

# Evaluating The Antecedents And Consequences Of ERP Implementation

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## ABSTRACT

*Despite the obvious advantages that can be derived from implementing ERP (enterprise resource planning) systems, many organizations fail to realize the ERP-related benefits. ERP-related successes or failures need to be analyzed from an organizational standpoint since ERP is essentially an organizational construct. In this paper, we have attempted to explore relationships between constructs that have been linked theoretically and anecdotally. The motivation, use of, and outcomes of ERP takes place at various levels and stages. For this study motivators for ERP, their business or organizational impact, impact at the individual or group level, ROI (and related issues) and facilitators and inhibitors associated with ERP are included. These constructs have subjected to pair-wise analysis. In doing so it has gone beyond the typical approach used to define and measure ERP implementation success that has been the critical success factors approach. The results indicate support for a model for ERP success that is based on four perspectives i.e. organizational, technological, strategic and tactical. The implications of our results in terms of theory and managerial utility have been discussed.*

## INTRODUCTION

When enterprise resource planning (ERP) systems are analyzed, it is generally expected to demonstrate how ERPs added value to the organization where they were implemented. However, the value adding potential of ERP has not been demonstrated in clear terms. It is believed that the impact an ERP has in an organization depends on many factors. These factors include the business and technical reasons for implementing the ERP and also the expectations from the ERP. Such factors are referred as the antecedents of ERP. The outcomes of ERP implementation include the desired benefits and the ERP's impact on such expected benefits. Such outcomes related to ERP are called consequences in this paper.

## LITERATURE REVIEW

ERP implementation has been studied from different standpoints. It is important to do so because a large number of ERP implementations fail to meet expectations. This indicates the magnitude of the problems involved in ERP systems implementation and also the importance of evaluation of ERP software (Stefanou, 2001). Only 42% of respondents in a study by Bradford and Roberts (2001) reported that their company actually measures the value achieved from their ERP system. Seventy-five percent of the companies that measured any type of value used the traditional return-on-investment (ROI) metric. While some companies calculated an overall ROI at the company level, others calculated ROI at the division, functional, or ERP module level (Bradford and Roberts, 2001).

Success factors in ERP tend to be correlated (Akkermans and Helden, 2002). The implication is that changes in any one of them would influence most of the others as well. Research by Motwani et al. (2002) examines factors facilitate or inhibit the success of ERP projects and what actions can be taken to bring troubled ERP projects under control. They used a case study methodology grounded in business process change theory to compare a successful ERP implementation with an unsuccessful one. We based our study on some of the factors identified by such prior research.

Organizations tend to be at different stages of IS maturity when planning to implement ERP systems. The eventual outcomes of ERP use ranging from the initial analysis, through completed standard implementations and to the sophisticated exploitation of enterprise resource planning (ERP) systems using advanced knowledge management, customer relationship management, and supply chain management systems. Holland and Light (2001) present a maturity model for ERP systems. Taking the off from their work, it is attempted to analyze whether the factors that led to ERP implementation have an influence on the effects of ERP on the organizational performance. Since the objective was to understand ERP effectiveness in the context of what preceded ERP implementation and how returns on investment were viewed, the following working propositions have been identified:

Proposition 1: There should be an association between the business reasons for ERP and technical reasons for ERP.

Proposition 2: While the ROI of ERP is an espoused ideal, it is a contentious construct

Proposition 3: Inhibitors and facilitators of ERP success tend to be complementary and behave differently in such roles.

## METHODOLOGY

A survey of organizations that had implemented ERP in the last 2 years has been conducted. The organizations were selected from a list provided by ERP vendors (SAP, Baan, J. D. Edwards, PeopleSoft, and Oracle) that had implemented ERP systems over the last one year and had gone live. This analysis uses a subset of the data used in the larger survey.

## RESULTS

The data were collected from 92 organizations. The Table below shows the profile of organizations from the standpoint of ERP implementation. The modal value of the number of implementations is 50 and the median value is 70. This means that this dataset is skewed to the right in terms of number of licenses. The average number of modules implemented per organization is 3. The number of sites is also widely dispersed. The majority of installations are single sites (see mode). The turnover of organizations is representative of the industry in terms of few large organizations with the majority of implementers being medium sized.

