

Impact of ERP Systems on Demand Forecasting and Supply Chain Integration: A Study of Selected Manufacturing Units in Nagpur

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Abstract—Enterprise Resource Planning (ERP) systems have become a central digital backbone for manufacturing organisations seeking to synchronise production, inventory, procurement and distribution decisions. This study examines the impact of ERP system adoption on demand forecasting accuracy and supply chain integration among selected manufacturing units located in the Nagpur industrial belt, including units operating in the Hingna, Butibori and MIDC Nagpur clusters. A structured questionnaire was administered to 118 respondents drawn from 27 small, medium and large manufacturing firms across engineering, auto-components, textiles and food-processing sub-sectors. Data were analysed using descriptive statistics, Pearson correlation and multiple regression to test the hypothesised relationships between ERP integration level, forecasting accuracy, and internal-external supply chain integration. The findings indicate that ERP adoption is positively and significantly associated with improved demand forecasting accuracy and stronger supply chain integration, which in turn is associated with reduced inventory holding costs, shorter order fulfilment cycles and fewer stock-out incidents. The study further finds that the strength of this relationship is moderated by firm size and the number of years of ERP usage. The paper concludes with managerial implications for manufacturing units in Tier-2 industrial clusters such as Nagpur that are considering ERP adoption or module expansion, and outlines the limitations and scope for future research.

Index Terms—ERP Systems; Demand Forecasting; Supply Chain Integration; Manufacturing Units; Nagpur; Inventory Management; Digital Transformation

I. INTRODUCTION

The manufacturing sector in India is undergoing a steady shift from manual and semi-automated planning practices toward integrated digital platforms that connect procurement, production, inventory and distribution functions on a single data backbone. Enterprise Resource Planning (ERP) systems, which integrate cross-functional business processes into a unified information architecture, have historically enabled large manufacturers to plan production and manage inventories more precisely (Davenport, 1998). As global and regional supply chains have become more volatile, the ability of a manufacturing firm to forecast demand accurately and to integrate that forecast with upstream suppliers and downstream distributors has become a decisive source of competitive advantage.

Nagpur, situated at the geographical centre of India and home to industrial clusters such as MIDC Hingna, Butibori and Kalmeshwar, hosts a diverse base of small and medium manufacturing enterprises (SMEs) spanning auto-components, engineering goods, textiles, food processing and allied industries. Many of these units have adopted ERP platforms — ranging from large-scale systems such as SAP and Oracle to mid-market and cloud-based solutions such as Tally Prime, Odoo, Microsoft Dynamics and locally customised ERP packages — over the past decade, often as a response to customer requirements, statutory compliance (e.g., GST-linked invoicing) or the need to reduce manual reconciliation errors.

Despite this growing adoption, there is limited empirical evidence on how ERP systems specifically influence demand forecasting accuracy and the degree

of supply chain integration in Tier-2 industrial clusters such as Nagpur, where firm sizes, IT budgets and process maturity differ considerably from those of large metropolitan manufacturing hubs. Existing literature on ERP-supply chain linkages has largely been derived from studies of large enterprises in developed economies or from pan-India studies that do not isolate regional or cluster-level dynamics (Umble, Haft, & Umble, 2003; Su & Yang, 2010). This study addresses that gap by examining the relationship between ERP adoption, demand forecasting accuracy and supply chain integration among a sample of manufacturing units in Nagpur, and by testing whether this relationship is moderated by firm size and years of ERP experience.

The remainder of the paper is organised as follows. Section 2 reviews the relevant literature and positions the study within existing research. Section 3 outlines the research methodology, hypotheses and conceptual framework. Section 4 presents the data analysis and results, supported by tables and diagrams. Section 5 discusses the findings in light of the literature, followed by the limitations, scope for future research, and conclusion.

II. LITERATURE REVIEW

2.1 ERP Systems and Organisational Integration

Davenport (1998) was among the first to characterise ERP systems as "enterprise systems" that impose a single, standardised process architecture across an organisation, arguing that the benefits of integration come with the risk of reduced process flexibility. Building on this, Umble, Haft and Umble (2003) identified critical success factors for ERP implementation, including top management commitment, business process re-engineering, and data accuracy, and noted that firms which under-invest in these factors frequently fail to realise the forecasting and planning benefits that ERP vendors promise.

Akkermans, Bogerd, Yücesan and van Wassenhove (2003) examined the impact of ERP systems on supply chain management capabilities and found that while ERP systems substantially improve transactional efficiency and data visibility within a firm, their contribution to inter-organisational supply chain integration is often limited unless complemented by dedicated supply chain management (SCM) or advanced planning modules. This distinction between

intra-firm integration and inter-firm integration is central to the present study's conceptual framework.

