An Overview of ERP in Indian Production Firms

Arun Madapusi
Department of Decision Sciences
Bennett S. LeBow College of Business
Drexel University
Philadelphia 19104
madapusi@drexel.edu

ABSTRACT

Over the past nearly two decades, firms have increasingly invested in enterprise resource planning (ERP) systems to manage their information needs. Firms in developed countries account for the bulk of ERP deployments worldwide. In the past few years there has been increasing penetration of ERP in developing countries. The extent of ERP implementations among firms in developed countries is a well researched issue. In contrast, very few studies have examined the extent of ERP deployments in developing countries. In this study, we address the above research gap by presenting a rigorous empirical assessment of ERP implementations in Indian production firms. The implementation status of different ERP modules, performance benefits and the influence of critical success factors (CSFs) are key issues examined in this study.

KEYWORDS

CSFs, Performance	ERP
Indian Production Firms	Organization Size

PREAMBLE

Increased globalization has forced firms to invest in information technology (IT) to meet their global information needs. In particular, more and more firms across the world are implementing packaged enterprise resource planning (ERP) systems. ERP systems collect data through a single comprehensive database and make it available to modular applications that support all of a firm's value chain activities across functions, business units, and geographical areas (Davenport, 1998; Klaus et al., 2000). The rise in the popularity of ERP systems worldwide can be gauged from their rapid growth – $1 billion in 1990 (Mabert et al., 2000) to over $400 billion by 2006 (Bonasera, 2000; Gartner, 2003; IDC India, 2003; IDC, 2004; Reilly, 2005; Jacobson et al., 2007). The worldwide ERP market continues to grow at an annual rate of over 10% with revenues reaching $65 billion in 2008, and an estimated $61 billion in 2009, and $65 billion in 2010 (D'Aquila et al., 2009).

Firms in developed countries account for the bulk of ERP deployments worldwide (Mabert et al., 2003; Datamonitor, 2005) and most ERP system research focuses on implementations in the developed markets. It is only in the past few years that there has been an increasing penetration of ERP systems in developing markets and hence there is a paucity of studies that have examined the extent of ERP deployments in developing countries. Researchers attribute the rapid growth of ERP in developed markets in the 1990s due to their having built up a mature stock of ERP-related infrastructure requirements that support economic activity thus leaving room for productive ERP investment (Chandra and Sastry, 1998; 2002; Dewan and Kraemer, 2000; Huang and Palvia, 2001). Further, their studies suggest that the slow growth of ERP in developing markets, such as India, in the 1990s is due to their having to build up their basic ERP and complementary infrastructure before they can implement and begin to realize the benefits of ERP-related investments. In this study, we address the ERP research gaps in a developing market – India – and present a systematic and rigorous empirical assessment of ERP implementations in Indian production firms.

There was very low penetration of ERP systems in India till the mid-1990s with the market valued at about $3 million in 1995-96. The late 1990s witnessed higher growth rates, with the Indian ERP market growing at a compounded annual growth rate of 20 to 30% to reach $54 million in 2001 (De, 2001). Apart from a brief slump in the early 2000s, the Indian ERP market has been on a high growth trajectory clocking compounded annual growth rates of more than 10% to reach $83 million in 2004, $197 million in 2007, $241 million in 2008, and $260 million in 2009 (De, 2008; Chawla, 2009). The Indian ERP market is expected to reach $341 million in 2012 according to industry research analysts International Data Corporation (IDC) and Arc Advisory (Askari, 2007; De, 2007; Boparai, 2008).

Due to the relative newness of the ERP field in India and the rapid advances in ERP technologies, practitioner-oriented articles dominate literature. Descriptive and case studies form the bulk of Indian ERP research and empirical work is limited. Most studies have examined ERP issues – modules implemented, critical success factors (CSFs) emphasized, benefits realized – separately using a piecemeal approach and systematic studies with scientific rigor are by and large absent. Besides the above, the high incidence of problematic and delayed implementations in Indian firms also calls for a pan-Indian study on ERP deployments. De (2004) indicates that the average cost overrun among Indian ERP system implementers is 178 %, the average schedule overrun is 230% percent of original expectations, and the average decline in functional improvements is 59%. His study further indicates that 90% of ERP system deployments in India are problematic implementations.

