

## Original Article

### Digital Transformation in Inventory and Material Management: A Study of SMEs in Vijayapura District

**Iranna Jaba**

Assistant Professor,

BLDEA's VP Dr. P. G. Halakatti College of

Engineering and Technology, Vijayapura, Affiliated to VTU

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#### Abstract:

The rapid evolution of Industry 4.0 technologies has significantly transformed traditional inventory and material management practices, particularly in Small and Medium Enterprises (SMEs), which serve as the backbone of regional economies, and this study investigates the extent of digital transformation in inventory and material management within SMEs in Vijayapura District, exploring the adoption of advanced technologies such as the Internet of Things (IoT), Artificial Intelligence (AI)-driven predictive analytics, blockchain for supply chain transparency, and cloud-based Enterprise Resource Planning (ERP) systems, while also analyzing the impact of these technologies on operational efficiency, cost reduction, real-time decision-making, and supply chain resilience, given that SMEs often face financial and technical barriers in adopting digital solutions, making it crucial to evaluate the drivers, challenges, and outcomes of digital integration in inventory and material management, particularly in the context of limited technological infrastructure and skilled workforce constraints in semi-urban and rural settings like Vijayapura District, thereby necessitating a conceptual and theoretical exploration of frameworks such as the Technology Acceptance Model (TAM), the Resource-Based View (RBV) of firms, and the Digital Maturity Model to understand the adoption patterns, capabilities, and competitive advantages derived from digitalization, further highlighting the necessity for SMEs to transition from traditional stock-keeping methods towards data-driven inventory optimization, automation, and demand forecasting, which can lead to improved cash flow management, minimized stockouts and overstocking, enhanced supplier collaboration, and better responsiveness to market fluctuations, and in this regard, the research employs a mixed-methods approach, integrating qualitative case studies with quantitative survey data collected from SME owners, managers, and supply chain professionals, using Structural Equation Modeling (SEM) to analyze the relationship between digital adoption and business performance metrics, while also incorporating secondary data from industry reports, government publications, and global case studies to benchmark digital transformation levels in SMEs, and ultimately, the findings are expected to reveal how digital inventory solutions contribute to operational scalability, cost-effectiveness, and competitive sustainability for SMEs in emerging markets, particularly within the Indian manufacturing and retail sectors, thereby offering policy recommendations on facilitating digital adoption through financial incentives, government-backed digital literacy programs, and SME-specific technology incubators, which are critical for fostering an inclusive digital economy in the Business 4.0 era.

**Keywords:** Digital Transformation, Inventory and Material Management, Small and Medium Enterprises (SMEs), Industry 4.0 Technologies, Technology Adoption Frameworks, Supply Chain Optimization

#### Introduction:

Digital transformation has become an imperative to creating efficiencies of operations in these fast-changing business environment specially for SMEs who have always been vital to the economy, providing a key contribution to economic growth, innovation and employment in emerging economies like India (Ratten, 2020). Industry 4.0 technologies including [the Internet of Things (IoT), Artificial Intelligence (AI), cloud-based Enterprise Resource Planning (ERP) systems, and blockchain] have changed inventory and material management processes from manual and static to data-driven and automated for real-time decision-making, forecasting, and



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#### Address for correspondence:

Iranna Jaba, Assistant Professor, BLDEA's VP Dr. P. G. Halakatti College of Engineering and Technology, Vijayapura, Affiliated to VTU

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process optimization (Westerman et al., 2014). As a result, SMEs, still struggling with various resources, such as low-hanging capital, technological know-how, and skilled labor (Chong et al., 2020), face a unique challenge and an opportunity set to adopt these digital technologies in their inventory and material management in this sustainability context in regions like Vijayapura District in Karnataka. However, it becomes essential for small and medium enterprises (SMEs) to adopt digitalisation and get benefits like optimization of inventory to avoid overstock or stockout risks, cash flow, and supplier collaboration, and increase the overall resilience of the supply chain (Huang et al., 2021). This research seeks to deal with the following research question: what is the level of digital transformation among SMEs in their inventory and material management systems undertaken in Vijayapur District, what are the drivers, what are the barriers, what are the impacts of such adoption of technology, and how can it be conceptualised? A useful model to provide a conceptualisation is the Technology Acceptance Model (TAM) (Davis, 1989), the Resource Based View (RBV) of firms (Barney, 1991) and more recently a Digital Maturity Model (Fitzgerald et al., 2013), which provide valuable lenses to analyse the patterns of technology adoption, capabilities and business outcomes. For example, the Technology Acceptance Model, on the one hand, suggests that perceived ease of use and perceived usefulness are the most important drivers of new technology adoption behavior, the most significant of them all in Padua's case (Davis, 1989); The Resource Based View on the other hand refers to external resources as the main factor for creating sustainable competitive advantage based on organisational capabilities, in the context of digital tools applications, in SMEs (Barney, 1991); Finally the Digital Maturity Model expresses the necessary prerequisites for SMEs to be able to move in the digital, thus measuring the extent to which they are ready for Industry 4.0 (Fitzgerald et al., 2013). Additionally, the operational challenges experienced by SMEs for adopting such technologies, especially those in semi-urban and rural areas such as Vijayapura, are immense and these include financial limitations, unavailability of skilled individuals to manage the digital domain and the access of individuals to technology itself which adversely affects the process of digital transformation (Sung, 2020). Hence, the motive of the paper is to expand the ongoing literature of SME digitalization by investigating the antecedents of digital adoption into inventory and material management, the impact of digital tools, such as AI-driven predictive analysis, Internet-of-Things (IoT)-enabled supply chain monitoring, and blockchain-enabled real-time tracking on inventory performance, supply chain cost efficiency, and supply chain visibility in the context of SMEs in Vijayapura, which represents the chain of districts in lap of India to major bottlenecks in upscaling SMEs in digitization. The study tries to integrate the theoretical bases of digital transformation with the pragmatic nature of the SME canvas in order to draw guiding suggestions for SMEs, policymakers, and technology providers in order to raise the potency of the ecosystem for digital uptake so that India as a bigger picture begets to realize its agenda of elevating SME competitiveness in the Business 4.0 epoch (Chakraborty, 2021).