Descriptive Statistics

	N	Mean	Std. Error	Median	Mode	Std. Deviation	Minimum	Maximum
Number of licenses	92	90.11	6.27	70	50	60.15	50	400
Number of modules	92	3.37	0.12	3	2	1.18	2	6
Number of sites	92	6.71	0.64	5	1	6.13	1	27
Annual turnover <sup>1</sup>	92	374.95	36.64	260	100	351.63	50	1850

Results pertaining to propositions stated earlier are presented below.

Table 1 shows that, in general, there is no relationship between business drivers and IS drivers of ERP. However, there are a few significant correlations. It is instructive that the need for efficiency (need for reduced cycle time) is correlated with Need to integrate existing information system. What the other significant correlations are showing is that when the priority for complementing legacy systems is high, the priority to reduce cycle time or improve organizational processes as a whole is low. When the priority for addressing the weakness in existing systems is high, then the priority associated with the drive to reduce process cycle times is low. While these results are consistent with our expectations, the absence of a relationship in most other quadrants needs explanation. It is possible

<sup>1</sup> In millions of Rupees. 1 Rupee = US\$ 45 (approx.)

that the expected alignment between business and IT strategies is absent. It could also be due to dissonance between the organizational requirements and IS maturity (Nolan, \*\*\*).

**Proposition 1**

**Table 1: Association Between Business Reasons And IS Reasons For ERP**

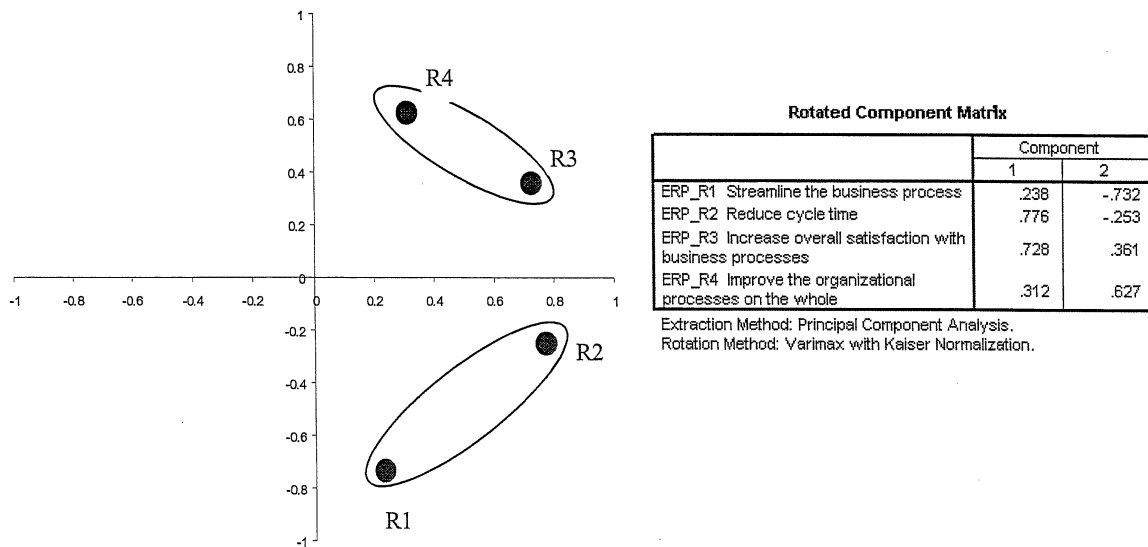
	Streamline the business processes	Reduce cycle time	Increase overall satisfaction with business processes	Improve the organizational processes on the whole
Replacement of legacy system	0.170 (0.127,82)	-0.001 (0.993,79)	0.002 (0.998,83)	0.110 (0.337,78)
Complementing legacy system	0.006 (0.958,69)	<b>-0.271</b> (0.029,65)	0.096 (0.432,69)	<b>-0.287</b> (0.019,67)
Weak existing information system	-0.051 (0.632,89)	<b>-0.213</b> (0.049,86)	0.129 (0.226,90)	-0.091 (0.408,85)
Need to integrate existing information system	0.031 (0.776,89)	<b>0.382</b> (0.000,86)	-0.046 (0.666,90)	0.115 (0.295,85)

**Proposition 2**

The impact of ERP was evaluated based on impact on business process and overall improvements that cannot be attributed to process improvements alone. The analysis was also based on the impact of ERP on decision-making, organizational performance and impact on individual and group work. The last set of analyses has to do with users' perceptions regarding how ERP has influenced individual and group work.