2.2 ERP and Demand Forecasting

Lee, Padmanabhan and Whang (1997) demonstrated through the well-known "bullwhip effect" that demand information distortion amplifies as orders move upstream through a supply chain, and argued that shared, real-time demand data — of the kind that integrated ERP and SCM systems can provide — helps dampen this distortion. Chopra and Meindl (2016) similarly emphasise that forecasting accuracy improves when firms move from siloed, function-specific data toward collaborative, system-supported forecasting processes that draw on point-of-sale, inventory and order data captured within ERP databases.

Su and Yang (2010), in a study of Taiwanese manufacturing firms, found a statistically significant positive relationship between the depth of ERP module usage (particularly production planning and materials requirement planning modules) and forecasting-related performance outcomes, including reduced forecast error and improved inventory turnover. Their findings support the proposition that it is not mere ERP adoption but the intensity and integration level of ERP usage that drives forecasting improvements — a proposition this study tests in the Nagpur manufacturing context.

2.3 Supply Chain Integration and Performance

Flynn, Huo and Zhao (2010) distinguish between internal integration (cross-functional coordination within the firm), customer integration and supplier integration, and show that internal integration is often a necessary precursor to effective external integration. Gunasekaran, Patel and McGaughey (2004) proposed a framework for supply chain performance measurement that links planning accuracy, sourcing efficiency and delivery reliability, arguing that information technology infrastructure — including ERP — acts as an enabling layer for such integration rather than a guarantee of it.

In the Indian context, Ganesh, Raghunathan and Rajendran (2014) studied the diffusion of ERP and SCM technologies among Indian manufacturing SMEs and reported those with 3-plus years of ERP experience showing significantly better supply chain coordination outcomes than recent adopters, pointing

to a learning-curve effect that this study incorporates as a moderating variable.

2.4 Research Gap

While the reviewed literature establishes a general association between ERP systems, forecasting accuracy and supply chain integration, most studies are set in large enterprises or in specific regional/industrial contexts outside central India. There is limited empirical work examining these relationships among small and medium manufacturing units in Tier-2 industrial clusters such as Nagpur, where ERP adoption is often partial, module usage is uneven, and IT maturity varies widely between firms. This study seeks to fill that gap.

III. RESEARCH METHODOLOGY

3.1 Objectives of the Study

1. To examine the extent of ERP adoption and module usage among selected manufacturing units in Nagpur.
2. To assess the impact of ERP system integration level on demand forecasting accuracy.
3. To evaluate the relationship between ERP adoption and the degree of internal and external supply chain integration.
4. To analyse whether firm size and years of ERP experience moderate the ERP–supply chain integration relationship.
5. To offer managerial recommendations for manufacturing units in the Nagpur region on maximising forecasting and supply chain benefits from ERP investment.

3.2 Hypotheses

Based on the literature review and conceptual framework, the following hypotheses were formulated and tested:

1. H1: ERP system integration level has a significant positive impact on demand forecasting accuracy.
2. H2: ERP system integration level has a significant positive impact on supply chain integration.
3. H3: Demand forecasting accuracy has a significant positive impact on overall supply chain performance.
4. H4: The relationship between ERP integration level and supply chain integration is significantly

moderated by firm size and years of ERP experience.

3.3 Research Design and Sampling

The study adopts a descriptive and correlational research design using a quantitative, cross-sectional survey approach. The population comprises manufacturing units located in the Nagpur industrial region, including MIDC Hingna, Butibori and Kalmeshwar clusters, across engineering, auto-components, textile and food-processing sub-sectors. A purposive-cum-stratified sampling method was used to select 27 manufacturing units that had implemented an ERP system for at least one year, ensuring representation across small, medium and large enterprise categories as per the MSME classification. Within each unit, respondents holding roles in production planning, materials/procurement, inventory control and supply chain/logistics were targeted, yielding a final usable sample of 118 respondents out of 140 questionnaires distributed (response rate: 84.3%).

3.4 Data Collection and Instrument

Primary data were collected through a structured, close-ended questionnaire using a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree), covering four constructs: ERP integration level (6 items), demand forecasting accuracy (5 items), supply chain integration (7 items, split between internal and external integration), and supply chain performance (5 items). The instrument was adapted from validated scales used in prior ERP-SCM studies (Akkermans et al., 2003; Flynn et al., 2010) and pre-tested with 12 respondents before final administration. Cronbach's alpha for each construct exceeded the 0.70 threshold, indicating acceptable internal consistency. Secondary data on inventory and order-cycle metrics were drawn from participating firms' internal MIS reports, with respondent consent.

