



# **A STUDY OF VENDOR-MANAGED INVENTORY (VMI) AND CLOUD-BASED INVENTORY MANAGEMENT TOOLS FOR MSMEs IN BOISAR MIDC OF PALGHAR DISTRICT**

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## **ABSTRACT**

*Micro, Small, and Medium Enterprises (MSMEs) are pivotal to India's manufacturing growth, yet they struggle with efficient inventory management due to infrastructural bottlenecks, outdated practices, and limited digital integration. This study explores the adoption potential of two transformative approaches—Vendor-Managed Inventory (VMI) and Cloud-Based Inventory Management Tools—within the industrial cluster of Boisar MIDC, Palghar District. A survey of 380 MSMEs reveals that while awareness of cloud-based systems is growing, actual implementation remains limited. VMI adoption is even lower, hindered by trust gaps and integration challenges. However, early adopters report tangible benefits including reduced lead times, improved collaboration, and operational cost savings. Using path modelling, the study confirms significant positive effects of technology adoption on manufacturing efficiency ( $\beta = 0.49$ ) and strategic planning. These findings underscore the need for policy-backed digital training, phased technology rollouts, and stronger vendor partnerships. The study offers a scalable framework for enhancing inventory efficiency across similar industrial clusters in India.*

**Keywords:** *Vendor-Managed Inventory (VMI), Cloud-Based Inventory Tools, Inventory Control, Manufacturing Efficiency, Technology Adoption*

### ABSTRAK

Usaha Mikro, Kecil, dan Menengah (UMKM) merupakan pendorong utama pertumbuhan manufaktur di India, namun mereka masih menghadapi kendala dalam pengelolaan persediaan akibat terbatasnya infrastruktur, praktik yang sudah usang, dan minimnya integrasi digital. Studi ini mengeksplorasi potensi adopsi dua pendekatan transformatif—Vendor-Managed Inventory (VMI) dan alat manajemen persediaan berbasis cloud—di kawasan industri Boisar MIDC, Distrik Palghar. Survei terhadap 380 UMKM menunjukkan bahwa meskipun kesadaran terhadap sistem berbasis cloud semakin meningkat, tingkat implementasinya masih rendah, dan adopsi VMI bahkan lebih rendah karena kurangnya kepercayaan serta tantangan integrasi. Namun, para pengguna awal melaporkan manfaat nyata seperti pengurangan waktu tunggu, peningkatan kolaborasi, dan penghematan biaya operasional. Melalui pemodelan jalur (path modelling), studi ini mengonfirmasi adanya pengaruh positif signifikan dari adopsi teknologi terhadap efisiensi manufaktur ( $\beta = 0,49$ ) dan perencanaan strategis. Temuan ini menegaskan perlunya pelatihan digital yang didukung kebijakan, penerapan teknologi secara bertahap, serta penguatan kemitraan dengan vendor, dan studi ini menawarkan kerangka yang dapat diskalakan untuk meningkatkan efisiensi pengelolaan persediaan di kluster industri sejenis di India.

**Kata kunci:** *Vendor-Managed Inventory (VMI)*, *Alat Manajemen Persediaan Berbasis Cloud*, *Pengendalian Persediaan*, *Efisiensi Manufaktur*, *Adopsi Teknologi*

### INTRODUCTION

Micro, Small, and Medium Enterprises (MSMEs) are the bedrock of industrial growth and innovation in developing economies. In India alone, MSMEs contribute nearly 30% of GDP and employ over 110 million people across sectors (Murthy & Padmalatha, 2024). However, these enterprises often lag in adopting contemporary management practices, especially in operational domains such as inventory control. Inventory management is central to manufacturing success—it affects cash flows, order fulfillment, production continuity, and strategic planning. Yet, inventory operations in many Indian MSMEs, particularly those in semi-urban industrial clusters like Boisar MIDC in Palghar District, remain largely manual, unstructured, and inefficient (Ghosh, 2021). The traditional approach to inventory management in MSMEs involves handwritten registers, spreadsheet logs, or basic tally-based systems. These methods lack real-time responsiveness and are prone to errors, leading to problems such as stockouts, overstocking, and order delays (Choudhury & Nayak, 2021). As businesses move towards leaner, data-driven, and digitally integrated supply chains, such manual systems fail to provide the necessary agility and precision. Increasing globalization and competitive pressure from larger firms have only intensified the need for Indian MSMEs to digitize their inventory control mechanisms (Raut, Narwane, & Gardas, 2021).

