii) convert the resultant digraph into an ISM-based model, by replacing element nodes with the statements,

The application of ISM methodology in this paper is in line with Jharkharia and Shankar (2005).

3.1 Formation of structural self-interaction matrix (SSIM): Three experts who were part of the ERP implementation team in their respective organizations were consulted in developing the interrelationship matrix. For analyzing the CFFs in developing SSIM, the following four symbols have been used to denote the direction of relationship between CFFs (i and j):

V- CFF i will help achieve CFF j; A- CFF j will be achieved by CFF i;
X- CFFs i and j will help achieve each other; and O- CFFs i and j are unrelated.

The following statements explain the use of symbols V, A, X and O in SSIM.

(i) CFFs 1 and 2 are unrelated (O)
(ii) CFF 2 helps achieve CFF 7 (V)
(iii) CFF 3 will be achieved by CFF 6 (A)

Based on these contextual relationships the SSIM is developed (Table II)

Table II Structural self-interaction matrix (SSIM)

Critical Failure Factors	9	8	7	6	5	4	3	2
1. Lack of change management	V	V	V	A	0	A	V	0
2. Excessive customization	0	A	V	0	0	A	V	
3. Dilemma of internal integration	A	A	A	A	A	A		
4. Poor understanding of business implication and requirements	V	V	V	X	X			
5. Poor data quality	O	V	V	X				
6. Lack of top management support	V	V	O					
7. Hidden cost	A	A						
8. Misalignment of IT with business	0							

3.2 Reachability Matrix: The SSIM has been converted into the initial reachability matrix (Table III) by substituting V, A, X and O by 1 and 0 as per the rules given in the ISM methodology and used by Jharkharia and Shankar (2005).

Table III Initial reachability matrix

Critical Failure Factors	1	2	3	4	5	6	7	8	9
1. Lack of change management	1	0	1	0	0	0	1	1	1
2. Excessive customization	0	1	1	0	0	0	1	0	0
3. Dilemma of internal integration	0	0	1	0	0	0	0	0	0
4. Poor understanding of business implication and requirements	1	1	1	1	1	1	1	1	1
5. Poor data quality	0	0	1	1	1	1	1	1	0
6. Lack of top management support	1	0	1	1	1	1	0	1	1
7. Hidden cost	0	0	1	0	0	0	1	0	0
8. Misalignment of IT with business	0	1	1	0	0	0	1	1	0
9. Limited training	0	0	1	0	0	0	1	0	1

After incorporating the transitivities as described in step (iv) of the ISM methodology, the final reachability matrix is shown in Table IV.

Table IV Final reachability matrix after incorporating transitivities

Critical Failure Factors	1	2	3	4	5	6	7	8	9
1. Lack of change management	1	1	1	0	0	0	1	1	1
2. Excessive customization	0	1	1	0	0	0	1	0	0
3. Dilemma of internal integration	0	0	1	0	0	0	0	0	0
4. Poor understanding of business implication and requirements	1	1	1	1	1	1	1	1	1
5. Poor data quality	1	1	1	1	1	1	1	1	1
6. Lack of top management support	1	1	1	1	1	1	1	1	1
7. Hidden cost	0	0	1	0	0	0	1	0	0
8. Misalignment of IT with business	0	1	1	0	0	0	1	1	0
9. Limited training	0	0	1	0	0	0	1	0	1

3.3 Level partitions: From the final reachability matrix, the reachability and antecedent set (Warfield, 1974) for each factor are found. The reachability set consists of the element itself and the other elements, which it may help achieve, whereas the antecedent set consists of the element itself and the other elements, which may help achieving it. Thereafter, the intersection of these sets is derived for all the CFFs. The CFFs for which the reachability and the intersection sets are the same occupy the top level in the ISM hierarchy.

The top-level element in the hierarchy would not help achieve any other element above its own level. Once the top-level element is identified, it is separated out from the other elements. Then, the same process is repeated to find out the elements in the next level. This process is continued till the levels of each element are found. To keep the length of the paper within the prescribed page limit we have presented the result of only one iteration here in table V.

Table V Partition of reachability matrix- first iteration

CFF	Reachability set	Antecedent set	Intersection set	Level
1	1,2,3,7,8,9	1,4,5,6	1	
2	2,3,7	1,2,4,5,6,8	2	
3	3	1,2,3,4,5,6,7,8,9	3	I
4	1,2,3,4,5,6,7,8,9	4,5,6	4,5,6	
5	1,2,3,4,5,6,7,8,9	4,5,6	4,5,6	
6	1,2,3,4,5,6,7,8,9	4,5,6	4,5,6	
7	3,7	1,2,4,5,6,7,8,9	7	
8	2,3,7,8	1,4,5,6,8	8	
9	3,7,9	1,4,5,6,9	9	

In this iteration CFF 3 was found to have level I. In the subsequent iterations it is found that CFF 7 is at level II, CFFs 2 and 9 are at level III, CFF 8 at level IV, CFF 1 at level V, and CFFs 4, 5, and 6 occupy the bottom positive at level VI.