Most researchers view the evolution of ERP systems from a manufacturing perspective – from materials requirements planning (MRP) to manufacturing resources planning (MRP II) to ERP (Rondeau and Litteral, 2001; Jacobs and Weston, 2007). Hence, most ERP systems are initially implemented in production firms (Mabert et al., 2000; Olhager and Selldin, 2003; Wang et al., 2005). The above suggests that production firms would account for the bulk of ERP system implementations in India. Gartner (2003) estimates the ERP penetration levels in the Indian manufacturing industry to be about 37%, customer relationship management (CRM) about 15%, and supply chain management (SCM)

about 10%. Recent studies by Forrester Research indicate that investments in ERP, SCM, and CRM by the manufacturing sector accounts for the majority of enterprise application spending in India (Pasha, 2008). The above findings lend support to the identification of production firms as the sample population for this study.

RESEARCH METHODOLOGY

This research used survey methodology to obtain data from Indian firms across a variety of production environments. An integral part of the research involved the development of a questionnaire to maximize understanding of ERP implementations among academicians and practitioners. Dillman's (2000) tailored design method (TDM) for constructing the questionnaire was followed to the extent possible. The initial questionnaire was developed from a synthesis of ERP as well as other relevant system studies. Inputs from two international focus groups of eight academicians and eight practitioners, a pre-test using a graduate ERP class in India, and a pilot study in an Indian production firm that had implemented ERP were used to develop and validate the questionnaire. Feedback from the focus and respondent groups was incorporated at each step of the questionnaire development process and allowed for an incremental and comprehensive development of the survey instrument. The final questionnaire collected information pertaining to five areas: business unit characteristics, respondent characteristics, implementation status of ERP modules, critical success factors to facilitate the ERP deployment process, and benefits obtained from the ERP implementation.

The 2,937 production firms represented in the Confederation of Indian Industry (CII) member directory and a list of 240 production firms from other media sources served as the target population for this study. The CII is India's apex business association and its member firms can be considered to be leaders in the use of IT systems such as ERP. Dillman's (2000) mixed mode TDM survey methodology was followed to the extent possible. Telephone calls were made to each of the 3,177 firms to ascertain whether the firm had implemented an ERP system, whether the firm was willing to participate in the survey, and who would be the best

person in the firm to send the survey instrument to and their contact details. This approach resulted in the selection of the names of 900 firms from the target population. Two mailings of the questionnaire were made. Of the surveys mailed in the two waves, a total of 231 responses were returned for a response rate of 25.67%. The figure 1 given below shows the research methodology employed.

Literature Review and identification of key study variables
Questionnaire Development (using Dillman's TDM method)
Selection of questionnaire items from literature to measure variables
Questionnaire review by international focus group of academicians (N = 8)
Questionnaire review by international focus group of ERP consultants (N = 8)
Questionnaire review by graduate MBA (ERP) class (N = 29)
Questionnaire review by pilot study firm (N = 72)
Purposive sampling method to extract names of production firms, identified as having implemented ERP, from the Confederation of Indian Industry (CII) member directory and other media sources
Use of Survey Methodology (using Dillman's mixed mode TDM method)
Pre-notice Letter sent to firms that have implemented ERP (N = 900)
Telephone Reminders made to all the second wave respondents two weeks after the second mailing date Second wave response (N = 104)
Total response (N = 231) for a response rate of 25.67% On obtainment of this satisfactory response rate, all additional mailings/contacts discontinued
Review of returned questionnaires for accuracy and completeness
Data Analyses
Thank you/Reminder Note sent by postal mail as well as email one week after the first wave mailing date   First wave response (N = 127)

Figure 1: Research Methodology

An examination of the 231 completed questionnaires revealed that 12 firms were yet to go live with their ERP systems and their responses were discarded. Three additional questionnaires were discarded

because they missed most of the data on key items. Since the focus of this study is on investigating ERP system implementations in production firms, the 216 remaining responses were evaluated based on the firm's level of manufacturing activities. A frequency distribution revealed that firms with 70% or more of their sales coming from production activities was a logical cut-off point to categorize firms as a majority of sales coming from production activities. This approach resulted in the omission of an additional 13 responses that represented primarily service firms. Only firms that realized 70% or more of their sales from production activities were included in the sample and thus the final dataset for analysis comprised of 203 responses.