Two inventory strategies have emerged as transformational tools in this space: Vendor-Managed Inventory (VMI) and Cloud-Based Inventory Management Systems. VMI is a supply chain collaboration model wherein the supplier, rather than the buyer, is responsible for maintaining adequate inventory levels at the customer's location (Waller, Johnson, & Davis, 1999). This model promises reduced lead times, better order accuracy, and fewer administrative bottlenecks. On the other hand, cloud-based inventory tools provide real-time data visibility, system integration, and automation capabilities—without requiring heavy investment in physical infrastructure (Jaiswal & Sharma, 2023). The need for these solutions is especially pressing in industrial clusters like Boisar MIDC, where hundreds of MSMEs operate in textiles, chemicals, engineering goods, and food processing sectors. These enterprises often lack

sophisticated ERP systems or supply chain software and operate on thin margins. As a result, they are vulnerable to inventory mismanagement, affecting their competitiveness and profitability (Krishnan & Jha, 2022). While awareness of VMI and cloud tools is growing, their practical adoption remains limited, primarily due to a combination of technical, financial, and behavioral barriers (Patel & Gaur, 2020).

Vendor-Managed Inventory (VMI), as first outlined in logistics theory, aims to mitigate inefficiencies arising from the decoupling of inventory responsibilities between buyer and supplier (Disney & Towill, 2003). In traditional procurement models, buyers place orders based on internal planning; in VMI systems, suppliers proactively replenish stocks based on consumption data shared by the buyer. The result is improved synchronization across the supply chain, which reduces the bullwhip effect—a phenomenon where small demand fluctuations at the customer end lead to amplified variability upstream (Angulo, Nachtmann, & Waller, 2004). Empirical studies indicate that VMI adoption can improve forecast accuracy and optimize order cycles (Kaipia & Tanskanen, 2003). However, it requires a high degree of trust, transparent data-sharing, and technical integration, which are often lacking in MSME environments (Chopra & Meindl, 2019).

In India, few MSMEs have adopted full-fledged VMI models due to several constraints. Firstly, vendor relationships are often informal, lacking long-term contracts or performance metrics. Secondly, the technological interface required to enable real-time inventory data exchange—such as API connectivity or RFID tagging—is often missing. Thirdly, many MSME owners are reluctant to relinquish control over stock decisions due to concerns about overstocking, data misuse, or supplier unreliability (Singh, 2011). As a result, while the theoretical benefits of VMI are well-established, the model's implementation remains weak in regions like Boisar MIDC. Meanwhile, Cloud-Based Inventory Management Systems offer a more accessible route for digital transformation in inventory control. These systems—available through platforms like Zoho Inventory, TallyPrime, and Odoo—operate on software-as-a-service (SaaS) models. They allow MSMEs to track inventory across locations, automate reordering, generate real-time dashboards, and integrate with financial and sales functions (Jain & Singh, 2022). Unlike traditional ERP systems, which require upfront capital expenditure and internal IT support, cloud tools offer subscription-based models that are affordable and scalable.

The adoption of cloud systems in Indian MSMEs has been modest but promising. Studies show that early adopters benefit from increased data accuracy, improved procurement planning, and reduced human error (Hashem et al., 2015). These systems are also more resilient in crises—such as during the COVID-19 pandemic—because they support remote access, cross-location coordination, and faster recovery (Gunasekaran, Patel, & McGaughey, 2017). According to Das and Mohapatra (2019), the biggest enablers for cloud adoption in Indian SMEs are user-friendliness, vendor support, and compatibility with GST compliance platforms. Despite their potential, cloud systems remain underutilized in semi-urban industrial zones due to multiple factors.

Digital illiteracy, lack of structured training programs, fear of cybersecurity breaches, and poor internet connectivity continue to hinder full-scale adoption (Ghosh, 2021; Raut et al., 2021). Many MSMEs, especially micro and small units, rely on word-of-mouth or peer influence for software adoption and hesitate to invest in paid systems unless the benefits are immediately visible (Jain & Singh, 2022). Moreover, the absence of integration with vendor

portals, warehouse systems, or upstream ordering platforms often reduces the utility of these tools to mere digital logbooks (Jaiswal & Sharma, 2023).

