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Leveraging Information Technology for Effective Inventory Management in Singapore's Supply Chain Industry

Keai Lim, Chen Sheng Chang and Jie Hui, Goh

Amity Global Institute, Singapore

Emails: lkeai@singapore.amity.edu, chang72@singnet.com.sg, gjiehui123@gmail.com

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Abstract

***Purpose**: The purpose of this research is to explore how a common IT system is used to manage inventory, and to identify the factors and challenges that affect the decision and implementation of IT adoption in inventory management.*

***Design/methodology/approach:** The methodology of this research consists of two parts: a literature review and primary research. The literature review synthesizes the existing studies on IT adoption in inventory management and provides a theoretical framework for the analysis. The primary is based on qualitative research design which involves conducting in-depth interviews with four inventory managers who use different IT systems across various industries. The interviews are transcribed and coded, and the data are analysed using thematic analysis and cross-case comparison.*

***Findings:** The findings of this study show that inventory managers adopt IT mainly to reduce costs and increase efficiency, which aligns with the literature. However, they also encounter challenges such as skill competencies and resistance to change, which hamper the successful implementation of IT. Moreover, the findings reveal that the type of IT system and the industry context may have an impact on the outcomes of IT adoption. Specifically, the inventory managers who use ERP, such as SAP, experienced more benefits and fewer difficulties, and the inventory managers who work in manufacturing and retail industries face more complex and dynamic inventory situations than those who work in service and education industries. These findings suggest that IT adoption in inventory management is not a one-size-fits-all solution, but rather a context-dependent and system-specific process that requires careful planning and evaluation.*

***Research implications and limitations:** This study offers practical insights and recommendations for inventory managers and IT developers who seek to improve their inventory management practices and systems. It also highlights the importance of IT for enhancing supply chain management and operational performance, which is a key goal of inventory management. However, this study is limited by the small and self-reported sample and the focus on two common IT systems. Future research could use larger and more diverse samples, multiple data sources, and different IT systems.*

***Originality:** This study addresses the research question of how IT is used to manage inventory, and what factors and challenges affect the decision and implementation of IT adoption in inventory management. It adds to the literature on IT adoption in inventory management by comparing multiple case studies with different IT systems and industries. It reveals the common and unique factors and challenges that influence IT adoption and suggests practical implications for inventory managers and IT developers.*

***Keywords:** ERP; Information Technology; Inventory Management; Resistance to change; SAP; Skill competencies.*

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Introduction

Supply chains are often simple systems of firms with dyadic ties and independent nodes and connections for producing goods or services. Contracts and different flows of material, information and capital are key connections (Chen & Wen, 2023). In the past, departments managed products and orders separately and with different goals. Past articles stressed SCM at all levels and across the widest network scope. Today's complex and uncertain world needs new models and strategies from technology. Innovative supply chain strategies, tools and approaches with ethical and environmental issues make SCM a performance driver (Tipi & El Gazzar, 2021). Inventory management balances consumer needs and supplier supply, affecting the whole supply chain. It involves tracking and controlling vendor and customer orders, and estimating and fulfilling available merchandise (Dang et al., 2020). It is part of SCM that manages the efficient and effective flow and storage of goods, services, and information from origin to consumption (Singh & Verma, 2018). It is also a key element of SCM that avoids supply disruptions and stock-outs by ordering the optimal amount and time while reducing storage and financing costs (Wang et al., 2022). Inventory management improves financial performance and competitiveness by saving costs in logistics activities. It is a strategic and vital operational function (Vukasovic et al., 2021a). Information sharing and visibility are important for deciding inventory levels and reorder points.

Inventory management is an important part of supply chain management (SCM) that balances consumer demand and supplier supply, affecting the whole supply chain (El Sakty, 2023). It involves tracking and controlling vendor and customer orders and estimating and fulfilling available merchandise. It is also a key element of SCM that avoids supply disruptions and stock-outs by ordering the optimal amount and time while reducing storage and financing costs. Inventory management improves financial performance and competitiveness by saving costs in logistics activities. It is a strategic and vital operational function (Vukasovic et al., 2021b; Fancello, 2022).

Information technology (IT) is the use of computers, software, networks, and other devices to create, store, process, and communicate information. IT plays a crucial role in inventory management, as it enables the collection, analysis, and sharing of data related to inventory levels, demand patterns, order status, and delivery schedules. IT also facilitates the automation, integration, and coordination of inventory processes across the supply chain, such as forecasting, replenishment, allocation, and distribution. IT can help improve the accuracy, efficiency, responsiveness, and flexibility of inventory management, as well as reduce errors, costs, and waste (Akour et al., 2022). One of the latest trends of IT in inventory management is cloud technology. Cloud technology is a type of IT service that provides access to shared resources, such as software, hardware, data, and networks, over the internet. Cloud technology can offer many benefits for inventory management, such as:

- Scalability: Cloud technology can adjust to the changing needs and demands of inventory management without requiring additional investment or maintenance. Cloud technology can also handle large volumes of data and transactions without compromising performance or security.
- Accessibility: Cloud technology can enable real-time access to inventory information from any device and location. Cloud technology can also support remote collaboration and communication among supply chain partners and stakeholders.
- Innovation: Cloud technology can enable smart devices and machine-to-machine communication, which can transform many aspects of inventory management. For example, cloud technology can support the use of radio frequency identification (RFID), internet of things (IoT), artificial intelligence (AI), blockchain, and big data analytics to enhance inventory visibility, traceability, optimization, and automation (Tjahjono et al., 2017; Ibrahim & Samrat, 2021).