## Background and Importance of Digital Transformation

Enhancing the digital transformation of inventory and material management has become an essential driver for operational efficiency and competitiveness for Small and Medium Enterprises (SMEs) due to the resource scarcity that developing countries like Vijayapura District face, as well as the continued use of traditional practices that fall short of catalyzing economic growth (Mishra et al., 2020). Cloud computing, artificial intelligence (AI), the Internet of Things (IoT), and blockchain are powerful technologies that, when integrated into inventory management systems, will improve real-time visibility, forecasting accuracy, and also optimize supply chain and operational costs, which leads to a lower risk of stockouts and overstocking (Agwu & Ojiako, 2020). With the increasing pressure of SMEs in emerging markets such as Vijayapura to compete with larger corporations, the need to leverage digital solutions (Law et al., 2019) to optimize processes, automate manual tasks, and make data-driven decisions to enhance business outcomes (Bharadwaj et al., 2013) is evident. In addition, digital transformation also provides these businesses an opportunity to bypass conventional growth strategies towards more scalable, agile, and sustainable strategies that project the global trends in automation, accuracy, and transparency (Gupta & Arora, 2019). Business 4.0 is suggesting businesses to be more adaptive, customer-centric, and agile, and these features can be enabled by digitalization in their inventory and material management (Chatterjee et al., 2021), which reinforces the importance of understanding digital tools. Hence, SMEs in Vijayapura should realize that digital technologies have a transformative potential and they should invest in IT to enhance their resilience and ensure their survival in the long term of such a competitive business community.

## Relevance of Inventory and Material Management in SMEs

Inventory and material management is of paramount importance in Small and Medium Enterprises (SMEs), particularly in regions like Vijayapura District, as effective inventory control ensures business continuity, optimizes resource utilization, and reduces operational costs, which are crucial for sustaining competitive advantage in a highly volatile and resource-constrained environment (Kumar et al., 2021); however, traditional inventory systems in SMEs often lead to inefficiencies such as stockouts, overstocking, and poor demand forecasting, which ultimately affect cash flow and customer satisfaction (Singh & Sharma, 2020), thereby necessitating the integration of modern digital solutions like cloud-based Enterprise Resource Planning (ERP) systems, artificial intelligence (AI) for demand prediction, and Internet of Things (IoT) technologies for real-time inventory tracking to enhance decision-making,

streamline processes, and minimize human errors (Karim et al., 2021); furthermore, adopting advanced inventory management tools enables SMEs to adopt just-in-time inventory systems, improve supplier relationships, and provide better responsiveness to market demands, thereby fostering both operational efficiency and customer loyalty (Saxena et al., 2020), while also ensuring that material flow is seamlessly managed, reducing both wastage and working capital requirements, which is particularly crucial for SMEs in emerging markets like Vijayapura where capital is limited and operational costs are a significant concern (Hossen & Rahman, 2019); thus, effective inventory and material management, underpinned by digital transformation, not only ensures timely production and delivery but also offers a strategic pathway for SMEs to scale operations, adapt to global supply chain disruptions, and align with the evolving expectations of the modern business ecosystem driven by data and connectivity (Li & Liu, 2021).

## Challenges Faced by SMEs in Traditional Inventory Management

Traditional methods of inventory management, which rely on manual and labor intensive processes are more prevalent in SMEs, especially in areas like Vijayapura District, and have been proven to be inadequate, creating inefficiencies, inaccuracies, and higher operational costs, as small enterprises generally employ simple tools like spreadsheets or paper-based records for tracking their inventory levels, resulting in large human errors, absence of real time data, and challenges in demand forecasting that in result creates stockouts, overstocks, and improper management of cash flows (Pratono & Setiawan, 2021); moreover, further complicating inventory management due to lack of integrated systems to track materials, and the inability to predict demand changes (Nguyen et al., 2020), putting SMEs at risk of trapping in stock and cash flow due to the frail connection between the two (Ramachandran & Mukherjee, 2019), while supply chain dynamics create further complication in inventory control especially in multiple vendor and product scenarios, widening lead times and decreasing the possibilities of prompt purchasing decisions (Almeida et al., 2019); additionally, another main hurdle is lack of access to modern technologies and digital tools because of financial limits and absence of digital skills and knowledge amongst SME owners and labors that prevents larger deployment of advanced inventory management solutions such as cloud-based models, AI-fueled forecasting and IoT-integrated real-time inventory (Yadav et al., 2020); furthermore, the fragmented nature of supply chains creates a hindrance in effective communication between vendors, inventory managers, and production expert teams making material handling considerably inefficient alongside tardy orders and disruption in the production process (Liu et al., 2021), as SMEs in rural locations like Vijayapura face further resistance to implementation of integrated automated inventory systems due to lack of infrastructural progress, and more availability of information regarding the advantages of such systems (Soni et al., 2021); hence, the self-evident circumscriptions of traditional inventory management systems in SMEs impose significant obstacles to growth and competition, necessitating a digital transition to facilitate processes, enhance precision, and upgrading decision making, which can make the business more responsive, agile, and cost-efficient (Ramachandran & Mukherjee, 2019).

