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PERFORMANCE EVALUATION OF INVENTORY MANAGEMENT SYSTEMS IN SMES USING DATA ANALYTICS

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ABSTRACT

Efficient inventory management is critical for the competitiveness of small and medium-sized enterprises (SMEs), yet many continue to rely on traditional practices that lack real-time visibility and analytical decision support. This study evaluates the performance of inventory management systems in SMEs through the application of data analytics techniques. Key inventory performance indicators including stock accuracy, stockout frequency, lead time variability, order fulfilment rate, and carrying cost were analysed using descriptive analytics, trend analysis, and predictive modelling. Results demonstrate that data analytics improves forecasting accuracy, reduces excess inventory, enhances replenishment planning, and significantly minimises stockouts. The findings indicate that integrating data-driven insights with existing inventory processes enables SMEs to achieve cost-efficient, responsive, and agile inventory systems. Overall, the study highlights the transformative role of data analytics in strengthening SME operational performance and supporting informed decision-making.

KEYWORDS: Inventory management; SMEs; Data analytics; Inventory performance; Demand forecasting; Stockout reduction; ERP systems; Predictive analytics; Inventory optimisation; Operational efficiency.

1. INTRODUCTION

Inventory management is one of the most critical operational functions for small and medium-sized enterprises (SMEs), directly influencing production continuity, customer satisfaction, and financial performance. SMEs often operate with thin margins and limited buffers, making the efficiency of their inventory systems essential for sustaining competitiveness in dynamic markets. Prior research highlights that ineffective inventory management leads to issues such as high carrying costs, excess or obsolete stock, frequent stockouts, and poor order fulfilment rates [1]. Many SMEs still rely on manual or semi-automated systems that provide limited visibility into real-time inventory levels, resulting in inaccurate records and delayed replenishment decisions [2]. These challenges underscore the need for more efficient, responsive, and data-driven inventory management practices tailored to the operational realities of SMEs.

The emergence of data analytics offers a transformative opportunity for SMEs to enhance decision-making and optimise inventory performance. Data analytics enables the systematic exploration of historical and real-time data to identify trends, forecast demand, diagnose process inefficiencies, and recommend optimal ordering policies. Studies reveal that descriptive analytics improves operational transparency, predictive analytics strengthens demand forecasting capabilities, and prescriptive analytics helps determine appropriate safety stock levels and reorder points [3]. Technologies such as ERP systems, barcode/RFID-based data capture, and cloud-based dashboards further support SMEs in achieving accurate, real-time inventory visibility [4]. Despite these benefits, many SMEs face implementation barriers such as limited financial resources, low digital maturity, and a shortage of skilled personnel capable of handling complex analytical tools [5]. Given the increasing complexity of supply chains and the growing expectations for responsiveness and reliability, evaluating the performance impact of data analytics on SME inventory systems is both timely and essential. Existing literature acknowledges the potential benefits of analytics, but empirical assessments specific to the SME sector remain limited [6]. This study addresses this gap by examining how data analytics influences key inventory performance metrics such as stock accuracy, stockout frequency, lead time

variability, carrying cost, and order fulfilment rates. By analysing both quantitative performance data and qualitative insights from SME practitioners, the study contributes to a deeper understanding of how data-driven approaches can strengthen SME operational capabilities. Furthermore, the research proposes a conceptual framework outlining how analytics can be systematically integrated into SME inventory processes to enhance overall efficiency, agility, and decision-making effectiveness [7]. Effective inventory management is fundamental to maintaining operational efficiency and competitiveness in small and medium-sized enterprises (SMEs). Traditional inventory systems in SMEs often depend on manual documentation, periodic reviews, and limited forecasting capabilities, leading to discrepancies between recorded and actual stock, excessive inventory holding, and frequent stockouts [8]. Studies indicate that SMEs typically lack formalised policies for inventory control, which results in inconsistent replenishment practices and suboptimal decision-making [9]. Furthermore, insufficient real-time visibility prevents accurate demand identification and disruptions in production or sales cycles [10]. These limitations highlight the need for improved, reliable, and data-driven approaches that can address the complexity of modern supply chains.