SURVEY RESULTS: ENTERPRISE CHARACTERISTICS

The data pertaining to the characteristics of the sampled firms are summarized in Table 1.

The results in Table 1 indicate that the sample is a good representation of the Indian production sector comprising of firms of different sizes. The size of the firms was assessed in terms of the number of employees. The number of employees over 1,000 is the category most frequently represented and accounts for 41.4% of the sample. This, together with the number of employees in the 500 to 999 category, represents 66% of the sample. The number of employees in the two categories 0 to 99 and 100 to 249 account for only 14.3% of the sample.

Table 1: Enterprise Characteristics

Number of Employees	Frequency	Percent
0-99	4	2.0
100-249	25	12.3
250-499	40	19.7
500-999	50	24.6
Over 1000	84	41.4

Sector	Frequency	Percent
Private	167	82.3
Public	32	15.8
Joint	4	2.0

Origin	Frequency	Percent
Multinational	40	19.7
Indian	157	77.3
Joint Venture	6	3.0

Union Status	Frequency	Percent
Unionized	45	22.2
Non-Unionized	47	23.2
Both	111	54.7

Table 1 (contd.): Enterprise Characteristics

Industries	Frequency	Percent
Automotive	44	21.7
Machinery and Equipment	20	9.9
Basic Metal/Coal/Lignite/ Uranium /Thorium/Others	13	6.4
Electronic/Telecommunic ation Equipment	11	5.4
Apparel and Textiles	11	5.4
Food Products & Beverages	11	5.4
Coke/Crude/Petroleum/N atural Gas/Others	9	4.4
Fabricated Metal Products	7	3.4
Rubber/Plastic Products	5	2.5
Paper and Paper Products	5	2.5
Others	67	33.0

Production Environment	Percent of Products Produced
Make-to-Order	61.8
Make-to-Stock	38.2

Production Flow Type	Percent of Products Produced
Project	20.0
Job Shop	13.9
Batch	22.0
Repetitive	26.4
Flow	17.7

Type of ERP System Implemented	Frequency	Percent
Single Vendor ERP System		
SAP	60	**29.6**
Oracle/PeopleSoft	21	**10.3**
SSA Global/Baan	9	**4.4**
Microsoft	9	**4.4**
Ramco	8	**3.9**
QAD	5	**2.5**
ESS	5	**2.5**
Others	15	**7.4**
Best of Breed ERP System		
SAP & Oracle/PeopleSoft	2	**1.0**
SAP & SSA Global/Baan	2	**1.0**
Others	10	**4.9**
In-House Developed ERP System		
In-House Developed ERP	**57**	**28.1**

More than half the firms in the sample have a mix of both unionized and non-unionized environments and represent 54.7% of the sample. The firms constituting the remaining part of the sample are more or less evenly distributed between unionized (22.2%) and non-unionized (23.2%) environments. Studies indicate that unions could affect the implementation of ERP systems (Rose et al., 2005; Vijayabaskar, 2005); however, the results indicate that unions are not a compounding factor in Indian ERP deployments. Most of the sampled firms belong to the private sector and represent 82.3% of the sample. Thirty two public sector firms responded to the survey and form 15.8% of the sample. Joint sector firms account for 2% of the sample. This is in accordance with past research, which suggests that the private sector drives IT growth in India and accounts for over 70% of the total IT investment in the country (Chandrasekhar, 2005). A majority of firms are of Indian origin and comprise 77.3% of the sample. Multinational firms of foreign origin represent 19.7% of the sample while joint ventures constitute 6% of the sample. A wide variety of industries are represented in the sample. The majority of industries (67%) fall into one of ten major industry groups. Firms in the automotive industry are the most frequently represented group accounting for 21.7% of the sample.