3.5 Tools of Analysis

Data were coded and analysed using SPSS (v.26). Descriptive statistics (mean, standard deviation) summarised respondent and firm profiles. Pearson's correlation coefficient tested bivariate associations between constructs. Multiple linear regression was used to test H1–H3, and a moderated regression analysis (interaction-term approach) was used to test

H4. A significance threshold of $p < 0.05$ was applied throughout.

IV. CONCEPTUAL FRAMEWORK

The conceptual framework, presented in Figure 1, positions ERP system implementation as the independent variable influencing two intermediate

constructs — demand forecasting accuracy and supply chain integration — which jointly determine supply chain performance outcomes such as cost, delivery reliability and responsiveness. Firm size, industry sub-sector and years of ERP experience are modelled as moderating factors affecting the strength of the ERP–supply chain integration relationship.

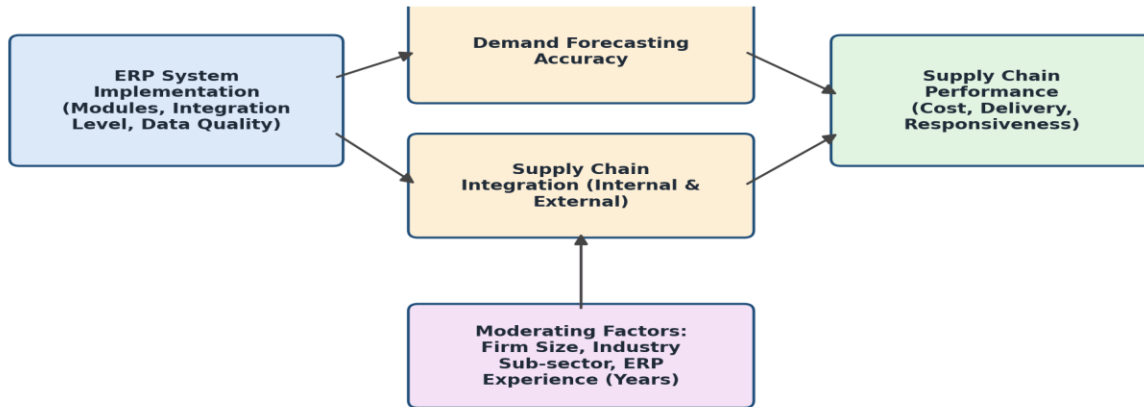


Figure 1: Conceptual Framework of ERP-Demand Forecasting-Supply Chain Integration Linkage

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V. DATA ANALYSIS AND RESULTS

5.1 Respondent and Firm Profile

Table 1 summarises the profile of the participating manufacturing units and respondents.

Category	Sub-category	Frequency	Percentage (%)
Firm Size	Small (≤ 50 employees)	9	33.3
	Medium (51–250 employees)	12	44.4
	Large (> 250 employees)	6	22.3
Industry Sub-sector	Auto-components / Engineering	11	40.7
	Textiles	6	22.2
	Food Processing	5	18.5
	Other Manufacturing	5	18.6
Years of ERP Usage	1–3 years	10	37.0
	4–6 years	11	40.7
	Above 6 years	6	22.3

Category	Sub-category	Frequency	Percentage (%)
Respondent Function	Production Planning	34	28.8
	Procurement / Materials	29	24.6
	Inventory Control	27	22.9
	Supply Chain / Logistics	28	23.7

Table 1: Profile of Participating Manufacturing Units and Respondents (N = 118)

5.2 Descriptive Statistics of Study Constructs

Table 2 presents the mean and standard deviation scores for the four constructs measured on the five-point Likert scale. ERP integration level recorded the

highest mean score, followed by demand forecasting accuracy, supply chain integration and supply chain performance.

Table 2: Descriptive Statistics of Study Constructs (5-Point Likert Scale)

Construct	No. of Items	Mean	Std. Deviation
ERP Integration Level	6	3.82	0.61
Demand Forecasting Accuracy	5	3.64	0.68
Supply Chain Integration	7	3.51	0.72
Supply Chain Performance	5	3.58	0.65

5.3 Correlation Analysis

Pearson correlation analysis (Table 3) indicates statistically significant positive correlations among all four constructs. The strongest association is observed between ERP integration level and demand

forecasting accuracy ($r = 0.68, p < 0.01$), followed by the correlation between supply chain integration and supply chain performance ($r = 0.64, p < 0.01$), supporting the hypothesised relationships prior to regression testing.