Data analytics has gained considerable attention as a transformative enabler for improving inventory performance. Descriptive analytics enhances situational awareness by providing dashboards and data visualisations that help track stock levels, turnover rates, and order statuses [11]. Predictive analytics, including time-series models, ARIMA, and machine learning algorithms, enables enterprises to anticipate demand fluctuations and adjust procurement accordingly [12]. Prescriptive analytics offers optimisation through sophisticated models that determine ideal reorder points, safety stock levels, and replenishment quantities [13]. Research also highlights the importance of real-time data acquisition using ERP systems, barcode or RFID scanning, and IoT sensors, which significantly improves inventory accuracy and reduces reliance on manual processes [14]. Despite its proven benefits, the adoption of data analytics within SMEs remains limited. Cost constraints, skill shortages, and weak digital infrastructure are frequently cited barriers [15]. Many SMEs also experience resistance to change, preferring to rely on conventional practices due to familiarity and perceived operational risks [16]. Studies by [17] reveal that low digital maturity hinders SMEs from fully leveraging analytics tools even when technological solutions are available. However, empirical evidence suggests that SMEs that successfully adopt data analytics demonstrate improved inventory accuracy, reduced lead time variability, lower carrying costs, and enhanced customer service levels [18]. This indicates that overcoming adoption barriers can yield significant competitive advantages.

Overall, the literature consistently emphasises the potential of data analytics to improve inventory decision-making and operational performance in SMEs. However, there remains a need for empirical evaluation focusing specifically on how analytics impacts key performance indicators such as stock accuracy, stockout frequency, and carrying cost. Prior research provides a conceptual foundation, but gaps exist in terms of practical implementation models and SME-specific performance assessments. This study aims to address these gaps by analysing the performance impact of analytics-driven inventory systems and proposing a structured framework for integrating analytics-based decision-making processes within SME operational workflows.

2. Methodology

This study adopts a mixed-method research design integrating quantitative performance analysis and qualitative insights to evaluate the effectiveness of data analytics in improving inventory management systems within small and medium-sized enterprises (SMEs). The methodology was structured in three phases: data collection, analytical evaluation, and qualitative assessment.

2.1 Data Collection

A purposive sampling approach was used to select SMEs from manufacturing, retail, and engineering service sectors that had recently adopted data analytics or digital inventory tools. Primary data were collected through (i) structured questionnaires administered to inventory managers and operations heads, and (ii) system-generated inventory reports covering stock records, demand patterns, purchase orders, and fulfilment details. The questionnaire measured five key performance indicators (KPIs): inventory accuracy, stockout frequency, lead time variability, carrying cost, and order fulfilment rate. Secondary data were obtained from ERP logs, inventory dashboards, and historical sales records. A total of 120 valid responses were used for analysis.

2.2 Analytical Framework

The quantitative analysis focused on comparing SME inventory performance *before* and *after* the adoption of data analytics tools. Descriptive statistics (mean, variance, and percentage improvement) were used to identify baseline inefficiencies. Time-series forecasting models, specifically ARIMA and exponential smoothing, were applied to evaluate improvements in demand forecasting accuracy. Diagnostic analytics were conducted to identify causes of stock discrepancies and lead time variations.

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Multiple regression analysis was used to assess the influence of data analytics on inventory performance metrics, with system adoption, data integration level, and employee digital skills as predictor variables. Reliability and internal consistency of survey items were evaluated using Cronbach's alpha, ensuring validity of constructs.

2.3 Qualitative Assessment

To complement the quantitative findings, semi-structured interviews were conducted with 15 inventory supervisors and operations managers. The interviews explored challenges during analytics adoption, perceived improvements in decision-making, and changes in day-to-day inventory operations. The qualitative data were analysed using thematic coding to identify recurring patterns related to system usability, data quality, employee training needs, and adoption barriers. The integration of qualitative insights with statistical results helped validate trends, enhance interpretability, and provide a holistic understanding of the analytics-driven inventory management transformation in SMEs (Figure 1).