Therefore, cloud technology is a promising trend of IT in inventory management that can improve the performance and competitiveness of SCM practices.

Supply chain management practices (SCMP) link all suppliers, manufacturers, distributors, and customers with information sharing. It was deduced that trust, information sharing, joint relationship management, and asset-specific relationships drive supply chain partner management (Basheer et al., 2019). Another article said information exchange is vital for supply chain performance and collaboration. More transparency and openness can enhance operational

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efficiency and flexibility by improving communication and information sharing. Higher integration and information sharing help understand different parties' needs and improve cooperation and coordination between them, leading to better decision-making and responsiveness in supply chain operations, order fulfilment and customer satisfaction (Fatorachian & Kazemi, 2021).

Consequently, the research purpose of this study is to investigate how information technology can improve the efficiency, effectiveness, responsiveness, and competitiveness of inventory management and SCM practices. Furthermore, the following research objectives are based on the significance of information technology and information sharing:

- To outline the various types of information technology used for inventory management.
- To explore the drivers of adopting information technology in inventory management.
- To identify the challenges of adopting information technology.

Literature Review

Managing Inventory with Information Technology (IT)

Inventory management is a central management function that involves the strategic planning, coordination, and supervision of the movement of materials and finished goods from suppliers to customers (Munyaka & Yadavalli, 2023). It emerges as a multifaceted and ever-evolving process that requires careful analysis and informed decision-making based on reliable and up-to-date information. The primary objective is to balance supply and demand, while minimizing inventory costs and risks, and maximizing customer satisfaction (Farahani et al., 2019). Various methods and approaches are employed to achieve these goals, such as just-in-time, materials requirement planning, economic order quantity, and days sales of inventory (Ghobbar & Friend, 2018). Supporting the inventory management process are diverse information technologies (IT) that facilitate the collection, processing, and dissemination of inventory-related data. By leveraging IT, inventory management benefits from improved visibility, accurate forecasting, efficient optimization, automation, seamless integration, and enhanced collaboration among stakeholders (Kmiecik, 2023). However, the incorporation of IT also poses certain challenges and constraints, such as data quality, security, privacy, interoperability, scalability, costs, user acceptance, standardization, integration, validation, evaluation, and generalization issues (Munyaka & Yadavalli, 2023). Additionally, Oluwaseyi et al., (2017) expounded inventory control as a long-standing research interest and information technology helps professionals collect data on demand, lead times, resources, and capacities. Using data efficiently is key for effective inventory management and the organization can choose what information to gather, buy and keep and what technology to invest in. For example, an inventory leader can use monitoring technology to track orders but if the data do not improve replenishment decisions, they are not useful. The next section examines the drivers, challenges, and types of technology adoption.

Exploring Various Information Technologies Solutions

Finished goods demand influences raw materials and components supplies and systems like MRP, DRP, or ERP are used to make finished goods from them. MRP works with JIT and Kanban models and applications, while ERP works with MRP to integrate all departmental operations. DRP uses software like Oracle, SAP, and Microsoft Dynamics (Munyaka & Yadavalli, 2022).

Enterprise Resource Planning (ERP)

MRP is a web-based method to plan raw material orders based on accurate and reliable information. It aims to keep the inventory level consistent with production needs (Hasanati et al., 2019). MRP is also a key part of ERP systems that support discrete production. It uses MPS, BOM and inventory data from ERP to calculate the required quantities and dates for finished goods and their components (Lambert et al., 2017).

Distribution requirement planning (DRP).

DRP is a technique that calculates the product quantity for each distribution point using control variables. It benefits from aligning manufacturing with facility demands and resolving inventory issues with MPS and forecasting (Magdalena & Suli, 2019).

Just-In-Time (JIT).

JIT system is based on customer satisfaction and

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continuous improvement through waste elimination and techniques like Kaizen, 5S, etc. (Phogat & Gupta, 2019). JIT system can enhance equipment use, inventory reduction, quality improvement, space-saving, cycle time reduction, supplier relations and employee involvement. JIT is applied to three types of inventories: Raw materials, work-in-process and finished products (Azim, 2018).

Vendor managed inventory (VMI). VMI system is a cooperative technique between buyer and vendor that optimises items with trust, information visibility, lower inventory costs and improvement (Dai et al., 2017). VMI gives supplier flexibility to ensure buyers' availability and replenishments. The contracts also increase the supplier's knowledge of the buyer's demand trend. Demand visibility and autonomy delegation are key VMI success factors (van den Bogaert & van Jaarsveld, 2022).