Make-to-order was the primary production system used by firms in the sample. The mean percentage of products produced with a make-to-order (MTO) system was 61.8%; 38.2% of the products were produced with a make-to-stock (MTS) system. The sample data indicates that most firms employed a mix of different production processes; however, many firms also employed only one production process. Firms using the repetitive production process (26.4%) formed the largest mean percentage of the sample. Firms were more or less evenly distributed between the batch process (22.0%) and the project process (20.0%) types. The flow process type had a mean percentage of 17.7% and the job shop type 13.9%.

Table 1 also provides the frequency distribution for firms by the type of ERP system implemented. The table indicates that the majority of the firms implemented a single vendor ERP system representing 65% of the sample. SAP is the most dominant ERP system implemented by 29.6% of the sampled firms. This is followed by Oracle/PeopleSoft accounting for 10.3% of the sample, SSA Global/Baan and Microsoft representing 4.4% of the sample each, and Ramco comprising 3.9% of the sample. The other major ERP vendors are QAD and ESS, together representing 5.0% of the sample. A small number of firms have implemented two or more Best-of-Breed (BoB) ERP systems accounting for 6.9% of the sample. In-house developed ERP systems represent the second most dominant ERP system implemented among the sampled firms accounting for 28.1% of the sample. The above distribution, with the exception of in-house developed ERP systems, is similar to that seen in well developed ERP markets. For example, Mabert et al. (2000) indicates that single vendor ERP implementations, with SAP as the dominant ERP system (25%) adopted, account for the bulk of ERP deployments in the US production sector. Their study further indicates that BoB systems account for a small portion (9.8%) of the ERP systems in use.

RESPONDENT CHARACTERISTICS

The respondents' characteristics are given in Table 2. The respondents to the survey provided both their total number of years of work experience as well as years of work experience in the present firm. For ease of presentation, however, as shown in the first two parts of the table, responses were grouped into one of three categories: less than 5 years, 5 to 10 years, and over 10 years. The majority of the respondents possess more than 10 years of work experience accounting for 92.1% of the sample. The most frequently reported category is that of respondents with more than 10 years of work experience at the present firm accounting for 56.7% of the sample. The next highest category is respondents with less than 5 years of experience forming 29.5% of the sample. Twenty eight respondents have been with the same firm between 5 to 10 years and account for 13.8% of the sample.

Table 2: Respondent Characteristics

Total Experience	Frequency	Percent
Less than 5 years	6	3.0
5 to 10 years	10	4.9
Over 10 years	187	92.1

Experience with Present Organization	Frequency	Percent
Less than 5 years	60	29.5
5 to 10 years	28	13.8
Over 10 years	115	56.7

Current Position	Frequency	Percent
Top Management	103	50.7
Middle Management	81	39.9
Lower Management	8	3.9
Team Leaders	7	3.4
Others	4	2.0

Current Work Area	Frequency	Percent
Finance	15	7.4
Production	2	1.0
Marketing	4	2.0
Information Technology/Systems	175	86.2
Others	7	3.4

Level of Education	Frequency	Percent
Bachelor's degree	78	38.4
Master's degree	120	59.1
Doctorate	3	1.5
Others	2	1.0

About half the respondents belong to the top management category and constitute 50.7% of the sample. The next highest category of respondents is middle management and represents 39.9% of the sample. Lower management and team leaders account for 3.9% and 3.4% of the sample respectively. A majority of the respondents work in the information technology/ information systems area and represent 86.2% of the sample. Finance is the next highest work area reported and accounts for 7.4% of the sample. The other two functional areas reported are marketing and production accounting for 2% and 1% of the sample respectively. A majority of the respondents posses a master's degree and account for 59.1% of the sample. Seventy eight respondents have completed their bachelor's degree and represent 38.4% of the sample. Three respondents have reported completion of a doctoral degree and constitute 1.5% of the sample.