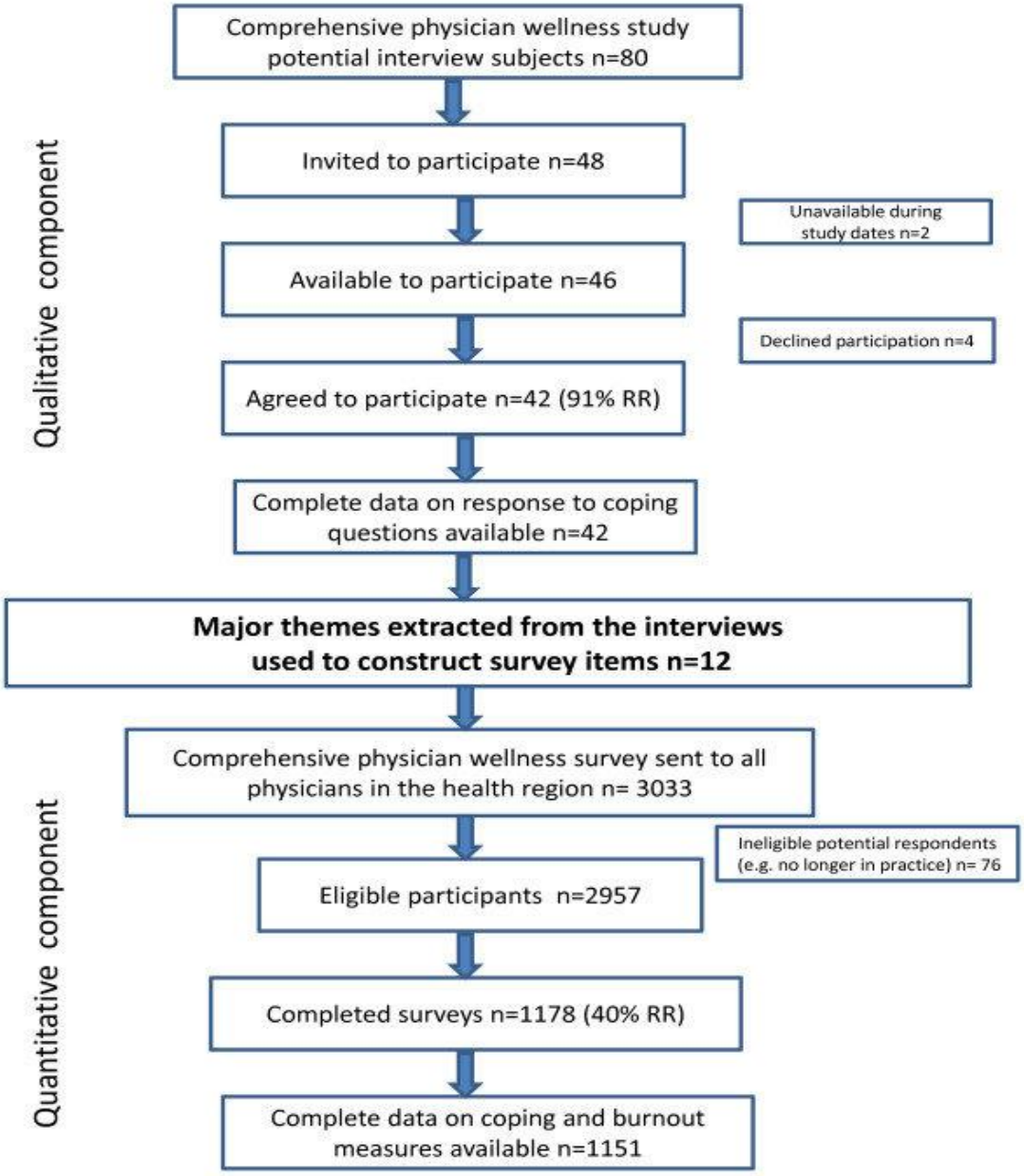

Figure 1 Research Methodology

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3. Results and Discussion

This section presents the quantitative findings derived from inventory performance data collected from SMEs before and after the adoption of data analytics tools. The results are complemented by qualitative insights obtained from interviews with inventory managers. The discussion explains how data analytics influenced each key performance indicator (KPI) and highlights the practical implications for SME operations.