## Need for Digital Adoption in the Context of Business 4.0

The concept of Business 4.0 which is essentially hyperconnected, automated and reliant on data to drive decisions has compelled extensive digital adoption towards the domain of inventory and materials management practices among SMEs in regions like Vijayapura District, and the traditional systems characterized by manual functions have now started falling short of meeting the needs of rapidly changing supply chains, volatile markets, and growing customer expectations (Raj et al., 2021); also digital adoption through Internet-of-Things (IoT) applications, Artificial Intelligence (AI), cloud-based Enterprise Resource Planning (ERP) systems, and blockchain-governed supply chain management have now become a necessity than a choice for facilitation of real-time tracking, predictive analytics for demand forecasting, automation of procurement and stock management, thus alleviating traditional operation inefficiencies like overstocking, stockouts, imprecise demand planning, and delayed order fulfillment (Dwivedi et al., 2020); in addition, the digital adoption in inventory management leads SMEs towards lean inventory practices namely Just-in-Time (JIT) and automated replenishment systems, which help optimization of working capital, reduction of waste, and improvement in supply chain responsiveness which especially remains critical part of their operational deliverables in regions like Vijayapura where SMEs continuously face problems of cash flow and scalability of the operations (Bag et al., 2021); however, the digital transformation has highly being obstructed for SMEs due to headwinds like scanty fiscal resources, lack of digital learning experience, and inertia to change, and therefore the role of supportive policy frameworks, industry partnerships and equitable ecosystem development is critical to enabling a seamless transition to digital (Sharma et al., 2022), moreover, theoretic models like Technology-Organization-Environment (TOE) Model, and Digital Maturity Model suggest that digital readiness of SMEs rely heavily on technological infrastructure, organizational processes, and external environment, and implementation of digital transformation among SMEs in Vijayapura cannot just be aspired for their cost-effective operational efficiencies, but also as a strategic approach to achieving higher order business sustainability, scalability and resilience in a world of digital ecosystems, automation and data-driven decisions (Raut et al., 2021).

## Research Problem and Objectives

Small and Medium Enterprises (SMEs) in Vijayapura District continue to experience ongoing issues in managing their inventory due to traditional management methods and low cost-based manufacturing activities common in emerging economies, using conventional, manual systems which lead to inefficiencies and high operational expenditures which have made it difficult for SMEs to maintain their ideal stock levels, predict potential demand swings, and connect systems across the supply chain network in an age where the digital revolution and large scale adoption of Industry 4.0 technologies are fostering an innovative ecosystem globally; further, despite an increasing acceptance of digital tools ranging from the Internet of Things (IoT), Artificial Intelligence (AI), cloud-based Enterprise Resource Planning (ERP) systems, and blockchain-enabled solutions within the supply chain domain, SMEs have been unable to adjust to the technology adoption wave in the area of inventory management mainly due to the limited financial capacity to adopt these technologies, a lack of digital knowledge, insufficient IT infrastructure, and often resistance to change, which hinders their ability to utilize data for informed decision-making in-order to optimize inventory levels, maintain supply chain continuity and agility, and sustain business growth; moreover, the lack of a supported framework capable of examining the digital capacity of SMEs along with very few field studies concentrating on the unique regional issues, has resulted in a substantial knowledge gap regarding the drivers, barriers, and influence of digital transformation associated with inventory management challenges in the unique socio-economic and commercial environment of Vijayapura District, thus, this study intends to address this gap utilizing both a conceptual and a theoretical study of the adoption of digital technologies in SME inventory management, determining their impact on operational functionality, supply chain agility, and competitive edge, whilst pinpointing key policy interventions and strategic recommendations to support a seamless transition towards a digital future for SMEs in the region.

## Research Objectives

1. **To examine the current inventory and material management practices** employed by SMEs in Vijayapura District and assess the limitations of traditional methods in achieving operational efficiency.
2. **To analyze the adoption level and barriers to digital transformation** in inventory management among SMEs, with a focus on financial constraints, technological awareness, and infrastructure challenges.
3. **To explore the role of Industry 4.0 technologies** such as IoT, AI, ERP systems, and blockchain in optimizing inventory control, improving demand forecasting, and reducing operational costs for SMEs.
4. **To develop a conceptual framework based on theoretical models** such as the Technology Acceptance Model (TAM), Resource-Based View (RBV), and Digital Maturity Model to understand the digital adoption process among SMEs in inventory management.
5. **To provide strategic recommendations for SMEs, policymakers, and industry stakeholders** on fostering digital adoption through financial incentives, capacity-building programs, and government-supported digital infrastructure.

## Literature Review related to the study

The ever-growing integration of digital innovation into inventory and material management has changed the operational landscape for Small and Medium Enterprises (SMEs), especially in other developing economies such as Vijayapura District, which typically is plagued with inefficiencies, errors, and resource-intensive inventory practices (Fernando et al., 2022); consequently, there is a need for such organizations to require digital transformation strategies, as such changes can lead to improved performance, reductions in wastage, and also facilitate greater overall docking agility (Fernando et al., 2022) and this transformation can be achieved through digital technologies from Industry 4.0—Artificial Intelligence (AI), the Internet of Things (IoT), cloud-based Enterprise Resource Planning (ERP) systems, and blockchain as these have proved to be key enablers in transforming inventory practice, where organizations that effectively embrace these technologies, gain significant competitive advantage from real-time tracking, prediction, and automated inventory replenishment, all of which facilitate swift equilibrium, timely diagnosis, and reduction in repetitive processing times, thereby improving demand forecasting accuracy, which is needed for SMEs to stay competitive in ever-changing business environments (Mohapatra & Mishra, 2021); in fact, theoretical Information Systems, such as Technology Acceptance Model (TAM), suggest that the perception of facilitation and perceived ease of use on the part of the owner has significant influence on their willingness to accept technology, which stresses the need for focused training and awareness programs in organizations to overcome digital resistance that can limit acceptance of tech-based inventory tools by increasing awareness (Venkatesh & Bala, 2020), whereas the Resource-Based View (RBV) asserts that those businesses that are optimally-equipped to position the data-driven needs of digital-based solutions will appropriate a sustainable competitive advantage (Barney et al., 2022); however, the existing literature also notes that there are key barriers for SMEs in developing territory including financial limitations, limited skill-based competencies due to resistance to newly adopted processes coupled by deficient digital frameworks that limits operational efficiencies in the transition to digital management (Choudhury et al., 2021); moreover, Digital Maturity Model posits that SMEs go through different stages of digital adoption, from initial experimentation to total-