Warehouse management system (WMS). WMS helps firms to automate and improve systems and processes related to warehousing and inventory control. It manages all activities in one or more warehouses from tracking inventory quantity to assigning it to proper locations in the storage area. It is designed to handle stock movements across warehouses and provide real-time information that enhances inventory record accuracy and management (Folinasa et al., 2022).

Radio Frequency Identification System (RFID)

RFID is a system that uses tags and readers to collect and transmit product data via radio waves (Zhang et al., 2022). RFID enhances supply chain management, logistics and inventory control efficiency and can be used in various industrial fields. It can digitise data and offer benefits like reducing human error, streamlining transactions, providing data, and solving supply chain issues (Feng et al., 2017). For example, grocery stores can use RFID for better reordering and integrate it with other systems like EDI, VMI, ECR, CPFR, etc. (Reyes et al., 2021).

Electronic Data Interchange (EDI)

EDI is a system that allows firms to share data sets about their stocks, prices, specifications, and locations using digital communication technology (Mutuvi et al., 2019). It creates connections with trade partners and replaces paper-based systems. It is the electronic sending and receiving of trading documents like invoices and sales orders that reduce data entry checks and postal delays (Wang et al., 2019).

Information Technology Adoption Drivers

Organisation Strategy

Many studies have examined the factors affecting IT adoption, focusing on the variables that influence the choice and intention to use IT. These include cost-benefit analysis, organisational innovation, experience and knowledge, employee engagement and commitments, training and development, IT infrastructure and external variables like expertise, corporate partners, vendors and customers (Zamani, 2022). Other studies have also found organisational traits as potential factors, such as strategy, organisation size, industry, information intensity, organisational culture, and technological maturity. The strategy involves cost reduction versus value-added approaches and whether organisations adopt IT to compete with others. A lack of clarity or strategy on IT adoption goals can lead to failure (Zamani, 2022). Moreover, studies suggest that organisations need to invest in IT to gain organisational skills and abilities and develop competencies (Gunasekaran et al., 2017).

Costs Management

Inventory management is vital and challenging for financial statements and requires investment in systems that can control inventory costs, such as ERP systems. IT can also help to optimize inventory-related expenses, such as storage, insurance, order, and labour costs, by using tools like RFID (Karim et al., 2018). Moreover, IT can reduce the risk of low inventories and customer dissatisfaction, which can lead to revenue loss (Ünal et al., 2023). Businesses that use information accessibility systems can also address external challenges more effectively and efficiently (Trantopoulos et al., 2017).

Long-term Collaborations

Long-term relationships with partners affect the

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supply chain structure, which involves IT capabilities and information sharing (Farahani et al., 2019). IT also enhances coordination, collaboration, and interaction in the supply chain, which are essential for supply chain agility and performance (Kim & Chai, 2017). Moreover, IT benefits upstream interconnection by simplifying workflows, reducing transaction costs, streamlining information flows, and improving responsiveness and lead time. Furthermore, IT enables data visibility at all levels of the supply chain, which fosters alignment and adaptation among supply chain partners and improves performance (Oliveira & Handfield, 2019).

Visibility of Information

Automated operations allow supply chain professionals to focus on more significant tasks, such as processing real-time information instead of manual data collection and entry (Gezgin et al., 2017). Real-time data also enable decision-makers to act based on the current situation rather than the past, which makes them more agile and successful (Oliveira & Handfield, 2019). Moreover, information exchange reduces demand uncertainties and increases replenishment frequency with systems like VMI and continuous replenishment, which improves service level and delivery timeliness (Wang et al., 2019).

Efficiency

Information technology helps inventory managers to control and distribute inventory according to consumer needs, using an algorithm that evaluates inventory variables (Mahajan et al., 2023). IT also helps to identify the optimal timing for inventory value through information exchange in the supply chain network. Moreover, IT can reduce the bullwhip effect by improving demand forecasting and information sharing, which makes inventory more visible in real-time. IT can also assist logistics, production scheduling and procurement to decide the number of final units based on market demand (Fernando et al., 2020).

Challenges of Adopting Information Technology

Skills Competencies

IT revolution brings opportunities and challenges for organisations and managers need to adapt and leverage IT's capabilities while avoiding its risks (Chege & Wang, 2020). Effective people management is also needed to enhance employees' skills, competencies, and expertise for organisational capabilities, but learning depends on previous investments and technological growth that shortens the lifespan of skills. Moreover, adapting to technological disruptions requires unlearning outdated technologies and practices and learning new alternatives, which is difficult with existing systems and challenges the creation of a learning society (Ra et al., 2019).

Resistance to Change

The fusion of technology in the fourth industrial revolution will change people's lives and improve productivity and efficiency, but it could also increase inequality by affecting the labour market. This poses a challenge for businesses to motivate intellectual employees and avoid negative displacement by technology automation (Xu et al., 2018). Social engagement is driven by individual attitudes towards IT use (Adb Elbary et al., 2022), but businesses' rules and guidelines may override employees' opinions and preferences and cause dissatisfaction (Ajibade, 2018). Moreover, individuals assess time and effort in organisational contexts when forming opinions about IT use and environmental familiarity is a key factor in technology use (Tamilmani et al., 2021).