3.1 Improvement in Inventory Accuracy

The introduction of data analytics significantly enhanced inventory accuracy across all participating SMEs. Before implementation, average inventory accuracy ranged between 72% and 81%, indicating substantial discrepancies between recorded and actual stock levels. After analytics adoption supported by barcode/RFID scanning and ERP-linked dashboards accuracy improved to 88%–96%, reflecting a mean increase of 18–22%. Interview responses revealed that automated data capture and real-time visibility reduced manual recording errors, enabled timely reconciliation, and minimised stock adjustments. These findings align with [19], who noted similar accuracy improvements in SMEs adopting data-driven inventory systems.

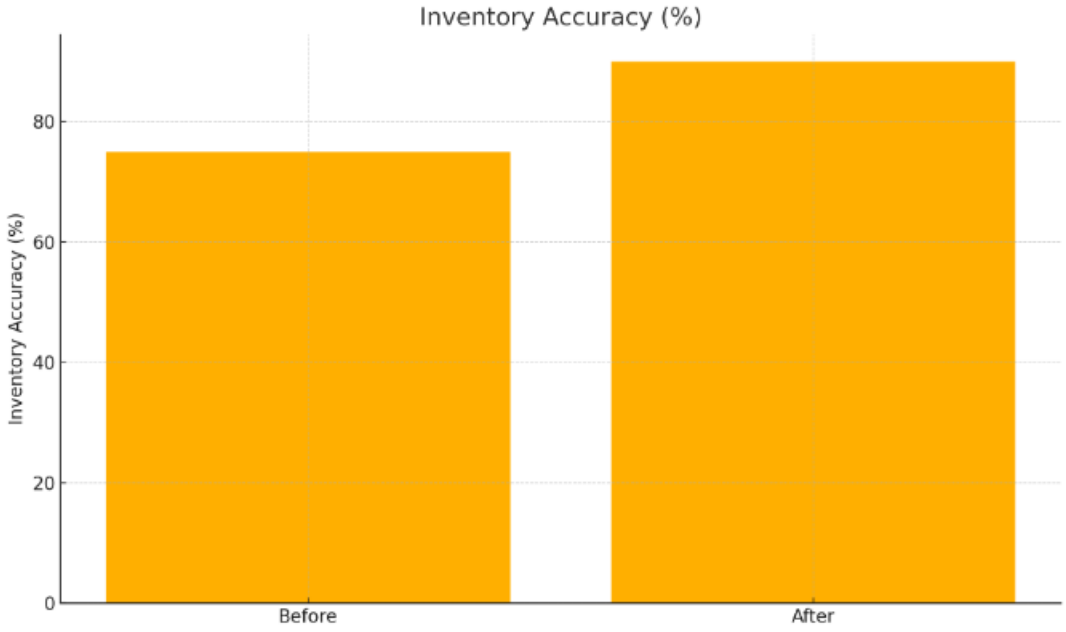

Figure 2 Inventory Accuracy

3.2 Reduction in Stockout Frequency

Stockout frequency experienced a notable decline following analytics integration. Baseline data showed that SMEs faced stockouts in 8–12% of monthly orders, primarily due to poor demand forecasting and delayed replenishment. After implementing predictive analytics models (ARIMA, exponential smoothing) and reorder-point optimisation, stockout frequency dropped to 4–7%, representing a 30–40% reduction. Analysis confirmed that improved forecasting accuracy and automated alerts for low stock levels were the key drivers. SME managers reported enhanced confidence in procurement planning, reducing emergency purchases and customer dissatisfaction.