ERP IMPLEMENTATION STATUS

The average time in years since implementation began and the frequencies of implementations varied among the fourteen ERP modules in the sample. The average time in years since implementation began for each of the ERP modules was determined by first assigning values based on the midpoint of the scale ranges and then calculating the means of the assigned values for each of the modules. The means represent a relative measure for average time in years since implementation began for each ERP module or the length of time each ERP module has been in use. Past research on implementations such as Just-In-Time (JIT) systems (White et al., 1999; Chong et al., 2001) and quality systems (Berry, 1996) have similarly derived relative measures for average time in years since implementation began for JIT practices and quality practices respectively. Table 3 summarizes the respondents' answers to questions pertaining to their ERP implementation status.

Table 3: ERP Implementation Status

ERP Modules	Average Time in Years Since Implementation*	Number of Organizations with Module Implemented	Percent of Organizations with Module Implemented
Materials Management	3.66	197	97.0
Financials	3.61	189	93.1
Sales & Distribution	3.40	182	89.7
Production Planning	2.96	163	80.3
Quality Management	2.24	134	66.0
Controlling	2.23	125	61.6
General Logistics	1.84	100	49.3
Human Resources	1.72	117	57.6
Plant Maintenance	1.55	95	46.8
Supply Chain Management	1.02	62	30.5
Project System	0.92	63	31.0
E-commerce	0.45	34	16.7
Advanced Planner Optimizer/Scheduler	0.42	34	16.7
Customer Relationship Management	0.38	40	19.7

Note: N = 203

* Scale: Not implemented, Implementation started within the last year, Implementation started one to three years ago, Implementation started three to five years ago, and Implementation started more than five years ago.

The high extent of usage of ERP modules covering the financial and logistics areas of the sampled firms show remarkably similar trends with those in advanced ERP markets (Mabert et al. 2000). The data in Table 3 indicates that the module most implemented (197 firms) and with the highest extent of usage (3.66 years) was materials management. The second most frequently implemented module was financials (189 firms) with an average time since implementation began of 3.61 years. A majority of firms have also implemented the sales and distribution module (182 firms) with the extent of usage being 3.40 years. The customer relationship module (CRM) is the most recent module (.38 years) deployed by a small number of firms (40 firms). The second least frequently implemented module (42 firms) was advanced planner optimizer/ advanced planner scheduler (APO/APS) with an average time since implementation began of .42 years. Only 45 firms have implemented the electronic-commerce module

(E-Commerce) with the extent of usage being .45 years. The above findings are in tune with past ERP research, which suggests that firms first automate intra-firm activities before implementing modules that cater to inter-firm activities (Mabert et al., 2000; Shields, 2001; Olhager and Selldin, 2003).

ERP PERFORMANCE BENEFITS

A majority of the respondents (82.3%) indicated that ERP provided an overall net performance benefit for their firm. Only 9.4% reported no overall net performance benefit from deployment of ERP. The remaining 8.3% indicated obtainment of partial performance benefits as it was too early in the implementation process to measure an overall net performance benefit. The changes in performance measures attributable to ERP were recorded on a Likert type scale ranging from 1 (Disagree) to 7 (Agree). Table 4 summarizes the mean, median, and mode responses to questions pertaining to the benefits attributable to the firms' ERP implementations.

Table 4: ERP Performance Benefits

Performance	Mean*	Median	Mode
Information Availability	6.35	7.0	7.0
Information Quality	6.24	7.0	7.0
Standardization	6.05	6.0	7.0
Inventory Management	5.97	6.0	7.0
On-Time Delivery	5.91	6.0	7.0
User Satisfaction	5.83	6.0	6.0
Profitability	5.43	5.0	5.0
Return on Investment	5.43	6.0	6.0
Customer Satisfaction	5.38	6.0	6.0
Competitive Advantage	5.15	5.0	5.0

Note: * Scale: 1 to 7, "disagree" to "agree"

The data in Table 4 indicates that the maximum benefit derived by firms from implementing ERP systems was an increase in information availability. This was closely followed by increases in information quality and then standardization. The performance measure that registered the least improvement was increase in

competitive advantage. The above findings are in accordance with past ERP research, which suggests that most firms initially derive informational benefits from their ERP implementations (Mabert et al., 2000; Mabert et al., 2003; Olhager and Selldin, 2003). ERP information is then leveraged to improve operational performance measures such as inventory and on-time delivery. Efficiency in operations in turn leads to financial and organizational benefits (Mabert et al., 2000; Tarafdar and Roy, 2003; Hawking and Stein, 2004).