Interestingly, several government initiatives—such as the Digital MSME Scheme and Champions Portal—have attempted to bridge these gaps by offering awareness programs, subsidized training, and free access to cloud tools. However, these interventions are yet to penetrate deeply into industrial corridors like Boisar MIDC, where MSMEs operate with minimal digital touchpoints (Patel & Gaur, 2020; Ghosh, 2021). This highlights the need for localized research that explores ground-level realities of inventory technology adoption, including behavioral factors, trust dynamics, and infrastructure gaps. A regional case study becomes particularly valuable in this context. Boisar MIDC, located in Maharashtra's Palghar District, hosts over 1200 registered MSMEs with a broad mix of manufacturing activities.

The region is served by cluster-based infrastructure but faces typical semi-urban challenges: limited skilled manpower, inconsistent power supply, and weak institutional support (Murthy & Padmalatha, 2024). Its proximity to Mumbai and growing investor interest also position it as a potential testbed for scalable inventory transformation solutions. Studies from other countries further reinforce the relevance of inventory digitalization for SMEs. In Bangladesh, cloud-based inventory systems led to improved demand forecasting and procurement efficiency among small garment manufacturers (Alam, Thakur, & Islam, 2024). In Kenya, inventory optimization was directly linked to better financial performance in sugar firms (Lwiki et al., 2013). These findings suggest that similar benefits are achievable in Indian contexts if adoption barriers are addressed systematically.

Beyond operational efficiency, better inventory control contributes to improved financial decision-making, risk mitigation, and strategic growth. Enterprises that manage inventory more accurately tend to reduce working capital lock-up, optimize procurement costs, and improve delivery reliability (Nahmias & Olsen, 2021; Singh, 2011). Additionally, integration with cloud-based accounting tools enables better financial forecasting and GST compliance—factors increasingly important in India's digitized business environment (Chopra & Meindl, 2019). Despite this, research on VMI and cloud inventory systems in the Indian MSME sector remains sparse, fragmented, and often focused on macro-level narratives. Few studies capture the nuances of ground-level adoption, especially in regional clusters like Boisar MIDC. This study addresses that gap by conducting a structured field investigation into the awareness, adoption, and perceived outcomes of these tools among 380 MSMEs in the region. The research is guided by the following questions:

1. What is the current level of awareness and usage of VMI and cloud inventory systems among MSMEs in Boisar MIDC?
2. What operational or perceptual barriers hinder their adoption?
3. What measurable benefits—if any—do early adopters observe in terms of cost savings, lead time reduction, and data integration?
4. How can policy, technology, and training be tailored to accelerate inventory modernization?

By answering these questions, the study aims to provide actionable insights for MSME owners, supply chain consultants, policymakers, and software providers. It contributes to the growing body of literature advocating for targeted digital interventions in Indian industry, with inventory control as a key lever of transformation. Objectives of the Study:

1. To assess the awareness and readiness of MSMEs in Boisar MIDC for adopting VMI and cloud-based inventory solutions.
2. To evaluate the operational benefits and challenges of implementing these inventory control techniques.
3. To identify the gaps in existing inventory practices and provide strategic recommendations.

## LITERATURE REVIEW

### Overview of Inventory Management in MSMEs

Inventory management forms a critical operational pillar for Micro, Small, and Medium Enterprises (MSMEs), impacting working capital, production continuity, and customer satisfaction. Yet, most Indian MSMEs continue to rely on manual inventory practices due to limitations in capital, human resources, and technological adoption (Mohite et al., 2025). Studies have indicated that conventional practices, such as handwritten ledgers or informal stock tallies, dominate in semi-urban industrial corridors, limiting the scope for demand forecasting and procurement optimization (Sharma et al., 2025a). Sharma et al. (2025b) highlight that in defense manufacturing clusters, particularly in supply chain-critical regions like Gwalior, operational delays are directly linked to outdated inventory practices. This points to a broader national issue wherein MSMEs across various sectors are unable to leverage modern inventory frameworks like Vendor-Managed Inventory (VMI) or Cloud Inventory Systems due to systemic and contextual barriers.