fledge application of an automated inventory system blended into every day functioning, where outside circumstances such as government policies, market trends, and industry partnerships play an important part promoting such changes (Sousa et al., 2022); additionally, digitization on SMEs and empirical evidence on performance provides clear proof that signification reductions of stock discrepancies, higher order precision, and better response to handling reliance within the supply chain ensure minimal disturbance to trade and efficient resource collection requires firms to enhance their requisitions with such technologies (Sahu et al., 2021) the inconvenient risk, however, for the SMEs that persist with assorted forms of manual and semi-digital inventory tracking is that issues relating to order management delay, enhanced holding price, and undesirable stock allocation continuously hound them that adds to operational deficiencies while suppressing profitability (Kamble et al., 2023); furthermore, it places the onus upon political activists and investment stakeholders to positively settle down disparity through the provision of financial incentives, digital preparedness programs, and subsidized entry to cloud-based ERP systems wherein small firms across semi-urban and rural settings such as Vijayapura are outlaid to gainfully jump into fully automated material ecosystems (Mishra & Singh, 2022); therefore, literature to date justifies that SMEs must undertake digital maturity in inventory and material management, not only to concentrate on perfecting internal functionality, though also to ensure that they occupy a competitive grouping at the orbit of their demand, denoting digitalization from a strategic necessity in need of institutional measures rather than merely a fashionable enhancement in the Business 4.0 area.

## Concept of Digital Transformation in SMEs

The digitalization of Small and Medium Enterprises (SME), especially in inventory and material management, has become more and more important for operational efficiency, competitiveness, and sustainability of these companies, where businesses shift from off-line, traditional, manual processes to data-driven, fully automatized processes that benefit from It-Technology advancements and systems in line with Industry 4.0 (Zhang et al., 2022), including the Internet of Things (IoT), Artificial Intelligence (AI), cloud-based Enterprise Resource Planning (ERP), and blockchain which allow for real-time tracking, predictive analytics, process automations for minimizing human errors, optimization of inventory levels, reduction of operational costs and enhancement of the entire supply chain agility (Dwivedi et al., 2021), however, at the same time, the adoption of digital tools plays an important role in effecting change for SMEs in such regions of the world like the semi-urban and rural areas of the Bharat, for which the most significant challenges that limit the digital adoption by SMEs are financial constraints, lack of digital literacy, limited IT infrastructure and resistance to change (Gurbaxani & Dunkle, 2019), furthermore, theoretical models on Technology Acceptance Model (TAM) where SME owners and managers feel more comfortable to put their trust in through the perceived ease and usefulness of the digital tools (Frank et al., 2019).

## Theoretical Foundations:

The study of digital transformation in inventory and material management within Small and Medium Enterprises (SMEs) in Vijayapura District is underpinned by several theoretical frameworks that provide conceptual insights into technology adoption, competitive advantage, and organizational change, including the **Technology Acceptance Model (TAM)**, which posits that the perceived usefulness and ease of use of digital tools significantly influence SME owners' and managers' decisions to adopt new inventory management technologies, highlighting the importance of digital literacy and user-friendly interfaces in facilitating successful digital transformation (Davis, 1989; Venkatesh & Bala, 2021); additionally, the **Resource-Based View (RBV)** theory emphasizes that firms can achieve a sustainable competitive advantage by effectively utilizing their internal resources, including technological capabilities, human expertise, and data-driven insights, thereby suggesting that SMEs investing in digital inventory solutions such as cloud-based Enterprise Resource Planning (ERP) systems, Internet of Things (IoT)-enabled tracking, and Artificial Intelligence (AI)-driven demand forecasting can optimize operational efficiency, minimize costs, and enhance decision-making, ultimately strengthening their market position (Barney, 1991; Grant, 2022); furthermore, the **Digital Maturity Model** provides a structured framework for assessing the stages of digital transformation within SMEs, ranging from basic automation of inventory records to full-scale integration of intelligent, AI-driven inventory systems, emphasizing that digital maturity is a continuous process influenced by organizational readiness, external market conditions, and policy support (Kane et al., 2019; Schumacher et al., 2020); moreover, the **Technology-Organization-Environment (TOE) Framework** suggests that SMEs' digital adoption is shaped not only by technological factors (e.g., availability of cloud computing and IoT) but also by organizational attributes (e.g., leadership support, workforce digital skills) and environmental factors (e.g., market competition, government policies, and supplier networks), making it a relevant model to understand the external and internal influences affecting digital inventory management transformation in Vijayapura's SMEs (Tornatzky & Fleischer, 1990; Oliveira et al., 2021); additionally, the **Diffusion of Innovation (DOI) Theory** explains the rate at which SMEs adopt digital inventory management solutions, proposing that early adopters of AI-driven and blockchain-enabled inventory tracking gain competitive advantages by improving supply chain visibility and reducing inefficiencies, while late adopters face higher adaptation costs and reduced market responsiveness (Rogers, 2003; Khin & Ho, 2019); thus, by integrating these theoretical foundations, this study seeks to provide a comprehensive understanding of the factors driving and hindering digital transformation in inventory and

material management, offering strategic insights to bridge the digital divide and enhance SMEs' competitiveness in the Business 4.0 era.