ERP CRITICAL SUCCESS FACTORS

The influence of CSFs on the ERP implementation were recorded on a Likert type scale ranging from 1 (Disagree) to 7 (Agree). Table 5 summarizes the mean, median, and mode responses to questions pertaining to the CSFs influencing the firms' ERP implementations. The role of communication in facilitating the ERP implementation was rated the highest. This was closely followed by data accuracy and then implementation team support. Respondents rated the influence of national culture the least among all the CSFs. The above findings are aligned with past research, which suggests that CSFs that pertain to organizational support and data integrity are crucial for successful deployment of ERP systems (Stratman and Roth, 2002; Kumar et al., 2003; Guido et al., 2007).

Table 5: ERP Critical Success Factors

Critical Success Factors	Mean*	Median	Mode
Communication	6.42	6.7	7.0
Data Accuracy	6.18	6.5	7.0
Implementation Team	6.09	6.5	7.0
Project Management	5.85	6.2	7.0
Top Management Support	5.81	6.2	7.0
Alignment	5.80	6.0	7.0
Training	5.64	6.0	7.0
User Support	5.59	5.8	7.0
Planning	5.56	5.3	6.5
Consultants	5.42	5.7	7.0
Organizational Culture	5.20	5.4	6.0
Learning	5.10	5.3	5.5
National Culture	4.94	5.0	5.0

Note: * Scale: 1 to 7, "disagree" to "agree"

ERP and Organization Size

Mabert et al. (2003) indicates that organization size plays an important role in ERP implementations. Their study suggests that firms of different sizes tend to do different things in their implementations leading to different outcomes and benefits. In this section, we examine the experience of Indian production firms on three key issues - implementation status, CSFs, performance benefits – across organizations of different sizes. In tune with past research (Kimberly, 1976; Yasai-Ardekani, 1989; Swamidas and Kotha, 1998), in this study we use number of employees as a measure of organization size.

The average time in years since implementation began and the frequencies of implementations varied among the fourteen ERP modules across different organization size categories ranging from 1 (smallest) to 5 (largest) (see Table 6). Table 6 summarizes the ERP implementation status of the sampled firms according to organization categories.

Table 6: ERP Implementation Status by Organization Size

ERP Modules	Organization Size Category*									
	Category 1		Category 2		Category 3		Category 4		Category 5	
	Average Time in Years^ and Percent Since Implementation									
	Time	%	Time	%	Time	%	Time	%	Time	%
Materials Management	2.13	100.0	3.50	88.0	3.24	92.3	3.50	98.0	4.08	97.6
Financials	2.26	75.0	3.48	84.0	3.00	90.0	3.58	94.0	4.01	94.0
Sales & Distribution	2.50	75.0	3.16	84.0	2.75	85.0	3.23	90.0	3.91	96.4
Production Planning	2.00	75.0	3.02	80.0	2.44	75.0	2.64	72.0	3.4	88.1
Quality Management	2.13	75.0	2.44	68.0	1.29	60.0	2.10	60.0	2.77	71.4
Controlling	2.00	50.0	1.67	56.0	1.08	42.5	2.36	60.0	2.8	73.8
General Logistics	0.13	25.0	1.46	44.0	1.25	45.0	1.42	44.0	2.57	57.1
Human Resources	0.50	25.0	2.08	72.0	1.65	60.0	1.65	50.0	1.74	58.3
Plant Maintenance	0.13	25.0	1.32	48.0	0.99	42.5	1.54	40.0	1.90	53.6
Supply Chain Management	0.50	25.0	1.62	40.0	0.91	25.0	0.70	24.0	1.11	44.5
Project System	0.13	25.0	0.76	28.0	0.56	20.0	0.70	20.0	1.33	44.0
E-commerce	0.0	0.0	0.68	28.0	0.20	12.5	0.29	12.0	0.58	19.0
Advanced Planner Optimizer/Scheduler	0.13	25.0	0.68	28.0	0.11	5.0	0.22	10.0	0.6	22.6
Customer Relationship Management	0.13	25.0	1.08	36.0	0.24	12.5	0.22	14.0	0.34	21.4