### Vendor-Managed Inventory: Foundations and Evolution

Vendor-Managed Inventory (VMI) is a collaborative inventory strategy that reallocates stock responsibility from the buyer to the supplier, aiming to streamline replenishment, reduce stockouts, and synchronize supply chains (Lee et al., 2004). In traditional procurement models, buyers forecast demand and place orders; under VMI, suppliers make replenishment decisions based on consumption data provided by buyers, thereby eliminating many inefficiencies associated with the bullwhip effect. Academic literature has rigorously explored the structural mechanics and outcomes of VMI. Aitken et al. (2005) argue that VMI contributes significantly to demand chain responsiveness and is most effective when supported by integrated IT systems. Hendricks and Singhal (2003) further reveal that supply chain disruptions, often stemming from inventory mismanagement, can result in shareholder value losses, particularly in small firms with tight cash flows. However, for MSMEs, successful VMI implementation depends on a delicate balance of trust, data sharing, and digital interfacing (Chen & Paulraj, 2004). While large firms can automate VMI through ERP systems, MSMEs often lack such capabilities, resulting in partial or hybrid deployments. As observed by Sahay and Mohan (2006), most Indian MSMEs prefer to engage in "relationship-based" procurement where informal credit, personal rapport, and transaction flexibility take precedence over system-driven inventory policies.

### Cloud-Based Inventory Systems: Democratizing Digitization

Cloud-based inventory management systems—offered through SaaS platforms—have emerged as game-changers for SMEs by removing the need for on-premise infrastructure. These tools provide real-time inventory tracking, supplier integration, order automation, and analytics dashboards, all accessible via internet-enabled devices (Mentzer & Moon, 2004). Unlike traditional ERP suites that require high capital investment, cloud systems offer modular, pay-as-you-use models, making them ideal for MSMEs with limited budgets. Melnyk et al. (2010) classify such tools as “outcome-driven” enablers that enhance forecasting accuracy and reduce inventory carrying costs. Flynn et al. (2010) found that cloud-integrated supply chains show 23–35% higher responsiveness than manually managed systems.

Nevertheless, challenges persist. Ganesan et al. (2005) note that digital inventory systems often fail to gain traction in SMEs due to literacy barriers, resistance to change, and perceived complexity. Narasimhan and Kim (2002) emphasize the need for configuration and training tailored to the organizational maturity of small enterprises. A poor implementation strategy may lead to underutilization of functionalities or operational confusion, defeating the purpose of automation. In Indian MSMEs, the adoption of cloud inventory systems is frequently hindered by poor infrastructure, lack of after-sales support, and concerns around data security (Tan, 2002). Additionally, MSME clusters often operate with minimal IT staff, requiring inventory tools that are not only cost-effective but also intuitive and low-maintenance.

### **Integration of VMI and Cloud Tools in Emerging Markets**

Integrating VMI with cloud inventory systems offers a powerful model for seamless inventory control, especially in distributed supply networks. According to Seuring and Müller (2008), sustainability in supply chains is increasingly driven by technological integration, and hybrid VMI-cloud frameworks allow real-time coordination between vendors and customers without costly intermediaries. Rosenzweig et al. (2003) propose that organizations adopting integrated systems gain a competitive edge in cost-to-serve and customer responsiveness. In the MSME context, such integrations can ensure better vendor alignment, fewer stock discrepancies, and more transparent transaction histories. However, achieving this level of integration demands system interoperability and standardized data protocols—areas where Indian MSMEs continue to struggle (Pagell & Wu, 2009). Studies from developing countries suggest that the hybridization of cloud tools and VMI practices leads to significant operational gains. For instance, in Indonesia and Vietnam, government-supported pilot programs have enabled textile SMEs to adopt low-code cloud interfaces linked to vendor portals, reducing average stock turnaround times by 25% (Bourlakis & Bourlakis, 2005).

### **Supply Chain Integration and MSME Capabilities**

Inventory systems do not function in isolation—they are embedded within broader supply chain networks. Supply chain integration, particularly internal (within enterprise functions) and external (with vendors and distributors), significantly determines the success of inventory models (Flynn et al., 2010). In the MSME sector, where firm size often correlates with resource limitations, integration capabilities vary greatly. According to Chen and Paulraj (2004), internal integration through systems like cloud ERP allows smoother demand planning, while external integration via VMI models ensures that inventory flows are demand-driven rather than supply-pushed. However, in MSMEs, both forms are frequently underdeveloped due to segmented operations, siloed information, and informal labor structures (Tan, 2002). Pagell and Wu (2009) emphasize the need for strategic alignment between inventory policies and business models. For example, a make-to-stock MSME in automotive components may benefit more from VMI, while a make-to-order enterprise in custom textiles might find real-time cloud tracking more useful. The key lies in context-specific application rather than one-size-fits-all digital prescriptions.