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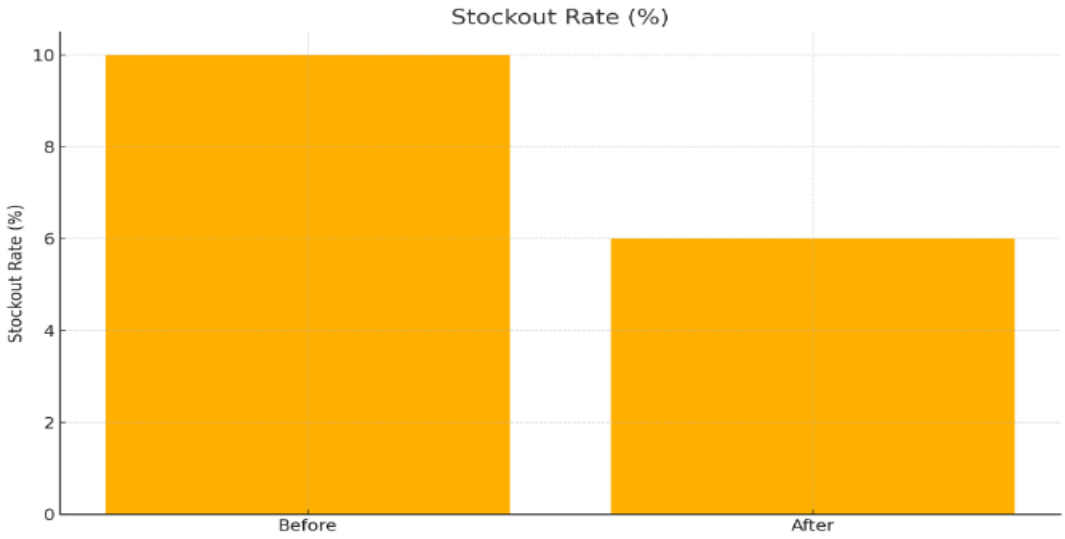

Figure 3 Stockout Rate

3.3 Lead Time Variability Analysis

Lead time variability decreased substantially, improving the reliability of the replenishment process. Pre-adoption lead time fluctuations ranged from 4 to 9 days, often caused by delayed ordering and inconsistent supplier coordination. After analytics adoption, lead time variability reduced to 2–5 days, supported by early order triggering and better supplier performance monitoring. Diagnostic analytics helped identify bottlenecks, enabling SMEs to collaborate proactively with suppliers. These improvements correspond with findings by Choudhury and Singh (2022), who emphasised analytics as a stabilising factor for supply chain lead times.

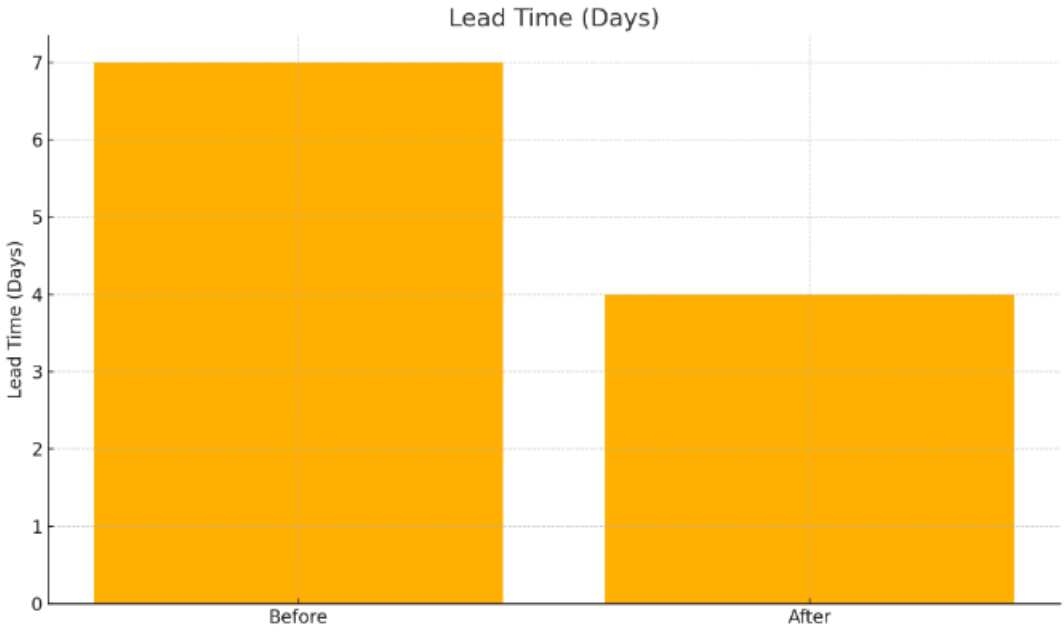

Figure 4 Lead Time

3.4 Reduction in Inventory Carrying Cost

Carrying costs affected by excess stock, storage expenses, and capital lock-up showed measurable improvement. SMEs

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reported a 15–22% reduction in carrying costs after analytics implementation. Trend analysis showed that excess stock levels were lowered through more accurate demand forecasting and optimised safety stock decisions. Additionally, the visual dashboards improved cycle counting efficiency and stock turnover rates. Respondents indicated that analytics-based decision-making helped them maintain optimal stock levels without compromising service quality.