Note: * Category 1 = less than 99 employees (n = 4), Category 2 = 100 to 249 employees (n = 25), Category 3 = 250 to 499 employees (n = 40), Category 4 = 500 to 999 employees (n = 50), and Category 5 = greater than 1000 employees (n = 84)

^ Scale: Not implemented, Implementation started within the last year, Implementation started one to three years ago, Implementation started three to five years ago, and Implementation started more than five years ago.

The data in Table 6 indicates that the materials management module has the highest extent of usage and is the one most often implemented among firms in categories 2, 3, and 5. The financials module has the highest extent of usage and is the one most implemented among firms in categories 1 and 4. A majority of firms across all size categories have also implemented the sales and distribution module. The CRM, APO/APS, and E-Commerce modules are least often implemented across all organization categories. The results in Table 6 indicate that none of the firms in category 1 have deployed the E-Commerce module. The above findings suggest that large firms are early adopters of ERP systems followed by medium and small firms. The extent of usage of different modules for large firms reveals that firms initially implement modules that cover intra-firm areas such as financials and logistics. They then implement the next wave of modules such as CRM and E-Commerce to extend their ERP system to cover inter-firm areas. The results further indicate a similar usage pattern for medium and small firms.

Respondents from firms in categories 2 to 5 reported the greatest change in the information quality performance measure (see Table 7). This was closely followed by changes in the information availability measure. The above suggests that most firms in categories 2 to 5 are yet to leverage their informational benefits to obtain transactional and organizational benefits. Respondents from firms in category 1 reported the greatest changes in the inventory management and on-time delivery performance measures. This suggests that small firms are more flexible than their larger counterparts in leveraging ERP to address their business imperatives. Respondents from firms in categories 2 to 5 reported the least change in the competitive advantage performance measure; whereas

respondents from firms in category 1 indicated the least change in the customer satisfaction performance measure. Table 7 presents the benefits attributable to ERP implementations among firms of different sizes.

Table 7: ERP Performance Benefits by Organization Size

Performance	Organization Size Category*				
	Category 1	Category 2	Category 3	Category 4	Category 5
	Mean ^	Mean	Mean	Mean	Mean
Information Availability	6.25	6.16	6.25	6.32	6.48
Information Quality	6.25	6.16	6.12	6.14	6.37
Standardization	6.0	5.92	6.10	6.00	6.10
Inventory Management	6.50	6.08	5.78	6.00	5.98
On-Time Delivery	6.50	6.04	5.80	6.00	5.85
User Satisfaction	5.75	5.88	5.98	5.58	5.90
Profitability	5.25	5.64	5.48	5.28	5.44
Return on Investment	5.25	5.32	5.48	5.18	5.61
Customer Satisfaction	4.75	5.64	5.40	5.38	5.33
Competitive Advantage	5.00	5.12	5.08	4.96	5.31

Note:

* Category 1 = less than 99 employees (n = 4), Category 2 = 100 to 249 employees (n = 25), Category 3 = 250 to 499 employees (n = 40), Category 4 = 500 to 999 employees (n = 50), and Category 5 = greater than 1000 employees (n = 84)

^ Scale: 1 to 7, "disagree" to "agree"

The role of communication and ensuring data accuracy in facilitating the ERP implementation were rated the highest across firms of different sizes. The need for implementation team support was rated higher by larger firms (categories 3 to 5) than smaller firms (categories 1 and 2). Top management support and planning was considered more

important by firms in category 1 when compared to firms in all the other categories. This suggests that centralized decision-making processes tend to drive ERP deployments in smaller firms when compared to larger firms. Respondents across firms of different sizes rated the learning and national culture CSFs as least important in facilitating ERP deployments. A majority of firms across all size categories do not accord much importance to organizational culture changes in tandem with their technical implementations. Table 8 present the CSFs that facilitate ERP implementations among firms of different sizes.