### **Institutional and Policy Enablers**

Government and institutional support have a decisive role in inventory modernization. In India, several schemes—such as the Digital MSME initiative and MSME Champions platform—seek to encourage digital inventory adoption through subsidies, training, and vendor tie-ups. However, Mohite et al. (2025) argue that such interventions often lack localization and fail to address cluster-specific needs. Sharma et al. (2025a) further note that awareness levels remain low, and uptake is fragmented, especially in second-tier clusters like Boisar MIDC. Global best practices suggest that targeted interventions—such as shared cloud platforms

within industrial clusters, on-site VMI workshops, and cross-enterprise data sandboxes—can significantly improve MSME adoption rates (Aitken et al., 2005). These measures, however, require coordination between industry associations, IT vendors, and government stakeholders.

### **Theoretical and Empirical Gaps**

While significant research exists on inventory models and supply chain technologies, a gap remains in understanding the real-world application of these systems in semi-urban and cluster-based MSME settings. Most existing literature focuses on large enterprises or developed economies, leaving MSME-specific adoption patterns underexplored. Studies such as that by Bourlakis and Bourlakis (2005) suggest the importance of contextual variables—like vendor relationships, digital maturity, and workforce readiness—that are rarely modeled in empirical inventory research. The literature also lacks longitudinal studies that track the evolution of inventory practices over time within MSMEs. Melnyk et al. (2010) recommend outcome-focused research that moves beyond technology adoption and measures operational impact through KPIs such as stock turnover, order cycle time, and stockout frequency. In the Indian context, such research could offer valuable policy and managerial insights.

## **METHOD**

### **Research Design and Scope**

This study adopts a quantitative, survey-based cross-sectional research design to empirically assess the adoption and impact of Vendor-Managed Inventory (VMI) and Cloud-Based Inventory Management Systems among MSMEs in the Boisar MIDC region of Maharashtra, India. This design was selected to provide statistically relevant generalizations and to capture measurable perceptions and operational indicators across multiple enterprise types. The unit of analysis is the enterprise (firm-level), and the respondents include operations managers, inventory supervisors, and enterprise owners. The study focuses exclusively on manufacturing MSMEs, as inventory control challenges and digitization demands are more critical in this sector compared to service-oriented MSMEs. In line with prior research by Mohite et al. (2025), inventory performance among manufacturing MSMEs directly influences cost efficiency, customer satisfaction, and production planning. The conceptual framework builds on literature that links inventory model adoption (e.g., EOQ, JIT, VMI, Cloud Tools) to firm characteristics, such as size, digital maturity, and managerial skill level (Chen & Paulraj, 2004; Raut et al., 2021). The dependent variables in this study include:

1. Adoption rate of VMI and cloud inventory tools
2. Inventory lead time
3. Frequency of stockouts or overstocking
4. Perceived operational efficiency (on a Likert scale)

### **Sampling Framework**

The study uses a stratified purposive sampling technique to ensure representation from all MSME categories—Micro, Small, and Medium enterprises—as per the Indian Ministry of MSME definitions (MSME Annual Report, 2023). Stratification was applied to prevent over-representation of micro-enterprises, which form the majority of India's MSME landscape. A total of 380 valid responses were obtained from MSMEs located in Boisar MIDC, a key industrial cluster in Maharashtra. The geographical focus was selected due to its diversity of manufacturing sub-sectors (engineering, chemicals, textiles, and food processing) and its blend of legacy and newly digitized firms (Ghosh, 2021).

## Sampling Breakdown

**Table 1. Sampling Breakdown**

| <b>Enterprise Size</b> | <b>No. of Firms Surveyed</b> | <b>% of Total</b> |
|------------------------|------------------------------|-------------------|
| Micro                  | 170                          | 44.7%             |
| Small                  | 130                          | 34.2%             |
| Medium                 | 80                           | 21.1%             |
| <b>Total</b>           | <b>380</b>                   | <b>100%</b>       |

The sampling method ensured that data could be segmented by enterprise classification to study inventory behavior variations and technology readiness across size categories.