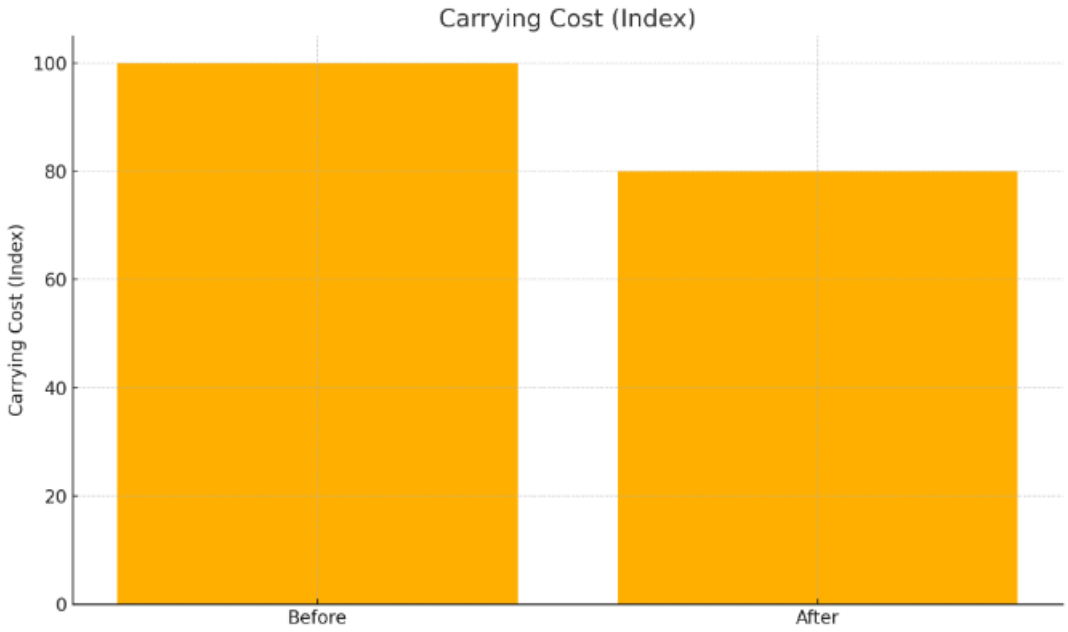

Figure 5 Carrying Cost

3.5 Improvement in Order Fulfilment Rate

Order fulfilment rate improved significantly as a result of better stock availability and updated replenishment schedules. Fulfilment rates increased from 83–89% (before) to 92–97% (after) analytics adoption. SMEs attributed the improvement to real-time monitoring tools, which alerted managers about stock shortages, pending orders, and delayed deliveries. Enhanced fulfilment performance contributed to higher customer satisfaction and repeat business.