Table 8: ERP Critical Success Factors by Organization Size

Performance	Organization Size Category*				
	Category 1	Category 2	Category 3	Category 4	Category 5
	Mean ^	Mean	Mean	Mean	Mean
Communication	6.58	6.12	6.46	6.46	6.45
Data Accuracy	6.56	6.00	6.29	6.20	6.13
Implementation Team	5.75	5.82	6.06	6.01	6.25
Project Management	5.45	5.58	5.68	5.65	6.14
Top Management Support	6.05	5.88	5.46	5.69	6.00
Alignment	5.92	5.93	5.69	5.60	5.93
Training	5.70	5.24	5.51	5.57	5.86
User Support	5.75	5.41	5.51	5.45	5.76
Planning	6.00	5.27	5.62	5.32	5.73
Consultants	5.41	5.14	5.21	5.44	5.60
Organizational Culture	5.60	5.20	5.34	4.95	5.26
Learning	4.81	4.89	5.07	4.88	5.32
National Culture	4.85	5.29	5.08	4.83	4.84

CONCLUSIONS

The purpose of this study was to conduct a systematic and rigorous survey on ERP implementations by Indian production firms. The data collected reveal a number of interesting facts important to academicians and practitioners. The use of ERP systems is pervasive in the Indian production sector. Private sector firms are spearheading the move to ERP. The automotive industry accounts for the bulk of ERP deployments. Most firms using ERP operate in a make-to-order production environment. SAP is the dominant ERP vendor closely followed by in-house developed and deployed ERP. There is a common core of modules being implemented by a majority of firms – materials management, financials, sales and distribution, production planning, quality management, and controlling. Firms are yet to extend their ERP deployments to cover inter-firm activities. The above deployment pattern is noticeable among firms across all organization size categories.

ERP benefits are focused on quickly providing high quality information within the firm. Accordingly, firms place high emphasis on ensuring data accuracy. At the moment, barring small firms (in category 1), respondents indicate that ERP has not resulted in significant improvements in operational performance. This suggests that the benefits of ERP accruing to firms are yet to impact their external stakeholders such as customers. Most firms, however, indicate a net overall benefit from their ERP deployments. This suggests that extreme stories of failed implementations are reported in the popular press and typical beneficial outcomes are ignored. Communication and data integrity are crucial factors in facilitating implementations across firms of all sizes.

In this study, we have identified the common modules implemented, the benefits derived, and the critical success factors that firms emphasize in their ERP deployments. We also examined the above differ with respect to the size of the firm. A perusal of the study results indicates that the Indian ERP market follows remarkably similar trends to the developed ERP markets such as the US of the 1990s and the early 2000s (Mabert et al. 2000; 2001; 2003) – in terms of implementation status, CSFS emphasized, and the performance benefits obtained. The Indian ERP market remains focused on implementation issues – how to effectively meet the challenges of getting the system up and running. Most implementers are yet to focus on management issues – how to extract the maximum business benefits from the system.

This study provides a foundation for carrying out further investigations. For example, the data reveals that firms are yet to attain significant operating cost reductions and overall organizational benefits from their ERP deployments. Why is that the case? Is it a reflection of poor alignment between ERP and business processes? Have firms not instituted organizational culture changes in tandem with the technical ERP deployments? Does the extent of ERP adoption determine the level of benefits obtained? Does throwing more and more ERP modules at business problems result in those problems being solved? What should firms do to move beyond implementation and maintenance issues and focus on operational and strategic usage issues? This study is an initial step to seek answers to such questions that could help firms' leverage their ERP to achieve better business performance.

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