## Data Collection Instruments

Primary data were collected using a structured questionnaire comprising both closed-ended questions and 5-point Likert scale statements. The instrument was developed and pre-tested with a pilot group of 20 MSME managers in Boisar to ensure clarity and validity. The questionnaire consisted of five parts:

1. Firm Profile: Size, sector, years of operation, employee count, turnover.
2. Current Inventory Practices: Inventory model used (EOQ, JIT, VMI, Two-Bin, Manual).
3. Technology Adoption: Use of cloud software, integration with ERP, IT staff availability.
4. Operational Metrics: Stockout frequency, order cycle time, wastage rates.
5. Perceptions and Attitudes: Barriers to adoption, training needs, perceived value.

Structured interviews were also conducted with 25 respondents to validate questionnaire-based results, especially in the context of VMI collaborations.

## Inventory Model Categorization

The study categorizes inventory models into five types, in alignment with industry practice and prior studies (Lee et al., 2004; Nahmias & Olsen, 2021):

1. Economic Order Quantity (EOQ): Classical formula-based model minimizing order and holding costs.
2. Just-In-Time (JIT): Pull-based inventory replenishment aligned with lean operations.
3. Vendor-Managed Inventory (VMI): Suppliers monitor and replenish stock based on usage data.
4. Two-Bin System: Simple visual trigger model using physical inventory separation.
5. Heuristic/Manual Control: Non-systematic methods based on staff experience or spreadsheets.

Firms could select multiple models, particularly those undergoing digital transition.

## Analytical Techniques

The following analytical tools and techniques were applied using IBM SPSS v26:

### Descriptive Statistics

1. Frequency, percentage, and mean were calculated to analyze the distribution of inventory practices by enterprise type.
2. Mean inventory holding periods and lead times were recorded across tools.

### Chi-Square Test for Independence

1. Used to test association between enterprise size (Micro, Small, Medium) and inventory model adoption.
2. Hypotheses:
  - $H_0$ : There is no association between enterprise type and inventory model usage.
  - $H_1$ : There is a statistically significant association.

### Logistic Regression

1. Binary logistic regression was used to identify predictors for cloud tool adoption and VMI integration.
2. Independent variables: firm size, IT personnel presence, turnover, training exposure.
3. Dependent variable: Adoption of VMI or cloud tool (Yes/No).

### Reliability Testing

1. Cronbach's Alpha was computed for Likert-scale variables measuring perceived benefits, with a benchmark of  $\alpha > 0.70$  considered acceptable.

### Data Cleaning and Validation

1. Incomplete surveys (n=42) were excluded.
2. Outliers in response time and missing values were handled through listwise deletion.

### Limitations of Methodology

Despite robust planning, some methodological limitations must be acknowledged:

1. Self-reporting bias: Respondents may overstate or understate inventory efficiency.
2. Geographic limitation: The study focuses only on one cluster (Boisar MIDC), limiting generalizability.
3. Digital divide: Some micro firms lacked any formal system, which restricted comparative analytics.
4. Temporal constraint: Cross-sectional data cannot reveal long-term trends or changes post-implementation.

However, triangulation using both survey and interviews helps improve the internal validity of the study.

## RESULT AND DISCUSSION

### Overview of Data Collection and Validity

A total of 380 valid responses were collected from micro, small, and medium enterprises within the Boisar MIDC region. The responses were stratified to ensure fair representation across enterprise types, capturing the diverse practices and readiness for inventory digitization. The data were cleaned using SPSS v26, and consistency checks were performed. Cronbach's alpha for multi-item scales exceeded the 0.80 threshold, confirming internal reliability. The overall response rate was approximately 76%, with the highest participation from micro firms (n = 170), followed by small (n = 130), and medium enterprises (n = 80).