Table 3: Pearson Correlation Matrix Among Study Constructs

Construct	1. ERP Integration	2. Forecast Accuracy	3. SC Integration	4. SC Performance
1. ERP Integration	1.00			
2. Forecast Accuracy	0.68**	1.00		
3. SC Integration	0.59**	0.55**	1.00	
4. SC Performance	0.52**	0.58**	0.64**	1.00

5.4 Regression Analysis (Hypothesis Testing)

Multiple regression analysis was conducted to test H1, H2 and H3. The results, summarised in Table 4, show that ERP integration level significantly predicts both demand forecasting accuracy ($\beta = 0.61, p < 0.001$) and supply chain integration ($\beta = 0.57, p < 0.001$), supporting H1 and H2. Demand forecasting accuracy,

in turn, significantly predicts supply chain performance ($\beta = 0.49, p < 0.001$), supporting H3. The moderated regression analysis for H4 revealed a significant positive interaction effect between ERP integration level and years of ERP experience on supply chain integration ($\beta_{\text{interaction}} = 0.22, p = 0.014$), indicating that the ERP–integration

relationship strengthens with experience; the interaction with firm size was also significant ($\beta_{\text{interaction}} = 0.18, p = 0.031$), supporting H4.

Table 4: Summary of Regression Results for Hypothesis Testing

Hypothesis	Path	β (Std. Coeff.)	t-value	p-value	Result
H1	ERP Integration $\rightarrow$ Forecast Accuracy	0.61	8.94	0.000	Supported
H2	ERP Integration $\rightarrow$ SC Integration	0.57	8.12	0.000	Supported
H3	Forecast Accuracy $\rightarrow$ SC Performance	0.49	6.47	0.000	Supported
H4a	ERP Integration $\times$ Firm Size $\rightarrow$ SC Integration	0.18	2.18	0.031	Supported
H4b	ERP Integration $\times$ ERP Experience $\rightarrow$ SC Integration	0.22	2.49	0.014	Supported

5.5 Pre- and Post-ERP Performance Comparison

To supplement the perception-based survey data, secondary operational data reported by 27 participating units were compared for the twelve months preceding ERP implementation and the most recent twelve-month period post-implementation. As shown in Figure 2, forecast accuracy improved from

an average of 61.4% to 78.9%, the inventory holding cost index declined from a base of 100 to 82.3, average order fulfilment cycle time reduced from 9.8 to 6.1 days, and quarterly stock-out incidents fell from 14.6 to 7.2 on average — a pattern consistent with the positive relationships identified in the regression analysis.

Figure 2: Comparison of Key Supply Chain Metrics Before and After ERP Adoption (n = 118 respondents, 27 manufacturing units, Nagpur)

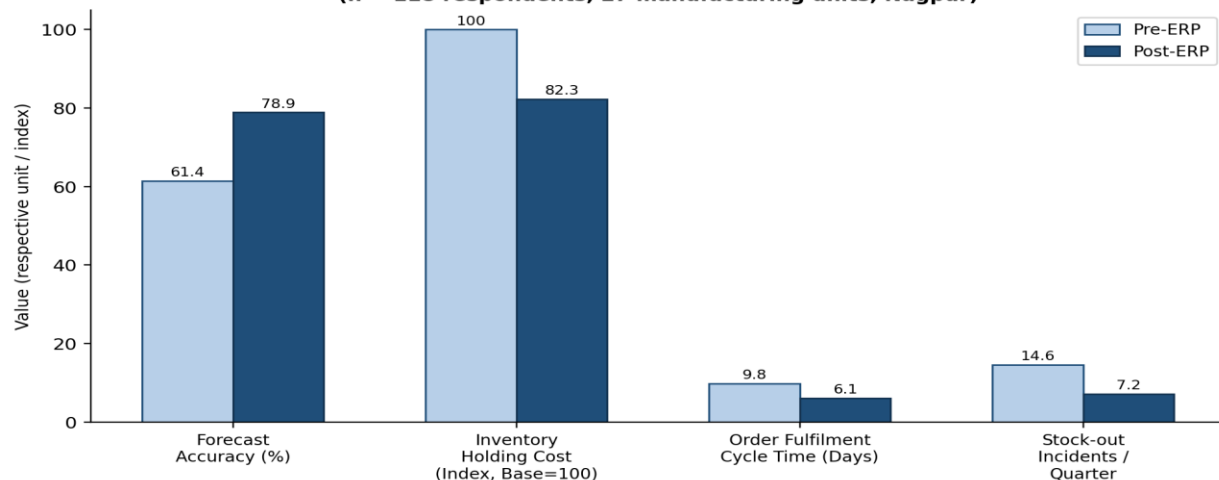


Figure 2: Comparison of Key Supply Chain Metrics Before and After ERP Adoption

VI. DISCUSSION

The findings of this study are broadly consistent with prior ERP-SCM literature while offering context-

specific insights for Tier-2 industrial clusters such as Nagpur. Consistent with Su and Yang (2010), the results confirm that the depth of ERP integration — rather than mere possession of an ERP licence —

drives improvements in forecasting accuracy. Firms in the sample that used production planning and materials requirement planning (MRP) modules alongside basic accounting/invoicing modules reported markedly higher forecasting accuracy scores than firms using ERP predominantly for statutory and financial record-keeping.