The initial analysis used four variables like streamline the business process (R1), reduce cycle time (R2), increase overall satisfaction with business processes (R3) and improve the organizational processes on the whole (R4).

**Figure 1: Factors For ERP Impact**



Factor analysis (Figure 1) shows two broad factors. These can be termed as individual process factor (R1 and R2) and the enterprise process factor (R3 and R4).

**Table 2: Impact Of ERP On Processes**

	<b>Streamlined the business process</b>	<b>Reduced cycle time</b>	<b>Increased overall satisfaction with business processes</b>	<b>Improved the organizational processes on the whole</b>
Absolutely agree				
Significantly agree		1		10
Agree to a large extent		41	9	28
Agree to some extent	4	31	35	33
Hardly agree	15	10	37	13
Don't agree	72	5	11	3
Can't say				

It is clear from Table 2 that a majority of respondents has not experienced process streamlining. On the whole, it is clear that process-related and enterprise-wide benefits have not manifested themselves as a result of ERP implementation. There is a high level of tentativeness associated with judging the performance of ERP at the process as well as the organizational level. This has implication in terms of the process as well as the productivity paradox.

**Decision Making And ERP**

Following the analysis carried out above, the factor analysis shown in Table 3. Decision flexibility is the first factor while decision effectiveness is the second factor. The third factor is a combination of managerial coordination and forecasting.

**Table 3: Factor Analysis For Decision-Making**

<b>Variable</b>	<b>Component</b>		
	<b>1</b>	<b>2</b>	<b>3</b>
Increased flexibility in decision-making	0.74	-0.08	-0.04
Reduction in time-frame for decision making	0.68	0.02	0.08
Better coordination between managers	0.29	-0.74	0.21
Improved forecasting	0.15	0.80	0.12
Reduced information delay	-0.19	-0.21	0.85
Overall decision-making	0.38	0.22	0.69

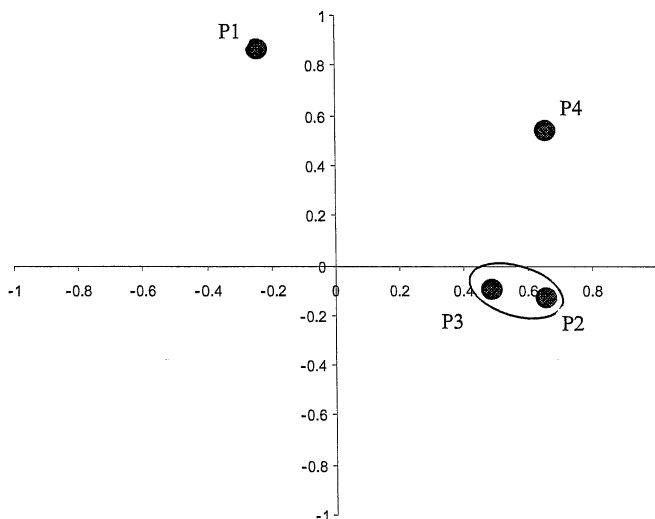
Table 4: Impact Of ERP On Decisions

	Increased flexibility in decision-making	Reduction in time-frame for decision making	Better coordination between managers	Improved forecasting	Reduced information delay	Improved overall decision-making
Absolutely agree				5		
Significantly agree				11		
Agree to a large extent	36	6	11	37	3	14
Agree to some extent	23	21	21	17	26	22
Hardly agree	22	36	27	13	31	35
Don't agree	7	22	29	2	31	21
Can't say						

Apart from improved forecasting, no other decision variable has shown any significant improvement due to ERP. Significant numbers in the “Don’t agree” row indicate that managerial decision-making has not been impacted by the ERP implementation.