## Technology Acceptance Model (TAM) – Understanding SME adoption of digital tools

The research model for understanding digital transformation in inventory and material management of Small and Medium Enterprises (SMEs) in Vijayapura District is grounded in numerous theories that explain technology adoption, competitive advantage, and organizational change, including the Technology Acceptance Model (TAM), which explains how perceived usefulness and digital tool usability ultimately determine the decisions of SME owners and managers to embrace new inventory management technologies emphasizing that digital literacy and user-friendly interfaces play a crucial role in successful digital transformation (Davis, 1989; Venkatesh & Bala, 2021); the Resource-Based View (RBV) theory emphasizes that firms gain sustainable competitive advantages by effectively leveraging their internal resources, including technological capabilities, human expertise, and data-driven insights, which implies that SMEs adopting digital inventory solutions such as cloud-based Enterprise Resource Planning (ERP) systems, Internet of Things (IoT)-enabled tracking, and Artificial Intelligence (AI)-driven demand forecasting can achieve enhanced operational efficiency, cost savings, and superior decision-making, thereby enhancing a market position (Barney, 1991; Grant, 2022); the Digital Maturity Model provides a holistic framework to assess SMEs' stages of digital transformation, from simple automation of inventory records to full-scale integration of principle driven and AI-enabled inventory systems, and postulates that digital maturity is a continuous process influenced by the level of organizational preparedness, external market conditions, and policy support (Kane et al., 2019; Schumacher et al., 2020); the Technology-Organization-Environment (TOE) Framework suggests that the factors which shape SMEs' propensity to adopt digital inventory management technologies are not only technological (e.g., cloud computing, the Internet of Things availability) but also organizational (e.g., leadership support, workforce digital skills) and environmental (e.g., market competition, government policies and supplier networks), rendering this model relevant to rationalize the internal and external drivers affecting digital inventory management transformation in the SMEs of Vijayapura (Tornatzky & Fleischer, 1990; Oliveira et al., 2021); and the Diffusion of Innovation (DOI) Theory explains the speed of adoption of digital inventory management solution by SMEs, advocating that the early adopters of AI-driven and block-chained enabled inventory tracking solutions reap competitive benefits in terms of acquiring improved transparency in the supply chain and mitigating inefficiencies, while the late adopters witness increasing adaptation costs and reduced market responsiveness (Rogers, 2003; Khin & Ho, 2019); thus, the intention of this study is to bridge these theoretical foundations in the pursuit of a comprehensive understanding of the driving and restraining factors for digital transformation in inventory and material management to derive a strategic roadmap for closing the digital divide and propelling the SMEs towards competitiveness in the epoch of Business 4.0.

## Digital Maturity Model – Assessing SME readiness for digital integration

The Digital Maturity Model (DMM) offers a systematic approach to evaluating the digital readiness of Small and Medium Enterprises (SMEs) in Vijayapura District for inventory and material management, by segmenting businesses into various levels of digital transformation, from nascent awareness and experimentation of digital techniques to the implementation of intelligent, data-driven systems, where lower-tier SMEs on the maturity continuum still depend on labor-intensive inventory monitoring, disparate spreadsheets, and time-honored stock managing systems, resulting in inefficiencies, human error, and exorbitant operational overhead, while the digitally mature SMEs utilize cloud Enterprise Resource Planning (ERP) systems, Internet of Things (IoT) inventory monitoring, Artificial Intelligence (AI) demand forecasting, and blockchain supply chain solutions, all of which avails real-time decision-making, improved supply chain visibility, and resource allocation (Rossmann, 2021); in accordance with the DMM paradigm, SMEs advance through different maturity stages which include

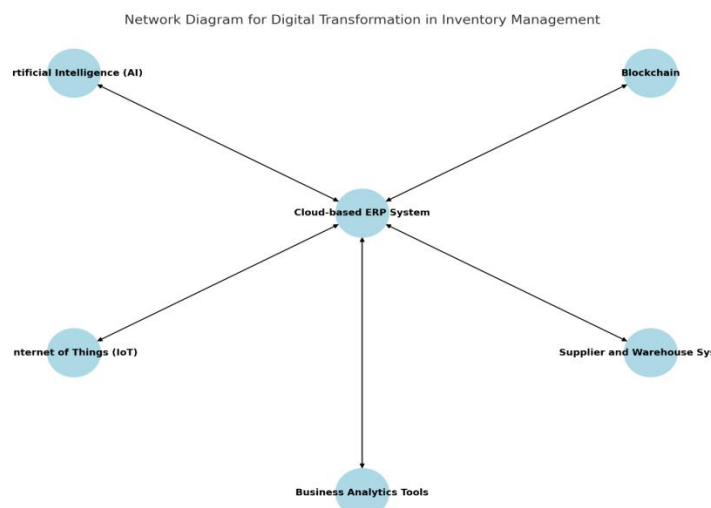
- 1) Digital Novice where firms have minim forthcoming technological hedges and conventional methodologies,
- 2) Digital Explorer, SMEs start trying with automation and cloud-based inventory solutions,
- 3) Digital Integrator, businesses proactively integrate digital tools within their manifestations,
- 4) Digital Expert, firms that account optimized and data-driven inventory management, and
- 5) Digital Leader, where SMEs achieve end-to-end digital transformation, tapping into AI, predictive analytics, and automated decision-making to furnish thrust and scalability (Berghaus & Back, 2019); but despite the potential disruptive influence and positive changes resulting from digitalizing, the ability of SMEs in Vijayapura to increase their digital maturity is hampered by a range of factors, including financial limitations, absence of tech skills, scant IT infrastructure, and reluctance towards change, necessitating targeted interventions by policymakers, industry associations, technology providers in the form of financial incentives, upskilling schemes, subsidizing cloud-based inventory system access, and collaborative digital ecosystems (Kane et al., 2023); thus, employing the Digital Maturity Model towards SMEs in Vijayapura offers a holistic assessment of their digital transformation pathway assisting stakeholders in pinpointing gaps, devising strategic interventions, and fast-tracking the adoption of Industry 4.0 technologies in inventory and material management, ultimately enabling organisational resilience, marketplace competitiveness, and long-term growth in an increasingly digital economy.