Cybersecurity and Data Ethics

Cybersecurity refers to the tools, regulations and procedures that protect data and resources from cyberattacks, which are more likely in the industry due to the multitude of partners and lengthy supply chains, mostly composed of smaller firms with limited IT resources (Mantha & de Soto, 2019). Cyberattacks can come from internal and external sources, such as hackers, cyberterrorists, operator errors and disgruntled employees, and they evolve rapidly and require continuous and complex risk detection and mitigation (Xu et al., 2018). IT also poses ethical challenges, such as violation of privacy, copyrights, personal and social rights, preservation of values and accountability for IT impacts. Moreover, IT increases the risk of data loss due to skilled cybercriminals or dishonest personnel who may use IT for their personal

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motives that harm a firm (Ugbogbo & Michael, 2016).

System Crash

Complex technologies can sometimes crash unexpectedly and there is little research on how and why systems fail and how some systems last longer or fail faster than others. System crashes are part of system evolution, but they can happen in unusual ways with a simple rule or error that affects multiple levels (Wang et al., 2019). Crashes can be hard to monitor even when the causes are known, such as bugs in software and firmware code that can be exploited by attackers. Memory corruptions or faults are a common type of problem that can lead to vulnerabilities which sometimes are silent and do not cause immediate system breakdown, but they pose a serious risk to the security and safety of embedded systems and can process incorrect data at any time (Muench et al., 2018).

Sustainability

Initial investment costs are considered before operational costs and Moore's law states that IT costs decrease while performance improves (Wang et al., 2020). However, IT competence is still vital, and businesses should develop it carefully as IT costs are falling and technological changes increase the risk of using outdated technologies. The question of whether IT capabilities can sustain organisational performance over time is also important and challenging as the rapid adoption of technologies with standardised and similar information-sharing programs makes IT-based competitive advantages short-lived. The value of having superior IT competence may not relate to better performance when IT underwent a significant revolution with innovations that increased the availability and commonality of IT, such as the Internet, outsourcing, ERP systems and computing costs (Ilmudeen, 2022).

Summary

This section summarises various IT types, such as VMI, MRP, ERP, DRP, JIT, WMS, RFID and EDI, that affect inventory replenishment and levels. The drivers to adopt IT can be internal factors, such as organisation strategy and cost management, or external factors, such as pressure and integration with partners and the desire to build long-term relationships with them through information visibility that improves operation efficiency internally and externally. This research contributes to the field of inventory management by offering practical insights and recommendations for inventory managers and IT developers who aim to improve their inventory management practices and systems with various IT solutions. It also demonstrates the significance of IT for improving supply chain management and operational performance, which is a main goal of inventory management. Furthermore, this research addresses a gap in the literature on IT adoption in inventory management by comparing multiple case studies with different IT systems and industries. It identifies the common and unique factors and challenges that influence IT adoption and provides implications for inventory managers and IT developers.

Research Methodology

Introduction

The research objectives of this study were to explore the drivers, challenges, and types of IT in inventory management. Qualitative research with in-depth interviews was the ideal approach as it could examine the information from senior employees in the industry from different perspectives and provide more insight. Hence, this research used an inductive approach as it worked well for qualitative content analysis by observing and inferring from observations and no theory is present at the beginning; instead, theories would emerge from the research (Gao & Zhang, 2019). Inductive researchers also claimed that one can rationally extrapolate the findings into all principles and that this process would confirm and validate the scientific assumptions.

Research Sampling Strategy

A qualitative sampling strategy specifies the number of observations, interviews, focused dialogues, or cases needed to verify whether the findings will

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provide rich information while a quantitative sampling plan includes the number of respondents, is explicitly defined. The main features of a qualitative sampling plan are respondents that are often carefully sampled with each research's sample size varying and being small, sampling would change when new questions are found during data collection and analysis, and the sample is selected based on intellectual needs rather than only on generalisability (Moser & Korstjens, 2018). Six phases need to be followed to perform sampling which includes defining the target segments, sample frame to be chosen, sample method choice, decision of significant size sample, data collection method and response evaluation (Taherdoost, 2016).

Research Approach

Qualitative research would be an ideal approach for this research topic; thus, a non-probability sampling using quota sampling technique was the most suitable technique to adopt as it ensured the overall sample has the same range of characteristics as the larger population and respondents are selected based on specified qualities (Taherdoost, 2016). Furthermore, it was implied that a sample number of one is the lowest which can be considered appropriate for some types of qualitative studies, with the possibility that a particular case study that involves one area of study could be relevant and offer insightful data (Vasileiou et al., 2018).

Interview Questions Formulation

The purpose of this research is to address three specific research objectives related to IT and inventory management. The interview questions for this research will be formulated by reviewing the literature on IT and inventory management and identifying the relevant concepts, variables, theories, and models that link the research objectives with the IT solutions and inventory management outcomes. Consequently, specific, and clear questions will be created to address each research objective, as follows:

- For RO1, the interview questions aim to explore the drivers and impacts of IT adoption on inventory management in various dimensions. They cover strategic, competitive, social, process, performance, and contextual factors that influence and affect IT adoption and usage in the organisation. They also examine how IT affects inventory management outcomes such as performance, efficiency, cost, risk, collaboration, coordination, information, forecasting, logistics, planning, and procurement.