**Organizational Performance**

Figure 2: Factor Analysis For Organizational Performance



**Rotated Component Matrix**

	Component	
	1	2
EFF_OP1 ERP usage results in direct benefits to the organization	-.243	.864
EFF_OP2 When ERP was not in use, organizational processes performed poorly compared to the post-ERP scenario	.655	-.135
EFF_OP3 When every user uses ERP, the results are good for the organization	.485	-.101
EFF_OP4 If the ERP system malfunctions or fails, organizational processes are adversely affected	.653	.539

Extraction Method: Principal Component Analysis.  
 Rotation Method: Varimax with Kaiser Normalization.

Of the two factors, usage (P2 and P3) is the more obvious factor than the factor that can be called impact due to use.

Table 5: Impact Of ERP On The Enterprise

	ERP usage has resulted in direct benefits to the organization	When ERP was not in use, organizational processes performed poorly compared to the post-ERP scenario	When every user uses ERP, the results are good for the organization	If the ERP system malfunctions or fails, organizational processes are adversely affected
Absolutely agree	2	4		
Significantly agree	4	3		
Agree to a large extent	38	22	29	5
Agree to some extent	23	42	36	5
Hardly agree	16	14	19	29
Don't agree		5	8	53
Can't say				

It can be seen from Table 5 that while the ERP has been beneficial, the degree of coupling between organizational processes and the ERP is still minimal. This is evident from the last column. The second-last column indicates that the degree of usage may still need improvement in order to experience the potential effect of ERP.

**ERP Usage And Individual Impacts**

When analyzing ERP impacts on IS use and individual work, we identified four distinct factors that are relevant in this context. Factor 1 address the advantages that accrue when ERP systems streamline interdepartmental processes and reduce the burden of administrative minutiae on individuals. Factor 3 is similar to factor 1. Factor 3 addresses productivity advantages that accrue due to reduced paperwork and are group-base. Factor 4 also addresses productivity advantages – those that relate to information availability.

Table 6: Factor Analysis For Individual And Task Effects

	1	2	3	4
EFF1 ERP helped in saving end-user time	0.702	-0.083	0.275	-0.266
EFF6 Inter-departmental relations improved	0.814	0.197	-0.158	0.209
EFF5 Feeling of ownership improved among functional heads and end-users	0.452	-0.559	0.250	0.134
EFF2 ERP simplified user's tasks	0.141	0.758	-0.007	0.053
EFF7 Control by few individuals over information reduced with the arrival of ERP <sup>2</sup>	0.011	0.298	-0.676	-0.086
EFF3 Paperwork was reduced in the organization	0.310	-0.075	0.603	-0.472
EFF9 Group / departmental productivity improved	0.014	0.426	0.702	0.280
EFF4 Information, which earlier could only be obtained from other departments, is now available on the ERP system	-0.126	-0.223	0.133	0.742
EFF8 Individual productivity increased	0.226	0.268	0.021	0.793

For most individual and task effects, the rating shown in Table 7 can be described as tentatively agreeing to the ERP-enabled effects. It is instructive to note that while individual users' tasks were not simplified, individual productivity was increased. Information is still not available across departments. However interdepartmental relations did improve.

<sup>2</sup> This could be a case of a problem with the construct/variable. However, it appears that with the arrival of ERP the control by a few individuals increases.

Table 7: Impact Of ERP On Individuals And Tasks

	EFF1	EFF2	EFF3	EFF4	EFF5	EFF6	EFF7	EFF8	EFF9
Absolutely agree	2						2	8	
Significantly agree	2	4	1		3	12	7	25	8
Agree to a large extent	19	49	15	9	21	45	25	35	35
Agree to some extent	39	18	13	18	47	11	25	7	37
Hardly agree	19	9	30	43	12	16	24	5	5
Don't agree	9	6	30	19	4	5	9	4	2
Can't say									

**ROI of ERP**

With respect to the return on investment on ERP, Table 8 shows that IS drivers tend not to be associated with ERP enabled ROI. However, there are a few notable exceptions in the form of associations between replacement of legacy systems and whether ERP can be computed or not. These significant relationships point to the difficulty of, and the need to, compute ERP enabled ROI. We analyze this further in Table 8. The associations for the complementary nature of legacy systems are easier to understand. Results from Table 8 imply that as the importance of the ERP in complementing the existing systems increases, the ease of computing ROI decreases and the possibility of calculating ERP also decreases. It becomes difficult to apportion benefits due to ERP when improvements can be attributed to multiple sources (including existing systems).