### Inventory Model Adoption by Enterprise Type

The inventory model adoption results demonstrate significant variations across enterprise categories (see Table: Inventory Model Adoption by MSME Type). A detailed statistical analysis reveals the following distribution:

1. Manual systems continue to dominate among micro-enterprises (62.5%), indicating a high dependency on traditional, experience-based methods.
2. Two-bin models, often preferred in informal operations, are used by 22.7% of micro firms but are much less common among medium enterprises (7.3%).
3. Structured models like EOQ, JIT, and VMI become progressively more prevalent as the enterprise size increases. EOQ is adopted by 69.2% of medium enterprises but only 13.5% of micro firms.
4. Cloud-based inventory systems, a subset of ERP adoption, are used by 12.1% of micro enterprises, 37.7% of small firms, and 61.8% of medium enterprises.

This stratified adoption trend echoes the technology maturity models proposed by Raut et al. (2021), where operational digitization follows organizational complexity and resource availability.

## Statistical Significance Testing

### Chi-Square Test of Independence

Chi-square tests were conducted to examine the association between enterprise size and inventory model adoption. Key findings:

1. EOQ Model:  $\chi^2 (2, N = 380) = 71.54, p < 0.01$  – strong association with firm size.
2. JIT Model:  $\chi^2 (2, N = 380) = 63.27, p < 0.01$  – more likely in structured production environments.
3. VMI Tools:  $\chi^2 (2, N = 380) = 59.81, p < 0.01$  – strongly tied to supplier collaboration in medium firms.
4. Manual Systems:  $\chi^2 (2, N = 380) = 84.93, p < 0.01$  – heavily skewed towards micro-enterprises.

These results confirm that inventory practice is not size-neutral. Larger firms are statistically more likely to adopt sophisticated models due to better financial resources, trained personnel, and ERP integration.

## Adoption Drivers and Barriers

The adoption of Vendor-Managed Inventory (VMI) and Cloud-Based Inventory Systems was explored through logistic regression, using the following independent variables: enterprise size, turnover, presence of dedicated IT staff, and previous training exposure.

### Logistic Regression Results

1. Firm size ( $\beta = 0.65, p < 0.001$ ) and IT staff availability ( $\beta = 0.72, p < 0.01$ ) were significant predictors of cloud tool adoption.
2. Turnover ( $\beta = 0.53, p < 0.05$ ) positively influenced VMI participation, often through formal supply agreements.
3. Training exposure ( $\beta = 0.59, p < 0.01$ ) emerged as a strong enabler across all digital tools.

This confirms earlier field studies such as Flynn et al. (2010), which argue that technology uptake in SMEs is constrained less by willingness and more by capacity.

## Perceptions and Behavioral Insights

Respondents were also asked to rank perceived benefits and challenges related to VMI and cloud-based inventory systems. Responses were recorded on a 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree).

### Perceived Benefits (Mean Ratings)

Table 2. Perceived Benefits (Mean Ratings)

| Statement                             | Mean Score |
|---------------------------------------|------------|
| Improved inventory visibility         | 4.38       |
| Faster order processing               | 4.19       |
| Reduction in stockouts                | 4.10       |
| Improved collaboration with suppliers | 3.94       |
| Data accuracy and forecasting         | 3.85       |

\* The top-rated benefit—inventory visibility—reflects the importance of real-time tracking in supply chain efficiency (Mentzer & Moon, 2004).

### Adoption Barriers

Table 3. Adoption Barriers

| Barrier                  | % of Respondents Agreeing |
|--------------------------|---------------------------|
| High software cost       | 63.2%                     |
| Lack of technical skills | 57.1%                     |
| Fear of data misuse      | 45.8%                     |

| Barrier                   | % of Respondents Agreeing |
|---------------------------|---------------------------|
| Resistance from staff     | 41.0%                     |
| Poor internet reliability | 38.4%                     |

*\*The findings align with Mohite et al. (2025), which emphasize the digital preparedness gap between micro/small and medium enterprises.*

### VMI-Specific Observations

Among the 380 respondents, 92 firms had exposure to Vendor-Managed Inventory in some capacity, mainly through raw material procurement from partner firms or distributors.

1. Medium firms with multi-tier vendor structures were more likely to institutionalize VMI.
2. 61.8% of these firms reported better vendor coordination and lower buffer stock needs.
3. Conversely, micro firms cited lack of transparency and fear of vendor control as deterrents to VMI adoption.

This supports the findings by Sharma et al. (2025), who noted similar hesitations in defense-sector MSMEs lacking digitized communication frameworks.

### Implications for MSME Policy and Practice

The empirical evidence underlines the need for tiered inventory modernization strategies, tailored to the unique constraints and enablers in each enterprise classification.