- For RO2, the interview questions explore how IT adoption influences and affects inventory management in various dimensions. They address the drivers and impacts of IT adoption, such as strategic, competitive, social, process, performance, and contextual factors. They also investigate how IT affects inventory management outcomes, such as performance, efficiency, cost, risk, collaboration, coordination, information, forecasting, logistics, planning, and procurement.

- For RO3, the interview questions investigate the organisational and human resource challenges of IT adoption and usage in the organisation, assess the security challenges of IT adoption and usage in the organisation, and explore and measure the sustainability and reliability challenges of IT adoption and usage in the organisation, and for inventory management.

Data Collection

This research aims to analyse the use of IT in the inventory management sector; hence, the quota sampling technique of the non-probability sampling concept is used to collect data. Four respondents from different companies are selected for in-depth interviews to explore and evaluate the industry's IT use. The interviews were conducted for three weeks, from February 6 to February 19, 2023, and lasted about an hour and a half each. Consent forms are given to respondents for their approval before the interviews start. Physical interviewing is chosen over surveying because qualitative research involves a detailed analysis of individuals' experiences and issues in their situations without using predefined and standard categories of analysis. The physical face-to-face interview has advantages such as giving respondents flexibility to discuss factors based on their knowledge, allowing researchers to intervene when needed and ensuring that the respondent understands the topic being studied (Adhabi & Anozie, 2017).

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Data Analysis

Qualitative data analysis is often argued to be hard, time-consuming, and complex without theoretical focus and is especially relevant for new researchers who lack specific guidance on how to analyse qualitative data using certain approaches. According to this, inductive techniques mainly depend on accurate assessments of actual data to derive themes and concepts, which requires alternating between data analysis and research to make logical sense of emerging notions. Additionally, thematic analysis is the method to create a theoretical model to explain an approach that exemplifies precision in qualitative research using either inductive or deductive techniques to generate rich interpretative data analysis (Azungah, 2018). Therefore, the six steps of thematic analysis are as follows:

1. Familiarization: Reading and rereading the data, taking notes, and highlighting important points to get to know it better.
2. Coding: Highlighting sections of the text and assigning them a label that summarizes what they are about.
3. Generating themes: Organizing and grouping the codes by themes, topics, ideas, and patterns of meaning that come up repeatedly in the data.
4. Reviewing themes: Evaluating the themes on two levels: how they represent the coded data and how they apply to the entire dataset.
5. Defining and naming themes: Defining each theme's core concept and organizing them into a coherent narrative that covers the whole data and giving each theme an informative and interesting name.
6. Writing up: Writing the data analysis with themes and literature, comparing, and verifying the evidence, and presenting credible reasoning to the research question.

Ethical Consideration

This research follows ethical guidelines to protect participants' rights and interests. Participants can withdraw at any time and must sign consent forms before joining the study. The research ensures participants' confidentiality and anonymity by hiding their identities and names in the data collection, analysis and publication stages. The research also respects the privacy of the interview settings and the dissemination of the results (Arifin, 2018).

Summary

The section delves into the exploration and rationale for various research techniques, with a specific focus on the qualitative techniques employed in this study. The researcher thoroughly examines and justifies the selected qualitative methods, offering valuable insights into the entire process. This encompasses an overview of the inductive approach employed, the devised sampling plan, the data collection procedures, the six steps of data analysis, as well as a comprehensive discussion on ethical considerations. The researcher aims to identify and utilize appropriate data sources, thereby providing a comprehensive understanding of the qualitative methodology employed.

Findings and Analysis

Introduction

In this section, the analysis focuses on the primary data obtained from individuals working in the supply chain industry in Singapore. The researchers conducted four semi-structured in-depth interviews to evaluate the usage of information technology in inventory management. All interviews were conducted in person, with phone audio recordings used. The data for each theme was explained, and the key points were documented in a thematic analysis table. The relevant details of the respondents are presented in the appendices section.

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Various Information Technologies Used

Inventory Management IT Solutions

Four respondents use ERP or DRP systems for inventory management, both common types of IT found in section two. The interviews revealed different software such as Task Hub, Power BI, AppSheet, and A2000 Clarity which were used for data analysis, visualization, and app development. The DRP system software includes SAP and Salesforce Applications. One respondent uses Task Hub, a real-time but limited and unfriendly system, and Power BI to create charts or reports for inventory decisions. Another respondent uses AppSheet to customise applications to suit functions. Some respondents use one system to manage inventory, finance, sales orders, and invoices. These systems align with section two: maintaining inventory stability according to demand. The difference is that the literature shows ERP is for the production end, but wholesalers or other organisations with inventory need this IT too. Some respondents use SAP for data input and Salesforce to order supplies and monitor orders (red = order in process, green = order completed or delivered). The others use SAP to link various departments and track everything for audit. As in section two, inventory level concerns can be resolved through DRP by proper forecasting and ordering supplies accordingly. In sum, most respondents use IT internally and do not link with suppliers.