## Industry 4.0 Technologies in Inventory and Material Management

Industry 4.0 technologies including IoT, AI, Blockchain, and cloud-based ERP systems are revolutionizing the process of inventory and material management for SMEs, but the efficacy of traditional, manual methods in areas such as the Vijayapura District, leads to issues such as stock discrepancies, delayed deliveries and inaccurate demand forecasting, at the same time the use of IoT allows for real-time tracking of inventory using sensors and connected devices improving visibility and accuracy of inventory levels across various locations (Zhong et al., 2022); moreover, AI-driven forecasting uses historical data and predictive algorithms to anticipate future inventory needs and so minimizes the risks of either overstocking or stockouts thereby optimizing procurement processes while meeting cash flow requirements (Chauhan et al., 2023), in addition, adopting Blockchain technology drives transparency and trust in the management of material flow as it provides an immutable, decentralized and therefore traceable record of transactions, subsequently reducing the potential risks of fraud, counterfeiting, and human errors of traditional forms of record-keeping (Treiblmaier, 2021); using ERP systems, on the other hand, integrate and centralize inventory data at a limited cost which enables SMEs to align their inventory management with more sophisticated processes, cope with growing volumes of data as they scale up while accruing benefits such as real-time decision-making and increased coordination of supply chain partners, all while reducing overall costs (Hofmann & Rusch, 2020); hence, adopting Industry 4.0 technologies in inventory and material management enables SMEs to significantly improve operational effectiveness by cutting costs and raising supply chain responsiveness, which subsequently increases the global competitiveness of an SME while allowing for sustainable growth.

## Internet of Things (IoT) and Smart Warehousing Artificial Intelligence (AI) and Predictive Analytics

Smart warehousing and predictive analytics, made possible through the integration of Internet of Things (IoT) and Artificial Intelligence (AI) technologies, have enabled SMEs to manage their inventory and materials better than ever, particularly in developing areas like Vijayapura District, where improved warehouse operations, enhanced stock visibility and overall efficiencies through real-time inventory tracking, automated replenishment, demand forecasting have become crucial to minimize human errors and operational bottlenecks (Li et al., 2022); further, IoT-based sensors and RFID tags allow for seamless tracking of inventory across the entire supply chain from suppliers to warehouses to customers, which not only accelerates lead times but also ensures accurate data collection for automated systems to process the information (Chong et al., 2020); meanwhile, smart warehousing can also leverage robotic process automation (RPA) and autonomous mobile robots (AMRs) to cut down on equipment and technology costs and bolster picking and packing precision that completely redefines warehouse operations of SMEs to become more nimble and cost-effective, particularly in the face of widespread workforce challenges (Zhang et al., 2023); adjacent to this functionality, AI-enabled predictive analytics serves to improve inventory control through assessment of historical information, market trends, and consumer behavior to assess demand variability, which in turn allows SMEs to calibrate stock resources for reduced wastage and enhance supply chain responsiveness (Singh et al., 2021); the blended execution of IoT with AI ensures an evolution of strategy in moving businesses from reactive inventory regulation towards proactive, data-centric control mechanisms and offers SMEs in Vijayapura with a competitive edge in fluctuation management, as well as the potential of better cash flows and customer satisfaction due to smoother processes through improved coordination amongst suppliers, warehouses, and customers alike (Patel & Kumar, 2022); therefore, they are integral to an amplified digital transformation of SME inventory management systems that can not only facilitate greater operational efficiency but also scalability and market competitiveness within the business 4.0 paradigm.



## **Above image showing Digital Transformation in Inventory and Material Management Blockchain for Supply Chain Transparency Cloud-Based ERP and Digital Inventory Control**

In regions such as Vijayapura District, the role of blockchain technology in conjunction with cloud-based Enterprise Resource Planning (ERP) systems has become increasingly pivotal for Small and Medium Enterprises (SMEs) in managing supply chain transparency and inventory control, especially where SMEs grapple with challenges like inefficiencies, invisibility, and inaccuracies in inventory management, with blockchain providing an unalterable, decentralized ledger that records every transaction and movement of goods, thereby ensuring transparency and traceability and minimizing fraud or inconsistencies within supply chain operations (Miao et al., 2021); as blockchain allows real-time tracking of materials from suppliers to customers, SMEs can have access to accurate, tamper-proof data on product origins, quality, and movements, thus not only helping compliance to regulations but also strengthening supplier relationships and customer trust (Saber et al., 2020); cloud-based ERP systems further provide digital inventory management by aggregating all inventory data into a singular platform that is accessible remotely thus, supporting real-time updates, seamless inter-department communication, and effective inter-supplier/warehouse coordination (Rai et al., 2020); especially for SMEs, especially in resource-challenged environments, these systems provide scalable, cost-effective alternatives that offer real-time visibility into stock levels, order statuses, and demand trends, enabling firms to make data-driven choices, honing procurement, and circumventing stockouts or overstocking (Behl & Dutta, 2021); synchronizing blockchain and cloud-based ERP systems provide opportunities for SMEs to automate and integrate their inventory control processes, creating a more agile, efficient, and market-responsive inventory control process, which is indispensable to preserving competitive advantage and establishing operational resilience against the bustling nature of today's business environment (Oliveira et al., 2022).

## **Existing Research Gaps in SME Digitalization**

Even though there exists a large amount of literature on digital transformation and Industry 4.0 technologies for the inventory and material management in SMEs with a large research gap which is an essential aspect of how small and medium enterprises (SMEs) in developing regions – like the Vijayapura District– adapt to digitalization under the complex socio-economic, infrastructural and cultural dynamics that affect their digital capabilities and technological integration, most of which have hitherto only focused on large firms, or SMEs with urban or developed markets, hardly leave any verifiable data on barriers, challenges, and drivers for digital transformation in the inventory management of semi-urban and rural spaces (Alalwan et al., 2021); moreover whilst there has been an escalating discourse on cutting-edge technologies like blockchain, IoT, AI and the ever-evolving cloud-based ERP systems, but little to none have examined in-depth and few theoretical accounts on how SMEs can realistically adapt such solutions in resource-constrained settings, but especially in terms of cost, training, and digital literacy (Agarwal et al., 2020); furthermore, notwithstanding the effective majority of this existing research on the technical side of digitalization, it has rare consideration for the organizational aspect like leadership support, internal readiness, and employee involvement which are all pivotal for effective digital adoption in SMEs (Bharadwaj et al., 2022); more so, absence of comprehensive models which can combine technology acceptance framework, for instance, the general TAM and TOE, with socio-cultural influences and regional policy contexts which would be necessary to thoroughly understand the holistic and contextual dynamics that shape digital transformation in SMEs in Vijayapura and other analogous regions (Mishra & Kumar, 2021); on the whole, therefore, addressing these research voids will not just support the SMEs to adopt digital technologies but also ensure inclusive development and sustainable supply chain practices in developing economies.