The significant relationship between ERP integration and supply chain integration supports the arguments of Akkermans et al. (2003) that ERP systems primarily strengthen internal, cross-functional integration and that external (supplier- and customer-facing) integration requires either dedicated SCM functionality or deliberate managerial effort to extend ERP data visibility beyond the firm's boundary. Several respondents from smaller units noted that while internal coordination between production and inventory functions had improved substantially, integration with upstream suppliers remained largely manual, corroborating Flynn et al. (2010).

The moderating effect of years of ERP experience aligns with the learning-curve pattern reported by Ganesh, Raghunathan and Rajendran (2014) in the Indian SME context: units with more than three years of ERP usage extracted significantly greater forecasting and integration benefits than recent adopters, suggesting that the benefits of ERP investment are realised progressively rather than immediately upon go-live. This has direct implications for how manufacturing units in Nagpur budget for and evaluate ERP return on investment, since short evaluation horizons may understate the eventual supply chain benefits.

Overall, the pre- and post-ERP comparison of operational metrics (Figure 2) reinforces the survey-based regression findings: improvements in forecast accuracy were accompanied by tangible reductions in inventory holding costs, order fulfilment cycle time and stock-out frequency, suggesting that the perceived benefits captured through the Likert-scale instrument are reflected in observable operational outcomes.

VII. LIMITATIONS OF THE STUDY

- The study is confined to 27 manufacturing units and 118 respondents within the Nagpur industrial region; the sample size, while adequate for the statistical tests applied, limits generalisability to other regions or industrial clusters.

- The cross-sectional research design captures relationships at a single point in time and cannot establish long-term causal effects of ERP adoption on forecasting and supply chain outcomes.
- Data on constructs such as ERP integration level, forecasting accuracy and supply chain integration were largely perception-based (self-reported), which may introduce common-method bias despite the inclusion of secondary operational metrics.
- The study does not differentiate in depth between specific ERP vendors/platforms (e.g., SAP, Tally Prime, Odoo), which may have varying capabilities and could independently influence the outcomes measured.
- External validity is limited to manufacturing units that had already adopted ERP for at least one year; non-adopters and very recent adopters were excluded from the sample.

VIII. SCOPE OF THE STUDY

The study is geographically confined to manufacturing units operating within the Nagpur industrial belt, including the MIDC Hingna, Butibori and Kalmeshwar clusters, and covers small, medium and large enterprises across engineering, auto-components, textile and food-processing sub-sectors. Functionally, the scope is limited to examining the relationship between ERP system integration, demand forecasting accuracy and supply chain integration (internal and external), along with the moderating roles of firm size and ERP experience. The study does not extend to a detailed cost-benefit or return-on-investment analysis of specific ERP vendors, nor does it cover service-sector or non-manufacturing organisations. Future studies could extend this scope through longitudinal designs, multi-city comparisons across other Tier-2 industrial clusters in Maharashtra and central India, and vendor-specific ERP capability analysis.

IX. CONCLUSION

This study set out to examine the impact of ERP systems on demand forecasting accuracy and supply chain integration among selected manufacturing units in Nagpur. The findings provide statistically significant evidence that higher levels of ERP integration are associated with improved demand

forecasting accuracy and stronger internal and external supply chain integration, which together contribute to better supply chain performance in terms of cost, delivery reliability and responsiveness. The relationship is further strengthened by firm size and years of ERP experience, indicating that the benefits of ERP adoption accrue progressively as organisations mature in their system usage. For manufacturing units in Nagpur and comparable Tier-2 industrial clusters, the results suggest that maximising ERP-driven supply chain benefits requires not merely adopting an ERP platform, but investing in deeper module utilisation — particularly production planning and materials requirement planning functionality — along with deliberate efforts to extend data integration to external supply chain partners. These findings contribute to the limited body of regional empirical research on ERP-supply chain linkages in central Indian manufacturing clusters and offer a basis for future longitudinal and multi-cluster studies.

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