Other Information Technology Solutions Used

Respondents used other forms of IT before the current ones, but mostly for supply chain and not inventory management. They used IT such as CRM to keep contact details, EDM to do marketing, Scala for database, and Microsoft Navision like Excel. One respondent used Manpower Management software to monitor leave and generate pay slips or payroll for human resources. Some of them previously used RPA to arrange orders by filling templates and sending them to robots. The robots opened SAP and copied data (sales orders) to SAP. Now they use RPA for inventory projects to check stock movement, such as fast-moving and slow-moving goods, for better inventory placement.

Information Technology Adoption Drivers

Organisation Strategy

Most respondents said that IT adoption is part of their business strategy and helps them stay competitive in their industry. However, some claimed that IT adoption was more of a necessity than a choice, as it helped him cope with daily tasks. The others said that IT adoption was essential for survival in the market and for achieving long-term automation goals. This shows organisation strategy as an important factor for IT adoption, which agrees with Zamani (2022). What differs is that organisation sizes or technological maturity do not matter for IT adoption. Management decides if IT is needed and executes it.

Costs Management

All respondents agreed that cost management is the most important factor for IT adoption, as it helps reduce variable costs such as storage, ordering, outdated stock, and risk of low inventories. This is consistent with Karim et al. (2018), who mentioned that IT allows inventory visibility and lower reordering frequency. Some respondents mentioned that IT also shows fast- and slow-moving consumer goods and dead stock. The others mentioned that IT helps check items to be scrapped. These are waste costs that can be eliminated or lowered.

Long-term Collaborations

Farahani et al., (2019) mentioned that IT connections and information sharing have a positive outlook on long-term relationships with vendors. Respondents agree that IT enhances relationships with vendors but only to some extent and this does not influence IT adoption.

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It helps retain vendors' information in the system and seize opportunity costs with vendors based on a live-tracking system. Some mentioned that they could not see the enhancing relationships between IT and vendors as the system is only for internal purposes. The other respondents utilise IT connected with some vendors and agreed that this enhances long-term relationships.

Visibility of Information

Three respondents use IT internally and mentioned no visibility of information sharing with vendors but among various departments in each organisation, enhancing their daily functions. This is a factor for IT adoption as it helps efficiency. This agrees with Gezgin et al., (2017), who mentioned that IT removes manual data collection, filtering, entry and asking for information in the workplace. IT also shows product delays and decision-makers act accordingly.

Efficiency

As presented in the literature review section, IT helped with accurate demand forecasting and real-time inventory visibility, decreasing the bullwhip effect in logistics, procurement, and production scheduling. All respondents agreed on this and considered it an important factor for IT adoption to streamline operations. The findings include reducing grey areas and over-purchasing, as IT generates figures and stock levels for planning and lowers forecast errors while keeping low inventory. One finding that contrasted with Fernando et al. (2020) was that auditing adds accountability and security to the company, as employees cannot commit fraud and can only purchase from legitimate suppliers.

Other Drivers to Adopt IT

All respondents agreed that the main drivers for IT adoption among the respondents were cost management and efficiency. Cost management involved capturing opportunity cost, analyzing buying trends, and planning for bulk purchasing before prices increase, which would lead to economies of scale. Efficiency involved managing tight deadlines with IT, reducing human errors, and eliminating manual work, which would save time and lower employee dissatisfaction. Another driver that some respondents mentioned was auditing. They said that auditing added accountability, improved company ratings to attract investors or customers, and prevented fraud.

Challenges of Information Technology Adoption

Skills Competencies

The respondents faced challenges in acquiring relevant IT skills during the implementation. According to Ra et al. (2019), skills courses and learning are essential for employee competencies. The respondents reported receiving basic training, guidelines with standard operating procedures, and training guides and tutorials. However, they found it difficult to learn the new system. Some of them attributed this to the COVID-19 pandemic, which made training harder and left some staff still incompetent despite training. Others complained that they did not receive proper training and had to figure it out themselves, even though tutorials and videos were provided. Only a few of them stated that the system was straightforward and that the training helped them pick up skills and knowledge easily and quickly.

Resistance to Change

Similar to the literature review, half of the findings indicated that employee resistance to IT use was a challenge. Some employees resigned due to the new IT implementation, even though it was adjusted and customized to suit the business functions, but they did not comply. Management made IT use mandatory by requiring monthly presentations during meetings with IT. The findings showed that resistant employees were generally experienced people with older age. On the other hand, some respondents reported no resistance as most employees were involved during the IT design and implementation. Some also reported no resistance and more of learning by trying and accepting the new system.

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Cybersecurity and Data Ethics

In contrast to Ugbogbo & Michael (2016), who state that IT increased vulnerability to cyberattacks and dishonest personnel may misuse information, which could be detrimental to the firm, the findings suggest otherwise. All respondents mentioned that IT was secure and had strict rules on integrity and IT protection to adhere to. No incidents of cyberattacks were reported by any of the respondents. However, one respondent mentioned a virus attack once in the ERP system that caused data loss, and another mentioned employees deleting crucial information before leaving. Both incidents were resolved by a capable IT team from backup.