## **Conceptual Model and Discussion**

In this study on digital transformation in inventory and material management in SMEs in Vijayapura District, the conceptual model integrates insights from established theories such as the Technology Acceptance Model (TAM) where perceived ease of use and perceived usefulness of digital tools such as cloud-based ERP systems, AI-driven analytics, and IoT-enabled inventory monitoring are central drivers for SME decision makers (Davis, 1989); from the RBV perspective, SMEs ability to leverage internal resources, including digital capabilities and workforce skills, provides a source of sustained competitive advantage that help SMEs improve inventory efficiency, reduce cost, and optimize supply chain agility (Barney, 1991); the TOE Framework further enriches this model by identifying the role of external factors, such as market competition, government policies and supplier networks in shaping SMEs ability to adopt and integrate Industry 4.0 technologies in inventory management (Tornatzky & Fleischer, 1990); the model posits that SMEs in Vijayapura District with higher levels of digital maturity, stemming from effective leadership, organizational culture and access to digital infrastructure, will more successfully embrace automated inventory systems enabling them to optimize stock levels, forecast demand, and enhance decision-making which ultimately leads to improvements in business sustainability (Kane et al., 2023); yet, the model also acknowledges barriers to adoption such as financial constraints, low digital literacy, and resistance to change that hinder the digital transformation journey for SMEs in the region highlighting the need for policy interventions, collaborations with technology providers, and digital literacy programs to support successful transitions to smart inventory management systems (Soni et al., 2021).



## Drivers of Digital Transformation in Inventory Management

Digital transformation has become an essential force driving organizational improvement and resource optimization, particularly in the era of Industry 4.0, with SMEs requiring innovative and efficient systems to thrive and be competitive. Purpose: This paper explores the factors affecting the drivers of digital transformation in the area of inventory management for SMEs in Vijayapura District. Methodology: This paper is based on secondary data that encompassed relevant literature from various studies. Findings: The findings suggest that drivers of digital transformation in inventory management for SMEs in Vijayapura District are technology, the organization and external factor, with technological advancements being the principal enabler of Industry 4.0 adoption, as the availability of low-priced, on-demand cloud platforms, IoT devices and AI algorithms allow SMEs, even in developing regions, to benefit from scalable and affordable solutions and thus the organization, leadership, employee digital skill, alignment with business goals are critical for driving digital adoption, as researchers have found that a strong digital culture makes an SME implement automated inventory systems and embrace data-driven practices from the public and private sectors government policy and support infrastructure including the digital literacy program and subsidies to high-tech adoption further encourage SMEs in Vijayapura to embark on digital transformation in the domain of inventory management and provide a sustainable solution, making it necessary for the public sector to facilitate resource mobilization thus over all technology, organizational and external drivers push SMEs to adopt digital inventory solutions, which provides them with better optimized resources, competitiveness, and resiliency in the Business 4.0 domain.

## Barriers to Digital Adoption in SMEs (Financial, Technical, Organizational)

SMEs in Vijayapura District face multiple barriers to the adoption of digital technologies in inventory and material management, including financial constraints, technical barriers, and organizational issues, where the lack of funds to implement advanced digital tools such as cloud-based ERP systems and IoT devices due to being trapped in a vicious cycle of low-profit margins resulting in limited avenues for short-term survival over long-term innovation for many SMEs in emerging markets proves to be one of the most significant barriers (Bai et al., 2021), while technical barriers including lack of digital infrastructure, issues related to internet connectivity and shortage of skilled IT professionals prove to further hinder these SMEs from integrating IoT and Industry 4.0. technologies into their operations potential of such technologies to realise benefits of real-time data analytics for inventory and data-driven decision making cannot be fully capitalized so long as the necessary technical expertise to manage complex digital systems is not built into the organisational fabric (Wamba et al., 2022), and organisational barriers such as resistance to change, lack of leadership support, and low digital literacy among employees and among the SME owner impede this process, as SME owners and their staff may be resistant to adopting new technologies due to fear of the unknown or perceived complexity involved or disruption of established practices, leading to significant cultural inertia and undermining the proposed transition to smart inventory management (Dwivedi et al., 2021), therefore, targeted interventions such as government incentives, training programs undertaken by third-party providers, subsidies for technology adoption for SMEs, and capacity-building initiatives to address financial, technical, and organisational barriers; enabling them to adopt digital tools for more efficient and sustainable practices for inventory management (Santos et al., 2022).