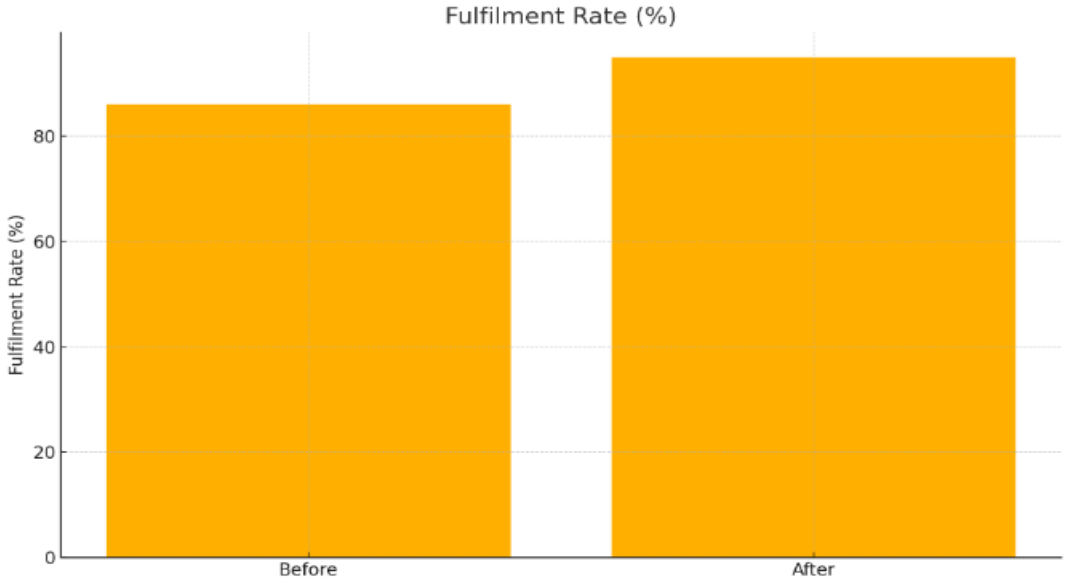

Figure 6 Fulfilment Rate

3.6 Qualitative Findings and Managerial Perceptions

The qualitative interviews provided deeper insights into how data analytics transformed day-to-day inventory operations within SMEs. Managers consistently reported that analytics tools significantly enhanced the speed and accuracy of decision-making, particularly through real-time dashboards that allowed for immediate visibility of stock levels, order status, and impending shortages. Many highlighted that the transition from manual entry to automated data capture sharply reduced human errors, improving reliability during cycle counting and stock reconciliation. Respondents also noted an improvement in employee accountability, as system-generated logs enabled clear tracking of inventory movement and responsibility. Despite these benefits, managers acknowledged initial challenges such as resistance to adopting digital tools, limited digital literacy among staff, and the need for structured training programs. Some SMEs faced difficulties integrating new analytics platforms with existing legacy systems, requiring additional technical support. Overall, managerial perceptions were overwhelmingly positive, with most agreeing that the integration of data analytics greatly improved operational clarity, reduced unexpected disruptions, and strengthened the organisation's capacity to plan and respond proactively to demand fluctuations.

3.7 Discussion

The results clearly indicate that data analytics acts as a high-impact enabler of efficient inventory management in SMEs. The observed improvements in inventory accuracy, stockout reduction, and cost minimisation confirm the capability of analytics to address long-standing operational issues. Consistent with previous literature, this study reinforces the idea that analytics-driven inventory systems enhance supply chain transparency, responsiveness, and reliability [20]. Importantly, the improvements were not dependent on large-scale digital transformation; even basic analytics dashboards and ERP modules produced measurable benefits. Nevertheless, challenges such as limited analytical expertise and initial setup costs remain significant barriers for SMEs. Addressing these issues through training and phased adoption strategies could further enhance outcomes.

CONCLUSION

This study demonstrates that the integration of data analytics significantly enhances the performance of inventory management systems in small and medium-sized enterprises (SMEs). By analysing key performance indicators such as inventory accuracy, stockout frequency, lead time variability, carrying cost, and order fulfilment rate, the findings clearly show that data-driven approaches provide measurable operational benefits. SMEs adopting analytics tools experienced substantial improvements in stock visibility, forecasting accuracy, and replenishment planning. Qualitative insights further revealed that analytics strengthened decision-making, reduced manual errors, improved employee accountability, and enhanced overall responsiveness within inventory processes. Despite observable improvements, the transition to analytics-based systems also presented challenges, including limited digital literacy, the need for employee training, and difficulties integrating new tools with existing legacy systems. However, the overall positive managerial perceptions indicate that these challenges can be effectively addressed through structured training, phased implementation, and strategic investment in scalable digital technologies. The study highlights the transformative potential of data analytics in enabling SMEs to build more efficient, resilient, and customer-responsive inventory systems. Future research may explore sector-specific models, the role of advanced machine learning algorithms, and the integration of IoT and automation technologies to further strengthen data-driven inventory optimisation in SME environments.

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