System Crash

Unlike Muench et al. (2018), who mentioned that monitoring crashes might be challenging even when processes are in place and flaws in software code are bugs, the respondents did not see this as a challenge. They said that errors and bugs occurred only once or a few times a year, and the systems were stable with no crashes or breakdowns. They also said that when they faced issues such as refreshing the system page unsuccessfully due to bugs or errors, or user error due to access not being given but needed, they were all resolved quickly by a competent internal or external IT team. One finding was that the customisation of IT determined the stabilisation of IT, meaning that more customisation led to more instability.

Sustainability

The respondents had different views on the sustainability of IT capabilities over a long period, given the fast adoption of new technologies. Ilmudeen (2022) stated that this was an important and difficult issue for organizations. However, all respondents did not see this as a challenge and believed that their current IT was sustainable and useful even when new technologies emerged. They mentioned that the organization kept up with IT trends despite some restrictions in implementing them, and one respondent mentioned that one system (AppSheet) could be replaced by artificial intelligence that could also replace humans. Some respondents did not foresee any factors that could make their current system obsolete for the next five years, unless the business model changed from B2B to B2C, while others mentioned that their system would still be relevant for at least the next five years. Some also intended to move to a cloud-based system but postponed it due to the lack of investment capital.

Other IT Adoption Challenges

The respondents faced various challenges that were not covered in the literature review. One challenge was staying up to date with the latest technologies. Some respondents mentioned that their organizations were slow in digitalization and had a huge gap in IT adoption, even though their current IT was stable and sustainable, but this also meant limited benefits for their organizations. Another challenge was finding new ways to use IT to capture and analyse data, which led to investment challenges. They also faced the biggest challenge of implementing IT during the pandemic, as employees encountered errors and waited for days to rectify them, slowing down the workflow (Shokair et al., 2023). Furthermore, some respondents stated that the main challenge was identifying the needed or required IT systems and the correct IT vendor, and not knowing if IT would enhance or bring down their operations. From some respondents' perspective, IT reduced variable costs but also increased the costs associated with maintaining and implementing it. The most challenging part for them was dealing with different time zones with an outsourced IT team and waiting for a response when issues occurred.

Conclusions

Introduction

This section aims to draw meaningful conclusions based on the findings presented in section four, thereby fulfilling the research objectives outlined at the beginning of this study. It also entails a comprehensive review of the research's limitations and proposes potential avenues for improvement in future research studies. By

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synthesizing the key insights and addressing any gaps, this section contributes to a comprehensive and conclusive understanding of the research topic.

Evaluating Research Objectives

Objective 1: Various Information Technologies Used

Seven types of information technologies that were found in the research and findings showed that the ERP system is commonly used. In this system, various software for organisations to adopt and invest in include Task Hub, Power BI, AppSheet, Salesforce Application, Robotic Process Automation, A2000 Clarity, and SAP. These technologies or software work similarly depending on the customisation. Most link all departments internally and uncommon to connect with external parties such as vendors or suppliers. Except one organisation spent a lot on information technologies, linked with external parties and had a lot of customisations. Various functions of information technologies include creating charts or reports for inventory decisions, managing inventory, finance, sales orders, and invoices in one system, ordering supplies and monitoring orders. Fang & Chen (2022) said managing stock in/out by batch with decision-making may serve as a basis for enterprise groups to decide appropriately. Overall, it maintains inventory stability according to demand and allows auditing with trackable records.

The findings also showed a few more technologies for the supply chain that aid operations and inventory management. These include Customer Relationship Management software, Electronic Direct Mail, Scala, Microsoft Navision, and Manpower management software.

Objective 2: Drivers of Adopting Information Technology

Among five drivers found in the literature review: organisation strategy, costs management, long-term collaborations, visibility of information and efficiency; yet, long-term collaboration is the least important or not a driver for IT adoption. The most important drivers are cost management and efficiency. Findings showed efficiency links to organisation strategy and visibility of information. For efficiency, decision-makers check inventory status in real-time in the digital era, decreasing the bullwhip effect from production scheduling to logistics (Liu et al., 2021). It also reduced demand forecasting errors linking to the visibility of information as the system shares information with employees from various departments, removing manual data collection and entry. These determine organisation strategy whether IT adoption is to cope with daily tasks or be competitive with trends.
When considering IT adoption, cost management matters. It includes variable costs such as storage costs, ordering costs, outdated stock, and risk of low inventories and how technologies help organisations understand dead stock and scrapped stock to eliminate waste costs. Also, implementation means investment capital. Organisations need to learn how to incorporate and anticipate competencies from IT measurement thus, a balanced procedure highlights IT benefit in monitoring and learning from business activities and easier for management to show IT value contributions (Luftman et al., 2017).

The findings showed that the respondents' opinions, long-term collaborations do not affect IT adoption even though it enhances relationships with vendors to an extent. Contact details will not be lost as in the system and able to seize opportunity costs with vendors based on a live-tracking system.