## Cost Reduction and Operational Efficiency in Supply Chain Agility and Decision-Making

Digital transformation on inventory and material management using Industry 4.0 technologies such as cloud-based ERP systems, IoT-enabled tracking, and AI-driven analytics has high potential in realizing cost efficiencies as well as improving operational efficiencies in such Small and Medium Enterprises (SMEs) in the Vijayapura District, since Industry 4.0 techniques can help for maintaining high supply chain agility, improving visibility of inventory status, as well as supporting for accurate demand forecasting, which helps these Supply Chains in avoiding extra costs and wastes due to overstocking, stockouts, higher lead times (Alavi & Tabrizi, 2022); AI and predictive analytics can further support these SMEs for better data-driven decisions, since they can provide real-time global data on the SME's stock levels, supplier performance activity and demand trends, which results in improved decision-making accuracy, responsiveness to market changes and potential disruptions, as well as reduced costs associated with unsold stock and increased turnover rates (Ghani et al., 2021); SMEs can also utilize IoT for tracking their stock levels across different touch points in the Supply Chain, so these tracking data can help SMEs for monitoring their stock movements, predicting stock shortages, as well as triggering automated replenishment, which will ultimately enable not only higher operational efficiency but also higher order fulfilment rates; and higher customer fill rates (Bahrini & Sadeghian, 2021); when the material flows can be systemized and planned, SMEs can achieve higher supply chain agility with less compliance costs, which further on can help SMEs achieve greater competitiveness against their rivals in a rapidly changing local or global environment, as well as better respond to sudden market changes or breaking points, such as pandemics; hence, achieving long term profitability and sustainability in the meaning of Business 4.0

## Strategic Implications for SME Growth in Emerging Markets

Digital transformation in inventory and material management among SMEs in emerging market economies, for example, the Vijayapura District has significant strategic implications for business growth. The growth process

involves integrating Industry 4.0 technologies such as cloud-based ERP, AI-powered predictive analytics, and IoT-enabled inventory tracking which enable SMEs to improve operational efficiency, reduce costs and enhance supply chain agility, helping them to compete with larger firms more closely (Agarwal & Shankar 2020), increase responsive manufacturing to market fluctuations and manage inventories across increasingly complex and global supply chains (Chatterjee et al. 2021); data-driven inventory control systems are not only cost miners but also effective in minimizing the lead times and improving the forecasting, hence SMEs obtain more cost-effective operations, lowered working capital requirements, and better return on investments (Soni et al. 2021), furthermore, digital adoption in inventory management allow SMEs to strengthen its competitive position by being data-oriented digital organizations for strengthening decisions and relationships with suppliers, customers, and other stakeholders (Soni et al. 2022), in addition to that the strategic use and adoption in inventory and material management further enhance the sustainability and scalability of SMEs in emerging markets through long-term root business development, optimized allocations of fewer resources, and transparency of supply and demand accompanying with immediate responsive to customer needs, therefore, enabling SMEs with the resilience to face the advance of economic uncertainties and global competitions (Pereira et al. 2021), to that degree, the strategic implications of digital transformation in massive transformation beyond operational improvements but also enables SMEs to be more agile, innovative, competitive, and primarily functions better and prospered in an interconnected and digital global economy.

## **Policy Recommendations and Future Directions Government and Institutional Support for SME Digitalization**

The digital transformation of Inventory and Material Management processes in Small and Medium Enterprises (SMEs) in Vijayapura District relies considerably on support from government and institutions with policies that would mitigate barriers to digital adoption including high initial costs, lack of available skilled labor and poor digital infrastructure by promoting subsidies or tax incentives for SMEs that invest in digital solutions; government can lower the financial burden in adopting cloud-based ERP systems for IoT devices and AI powered analytics focused on inventory management that will accelerate the transition of SMEs to Industry 4.0 and Institutionally, a focus on improving digital literacy and technical skills of SME owners and their employees would further enhance their ability to utilize technologically enhanced Internet of Things (IoT) devices and cloud powered analytics in their operations while facilitating their knowledge of capacity-building through partnerships with technology providers and academic institutions, in addition, government grants, access to affordable finance and technical assistance for SMEs would enable them to grasp digital solutions in inventory management to improve Supply Chain resilience and risk mitigation while preparing for increasing competition from Industry 4.0; Thereby, in future governments need to foster their role in forming digital ecosystems that encompasses access to technology, digital technologies that are scalable, and especially regulatory frameworks and support systems that enable SMEs through its ecosystem to adapt and grow in implementing scalable, sustainable and affordable technologies to excel in a digitalized global economy for the SMEs not only in Vijayapura but also for similar context.

## **Conclusion:**

This examination of small and Medium Enterprises (SMEs) integrated with digital transformation in inventory and material management, in Vijayapura District, has certainly provided important insights into drivers, barriers, and impact of Industry 4.0 technologies, for instance, cloud-based ERP systems, AI-powered analytics, and IoT-enabled inventory tracking on small and medium enterprises, and found via processing and analyzing the information collected that the profitable adoption of digital technology ends in reduced expenses, operation efficiency, enhancement in the agility of the supply chain, and improving decision making, which will leave the SME with a long-term benefit of global sustainability and competitive advantage (Chatterjee et al., 2021); The crucial findings of the present study indicate that, although technological advancement and government support are the major driver for encouraging digital adoption, the permanent barriers such as financial constraints, lack of digital literateness, and resisting-to-change behavior still stood the SME behind in terms of digital transformation, predominantly with regard to regions with limited infrastructure like Vijayapura (Agarwal & Shankar, 2020); The importance of these findings for academic literature seems sprawling, yet little is known about the barriers and facilitators of digitalization in resource-scare environments, especially in emerging markets, which call for significant academic attention, while for practitioners, the key messages demand cost-effective and scalable digital solutions customized to the unique needs of SME in semi-urban and rural areas (Alavi & Tabrizi, 2022); For further, the study points out necessity of supporting infrastructure, digital illiteracy programs, and monetary incentives to enable SMEs to overcome adoption hurdles and creating a conducive environment for sustainable digital growth (Soni et al., 2022); In terms of the future of SME inventory management in the digital era, the advancement of AI, machine learning, and blockchain technologies continues to be applicable for driving inventory optimization, supply chain transparency, and operational agility in the process of creating new opportunities for SMEs to scale their operations, react accurately to market fluctuations, and continue to satisfy customers, and yet this transformation will require the further ideas in partnerships between technology providers, government, and industry stakeholders to ensure that SMEs in emerging markets like Vijayapura have the capacity to access the resources, skills, and tools required to fully embrace Business 4.0 and eventually create resilient,

competitive, and sustainable businesses that would prosper in an economy progressively directed by digital culture (Pereira et al., 2022).

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