Table 8: Relating ROI And IS Drivers For Implementing ERP

Pearson product-moment correlation (p-value, sample size)	ERP ROI can be computed	Your organization has computed an ROI for the ERP	ERP ROI can not be computed	There are more tangible benefits from ERP	There are more intangible benefits from ERP	We should not attempt to compute ROI for ERP	Top management benefits the most from ERP use
Replacement of legacy system	0.321 (0.005,74)	0.051 (0.666,75)	0.274 (0.016,77)	-0.112 (0.323,80)	0.040 (0.722,81)	0.176 (0.260,43)	0.209 (0.058,83)
Complementing legacy system	-0.371 (0.003,63)	-0.474 (0.000,62)	-0.003 (0.978,64)	0.011 (0.929,66)	0.130 (0.293,67)	0.139 (0.428,35)	-0.180 (0.138,69)
Weak existing information system	-0.032 (0.775,82)	0.025 (0.822,82)	-0.095 (0.391,83)	-0.023 (0.832,87)	0.101 (0.351,88)	0.088 (0.533,52)	0.122 (0.253,90)
Need to integrate existing information system	0.133 (0.238,81)	0.138 (0.217,82)	-0.164 (0.141,82)	0.072 (0.505,87)	0.097 (0.368,88)	-0.134 (0.354,50)	-0.056 (0.603,90)

The source of the paradoxical finding was investigated in Table 7 by associating the two variables – ROI can be computed and ROI cannot be computed. Results in Table 8 show that those who responded that ROI cannot be computed also reported that ROI can be computed. Analyzing further, it was found that those who reported that there are tangible benefits from ERP tended to report that there are no intangible benefits from ERP. This tends to offer a partial explanation for the first association. While ERP based ROI can be computed for certain aspects of benefits, such ROI cannot be computed for other benefits – which are either absent or intangible. Even though ROI can be calculated, organizations have not computed ERP enabled ROI (Table 8, row 3). Management benefiting from ERP has no relationship with the computing of ROI.

Table 9: Chi Square Analysis Of ROI And Associated Variables

	Pearson $\chi^2$ (d.f.)	Gamma (T)
ERP ROI can be computed * ERP ROI cannot be computed	37.71 (15) p = 0.020	0.432 (2.488) p = 0.013
There are tangible benefits from ERP * There are intangible benefits from ERP	129.30 (20) p = 0.000	-0.713 (-7.185) p = 0.000
ERP ROI can be computed * Organization has computed ROI for the ERP	61.035 (10) p = 0.000	0.163 (0.862) p = 0.389
Organization has computed ROI for the ERP * Top management benefits most from ERP	7.286 (8) p = 0.506	0.165 (1.024) p = 0.306

**Proposition 3**

It was believed that while the same variables could serve as facilitators and inhibitors of ERP effectiveness, the way they came together as facilitators would be different from the way they would come together as inhibitors.