3.4 Formation of ISM model: From the levels as identified in section 3.3, the Interpretive Structural Model is developed. If there is a relationship between the CFFs *i* and *j*, this is shown by an arrow which points from *i* to *j*. This graph is called a directed graph or digraph. After removing the transitivities (refer step iv of the ISM methodology), the digraph is finally converted into ISM-based model (Figure 1).

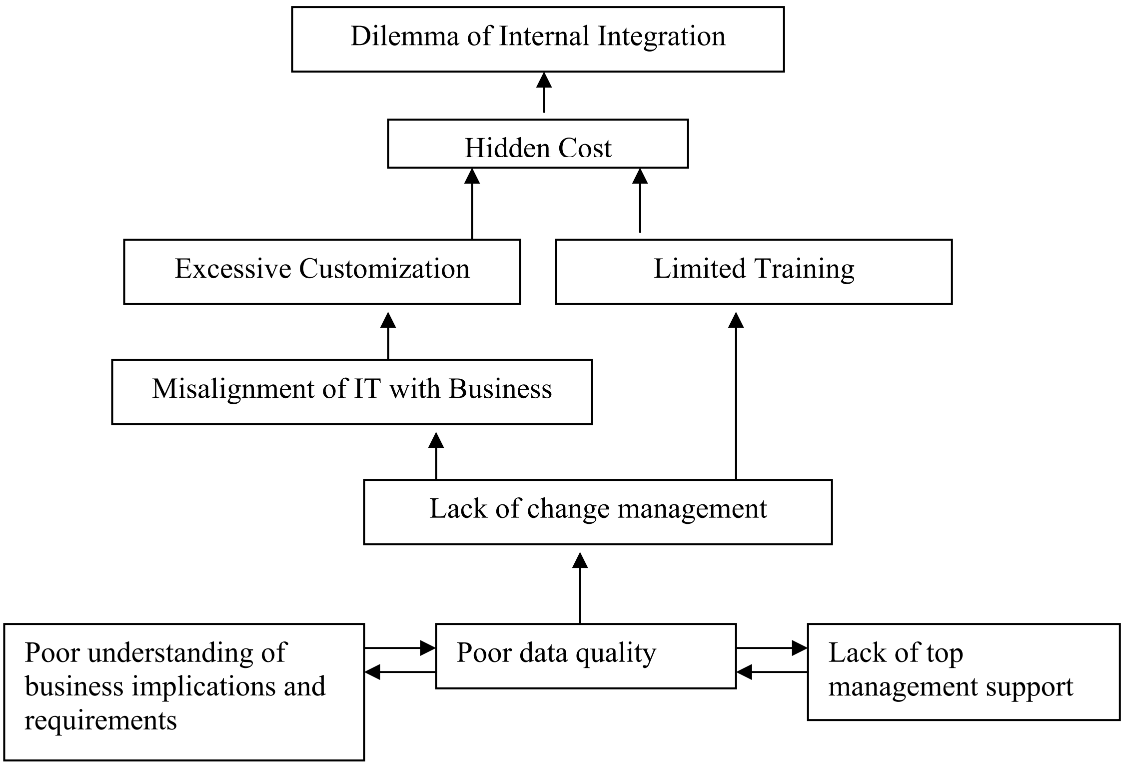

Figure 1: ISM-based model for the Critical Failure Factors

4. Discussion and Conclusion

The ISM model suggests that three CFFs namely ‘Poor understanding of business implications and requirements’, ‘Poor data quality’, and ‘Lack of top management support’ are at the root of other CFFs and have great influence on all other failure factors. On the other hand, ‘Hidden cost’ and ‘Dilemma of internal integration’ are the factors with low driving power and high dependence. They lie at the top of the ISM model. The support of top management has been widely acknowledged as one issue which is critical to the success or failure of ERP implementation. In the present ISM model also it has high driving power and hence occupied a bottom position in the ISM-based model. This is in line with the observation made by Dong (2001) that top management support influences both commitment to resources and commitment to change management. Lack of change management is another factor which is having a high driving power and influences many other factors towards ERP implementation. An organization which is not willing to change is more likely to fail in the process of ERP implementation. The strong value system of the organization and the role of change management become important in this case. The mutual dependence and driving power of all the CFFs can be seen in the ISM-based model. The awareness about the mutual relationships of all the CFFs may help the decision makers in formulating a better strategy for ERP implementation.

At the end, it would be interesting to examine the scope of future research. In this research, through ISM, a relationship model among the CFFs has been developed. This model has been developed on the basis of input from the experts as suggested in the ISM technique. Yet, this model has not been statistically validated. Structural equation modeling (SEM), also commonly known as linear structural relationship approach has the capability of testing the validity of such hypothetical model. Therefore, it may be applied in the future research to test the validity of this model. It is to be mentioned here that though SEM has the capability of statistically testing an already developed theoretical model, it cannot develop an initial model for testing. On the other hand, ISM has the capability to develop an initial model through managerial techniques such as brain storming, nominal group techniques (NGT) etc. Normally, the management may not have enough time to conduct a survey and therefore, scope to have a statistically validated model is limited. ISM is a supportive analytic tool for this situation. However, it may be suggested that due to the complimentary nature of both of these techniques, the future research may be directed in first developing an initial model using ISM and then validate it using SEM.

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