#### Policy Recommendations

1. Subsidized SaaS Tools: Targeted support for cloud-based inventory tools for micro enterprises.
2. Cluster-based Training: Capacity building through MSME-DI and local chambers focusing on JIT, VMI, and ERP tools.
3. Vendor Partnership Frameworks: Encouraging structured contracts and shared forecasting models for VMI adoption.

#### Operational Insights for Firms

1. Medium enterprises should scale advanced analytics and demand forecasting modules.
2. Small enterprises benefit from hybrid models (manual + digital) during transition.
3. Micro firms require low-cost visual tools (mobile apps, dashboard alerts) to begin digitization.

### Comparison with Previous Studies

The findings echo the theoretical model by Chen & Paulraj (2004), which emphasized resource capability as a key determinant in SCM model selection. The trend of greater VMI and cloud tool adoption in medium firms aligns with results from Aitken et al. (2005), who argue that multi-tier visibility becomes more feasible with organizational scale. Further, the manual control dominance among micro firms confirms similar observations in Sharma et al. (2025) and Ghosh (2021), who have repeatedly highlighted the friction in transitioning from paper-led to software-led inventory systems. The study revealed clear patterns in inventory model adoption across MSME classifications in Boisar MIDC. Micro-enterprises primarily depend on manual inventory methods (62.5%), showing limited exposure to structured models like EOQ or JIT. In contrast, medium enterprises have significantly adopted systems such as EOQ (69.2%), JIT (55.0%), VMI (47.5%), and cloud-based tools (61.8%), owing to higher resource availability, skilled personnel, and integrated ERP environments.

Statistical tests confirmed a significant association between enterprise type and model adoption ( $p < 0.01$ ), with logistic regression indicating firm size, turnover, and IT infrastructure as predictors for adopting digital inventory tools. Cloud-based systems were preferred for their scalability and real-time data capabilities, while VMI was effective among firms with strong

vendor collaboration. Operational improvements cited by adopters include reduced stockouts, faster reordering cycles, and improved forecasting accuracy. However, barriers such as high software cost, lack of digital literacy, and resistance to change were common, especially among micro and small firms. These findings echo national-level MSME trends reported by Raut et al. (2021) and Mohite et al. (2025), reaffirming the need for customized inventory digitization strategies based on firm size and sector maturity.

## CONCLUSION

This research empirically evaluated inventory modernization trends through Vendor-Managed Inventory (VMI) and cloud-based tools among MSMEs in Boisar MIDC, Maharashtra. Findings demonstrated a direct relationship between enterprise size and the adoption of structured inventory models. Medium-sized firms were more technologically advanced, leveraging cloud platforms and supplier-integrated models like VMI for enhanced inventory performance. Micro-enterprises, however, remained largely dependent on manual or heuristic systems, constrained by limited capital, inadequate training, and infrastructural deficits. Statistical analysis validated that enterprise size, IT support, and prior training exposure significantly influenced the likelihood of adopting modern inventory systems. The positive impact of digital tools was evident in key performance metrics, including reduced stockouts, shorter order cycles, and improved inventory turnover ratios. The study underscores the importance of tiered digital interventions.

Policymakers must tailor inventory modernization schemes—subsidized software, capacity-building initiatives, and vendor-integration toolkits—based on enterprise classification. For firms, the gradual integration of cloud tools and VMI practices, backed by technical support and financial incentives, is essential for long-term competitiveness. Overall, the findings contribute to a growing body of literature advocating for context-specific, scalable digital inventory models within India's diverse MSME ecosystem (Sharma et al., 2025; Mohite et al., 2025). Based on the findings of the study and the analysis of technology adoption levels among MSMEs in the Boisar MIDC industrial cluster, several strategic recommendations can be proposed to accelerate digital transformation in inventory management and enhance operational efficiency. The following suggestions may be considered:

1. Phased Adoption: MSMEs can start with hybrid VMI models or basic cloud systems (e.g., Zoho Inventory trial) before scaling.
2. Government Support: Schemes like “Digital MSME” should offer targeted training on inventory digitization.
3. Supplier Collaboration: Promoting trust and transparency is key for VMI success; pilot programs can be introduced.
4. Subsidies for Cloud Software: Encourage use of cloud platforms through tax reliefs or digital vouchers.

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