Table 10: Factor Analysis – Facilitators

Variable	1	2	3	4	5
SUCC_R01 Top management support	0.928	-0.058	0.128	0.011	-0.028
SUCC_R08 Overall support for ERP in the organization	0.330	-0.097	0.154	0.001	-0.778
SUCC_R02 Strong MIS department	0.317	0.562	0.112	0.322	0.495
SUCC_R11 Users' involvement and participation	0.031	0.799	0.097	-0.136	-0.006
SUCC_R13 Strong IT infrastructure in place	0.002	0.649	0.134	0.417	0.289
SUCC_R04 Functional area support	0.101	-0.025	0.705	-0.251	0.060
SUCC_R05 Good implementation partner	-0.341	-0.153	0.537	0.524	-0.075
SUCC_R12 Shared understanding of the ERP concept	0.156	0.217	0.687	0.308	-0.124
SUCC_R07 Good planning for the ERP project	0.173	-0.066	-0.176	0.838	-0.183
SUCC_R09 Effective change management	-0.062	-0.021	0.126	0.836	0.200
SUCC_R10 Right ERP software selected	0.355	0.230	0.023	0.245	0.759
SUCC_R03 Quality of ERP team members	0.194	-0.752	0.179	0.269	0.248
SUCC_R06 Strong and meaningful training programs	-0.003	0.293	-0.035	0.190	-0.788

Factor 1 can be called organizational support. Factor 2 represents an organization’s internal strength for ERP success. Factor 3 captures stakeholder dimensions. Factor 4 has to do with strong and disciplined implementation processes.

**DISCUSSION AND CONCLUSION**

ERP implementation is a socio-technical that requires a fundamentally different outlook from technologically driven innovation, and will depend on a balanced perspective where the organization as a total system is considered. ERP implementation is considered to rely on behavioral processes and actions. It is a process that involves macro-implementation at the strategic level, and micro-implementation at the operational level. This therefore means that implementation in the context of ERP systems is not possible through an ON/OFF approach whereby deployment of the new systems will necessarily yield the desired and expected results. This paper proposes an integrative framework for ERP implementation based on an extensive review of the factors and the essential elements that contribute to success in the context of ERP implementation (Al-Mudimigh et al., 2001).



Table 11: Factor Analysis – Inhibitors

Variable	1	2	3	4
IMPL_P01 Lack of top management support	0.694	0.120	0.515	0.205
IMPL_P04 Lack of functional area support	0.678	0.209	0.417	0.006
IMPL_P06 Weak training programs	0.842	0.014	0.056	0.146
IMPL_P12 Poor understanding of ERP concept	0.668	0.450	-0.044	0.095
IMPL_P02 Weak MIS department	0.121	0.880	-0.039	-0.05
IMPL_P11 Lack of users' involvement and participation	0.175	0.668	0.3445	0.216
IMPL_P03 Poor quality of ERP team members	0.529	0.050	0.698	0.103
IMPL_P05 Weak implementation partner	0.605	0.104	0.668	-0.18
IMPL_P07 Poor planning for the ERP project	-0.046	0.078	0.939	0.063
IMPL_P09 Improper change management	0.256	0.051	0.852	0.121
IMPL_P08 Lack of overall support for ERP in the organization	0.119	-0.031	-0.174	0.728
IMPL_P10 Inappropriate ERP software selected	-0.040	0.096	0.391	0.828
IMPL_P13 Inadequate IT infrastructure	0.139	0.089	0.107	0.900

ERP software packages are as popular as ever, but you wouldn't know it, judging by some of the major vendors' current stock prices and the grumblings of organizations that have implemented the systems. What are the "frustration generators" for ERP customers? Some CIOs would argue that there are three interrelated issues: 1. Justifying the initial purchase with return on investment (ROI). 2. Struggling to implement the product itself. 3. Trying again to find the ROI after the implementation. As a result, some ERP buyers are now forgoing up-front ROI analysis, implementing the "vanilla" package, and simply trusting in the software to cure their business ills. And, guess what? It seems to be working! So, how can you make this contrary purchasing and implementation strategy work for you? (Vickers, 2000).

Customization and implementation of ERP systems became an industry on its own. But particularly small- and medium-sized enterprises are not able to pay consultants millions of dollars for ERP implementation. Hence, modeling methods, architectures, and tools have become increasingly popular because they can help to reduce the cost of software implementation and at the same time increase user acceptance of ERP software solutions. ERP implementation should involve the analysis of current business processes and the chance of reengineering, rather than designing an application system that makes only the best of bad processes. If business process are properly redesigned and business process models document the improved situation accordingly, ERP systems can be configured by these conceptual models. (Scheer and Habermann 2000).

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**NOTES**