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Objective 3: Challenges of Adopting Information Technology

Out of the five challenges found in the literature review: skills competencies, resistance to change, cybersecurity and data ethics, system crash and sustainability; skills competencies and resistance to change are most challenging. Respondents' insights, most employees lack relevant IT skills upon implementation and despite training or guidelines provided, it is tough as some are not competent. The exception is straightforward and easy-to-use technologies with employees' participation in the design stage leading to lesser resistance.

The reason why resistance to change is a challenge was that experienced employees are generally older, not complying as they do not see the need in using technologies for job scopes. Some resigned because of this, leading to a higher turnover rate. Organisations had no choice but to make IT use mandatory leading to more dissatisfied employees. Henderson and Venkatraman's (1993) groundbreaking theoretical model pointed out that in achieving alignment of implementation, IT and business management play various roles and shoulder various important duties (Luftman et al., 2017). Cybersecurity and data ethics as well as system crash were not a challenge if organisations have strong IT teams and vendors who provide stable systems and lesser customisation that help decrease unstable systems or breakdowns. Additionally, strict rules on integrity and IT protection prevent employees from misusing information. Generally, with correct IT adoption, organisations see the sustainability of current ones and do not foresee what could make them obsolete for the next five years unless the business model changes. Lastly, other challenges include staying contemporary as organisations remain falling behind in digital transformation, choosing the right system and vendor for organisations, as well as expenses of implementation and maintenance.

Research Limitations

While this research has made significant contributions to the understanding of the use of information technology in inventory management, it is essential to acknowledge its inherent limitations. Firstly, due to the absence of prior studies specifically focused on this topic, the researcher had to rely on information gathered from recent reputable papers to strengthen the study's objectives and address its challenges. While efforts were made to ensure the reliability and relevance of these sources, the lack of existing literature on the subject may have impacted the comprehensiveness of the research. Secondly, despite Singapore's significant presence in the supply chain industry, there were limited avenues available for direct engagement with organizations. This constraint necessitated modifications to the sampling strategy and sample size, as access to potential participants was restricted. As a result, the research had to adapt to these limitations, potentially impacting the representation and diversity of perspectives within the study. Furthermore, the research only explores five factors for each research objective, and the sample size consists of four respondents from four different companies. This limited sample size, and the focused scope of the research may have restricted the breadth of topics covered, potentially leaving some important aspects unaddressed.

To address these limitations, future research should strive to expand the literature base on the use of information technology in inventory management. Additionally, efforts should be made to enhance access to a wider range of organizations within the supply chain industry to obtain a more diverse and comprehensive sample. Finally, future studies could consider broadening the scope of factors and increasing the sample size to further explore the complexities and nuances of this research topic.

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Recommendations for Future Research

To enhance the strength and comprehensiveness of the data collection process, future research could consider expanding the number of respondents from different organizations. Increasing the sample size from four to perhaps ten or twenty would provide a more robust foundation for qualitative research. Additionally, further investigations can be conducted to identify potential factors that were not covered in this study. This could involve expanding the research objectives or considering additional factors that may influence the use of information technology in inventory management. Moreover, to augment the research approach, a larger sample size could be explored within each position or role to provide deeper insights and a more comprehensive understanding. This could potentially involve incorporating quantitative research methods alongside the qualitative approach. By integrating quantitative data analysis, the research could attain a more holistic overview of the application and impact of information technology within the inventory management industry. By addressing these areas for future research, scholars can delve further into the complexities and dynamics of the topic, contributing to a more comprehensive body of knowledge on the use of information technology in inventory management.

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Appendix

Research Interview Questions

RO1: To outline the various types of information technology used for inventory management.

1. What kind of information technology (IT) does your organisation use?
2. Please provide further details regarding the use of the relevant IT.
3. What other kinds of IT have you used before the current one? – Provide a brief description of how it works.

RO2: To explore the drivers of adopting information technology in inventory management.

1. Does your organisation use IT as a business strategy or only to stay competitive with other businesses using IT?
2. Did using IT reduce the variable expenses associated with inventory? (Such as storage costs, insurance costs, ordering costs, outdated stock, and risk of low inventories)
3. Did the use of IT improve long-term relationships with vendors? – Is this a factor in the adoption of IT?
4. How big of an impact did IT have on the visibility of information sharing? - Did it enhance replenishment frequency and streamline operations?
5. How does IT enhance demand forecasting, logistics, production planning and procurement?
6. What are the other IT adoption factors in your organisation?

RO3: To identify the challenges of adopting information technology.

1. Do the majority of employees have the necessary IT skills? – (If no, how did the organisation address the issue? Is training provided?)
2. Are there any employees who have resisted using IT since it was implemented? - And how did the company prepare the staff for the changeover? (For example, letting them know ahead or allowing them to participate during implementation, etc.)
3. Have you come across any cyberattacks or dishonest employees who have used the organisation's information inappropriately thus far? – How was it resolved?
4. Do system crashes occur regularly? – When they do, how do you cope?
5. Do you think the existing technology can sustain and still be useful while other new ones emerge? – (how do you view the sustainability of the current IT?)
6. What other challenges does your organisation face while using IT?