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# IMPACT OF INTELLIGENT INVENTORY SYSTEM ON IMPROVEMENT OF REVERSE LOGISTICS: A CASE OF SAUDI MANUFACTURING INDUSTRY

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***Abstract:*** *The Saudi manufacturing industry is undergoing rapid change, and its practitioners are employing technology-driven process management solutions. Recent research has focused on constructing an efficient and sustainable reverse logistics supply chain, particularly in light of the two-year supply chain disruption caused by the pandemic. However, reverse logistics involves numerous stakeholders and intricate processes, making managing and guaranteeing customer satisfaction challenging. To address these issues, researchers advocate implementing artificial intelligence-based inventory management systems, which are more automated and enable adaptable supply chain management. This study adopted a semi-structured interview approach to collect data from 5 experts in the field to investigate the impact of intelligent inventory systems on reverse logistics in the Saudi Arabian manufacturing industry. The study's findings indicate that reverse logistics faces several challenges; however, using an intelligent inventory system improves the operational and warehousing activity of the reverse logistics system and encourages adequate resource replacement in the event of resource unavailability. In addition to the limitations of the researcher, several theoretical and practical implications of this study have been outlined.*

***Key words:*** *Reverse Logistics, Inventory system, Manufacturing Industry, Saudi Arab, Artificial Intelligence*

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## 1. Introduction

In the past three years, the entire business sector has faced global supply chain issues (Ivanov, 2022; Verbeke, 2020; Zhu, Chou, & Tsai, 2020). These issues were exacerbated by the pandemic's environmental, legal, and social implications, which has led to a heightened interest in logistics and supply chain research (Montoya-Torres, Muñoz-Villamizar, & Mejia-Argueta, 2021; Queiroz et al., 2022). In addition, reverse logistics and closed-loop supply chains have attracted renewed research interest (Kuah & Kim, 2021; Paul et al., 2021; Wang, Dang, & Nguyen, 2021). Reverse logistics enables the return of products or waste material from end-users to merchants, suppliers, manufacturers, or recycling companies along the supply chain. The fundamental objective of reverse logistics is to maximize the recovery of any remaining value from products that have reached end-of-life (EOL) through the use of appropriate techniques of designing, controlling, operating, and maintaining an effective and efficient flow of processes beginning with the customers and ending with the manufacturers or suppliers (Kumar Singh, Chauhan, & Sarkar, 2022; Wang et al., 2021; Wilson & Goffnett, 2022). In addition, reverse logistics enables the disposal of non-recyclable materials appropriately.

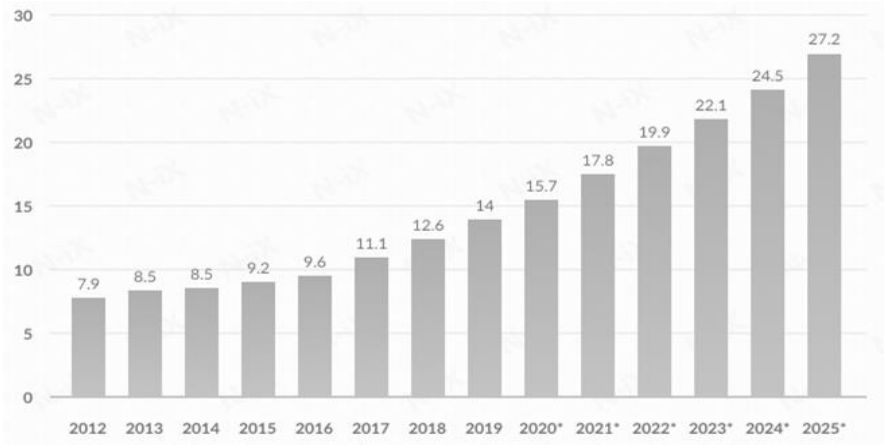


*Figure 1: Automated Inventory and Warehouse Management Software Market Growth Prediction*
*Source: Statista.com*

Alkahtani and Ziout (2019) and Dev, Shankar, and Qaiser (2020) state that operating and designing a reverse logistic system must be incorporated into all industrial sectors of a developing economy to balance the tradeoff between social sustainability, economic conditions of the country and environmental factors. However, it is not a simple endeavor because numerous stakeholders are involved in the process, and it is challenging to manage such an operation without any problems and obstacles (Paula et al., 2020). In addition, the reverse logistics system is plagued by numerous other issues, such as an increase in operational costs, uncertainty regarding the quality of end-of-life (EOL) products, a lack of relevant information on which to base decisions, and a lack of collaboration (Liu & De Giovanni, 2019; Plaza-Úbeda et al., 2020; Trochu, Chaabane, & Ouhimmou, 2018; Wang & Wang, 2019). Consequently, several significant obstacles are in the way of sustainable reverse logistics administration.

Multiple technologies that facilitate internet-based, intelligent, and autonomous operations of both logistics and manufacturing processes (Bekrar et al., 2021; Rad et al., 2022) can address these challenges more effectively. Combining multiple cutting-edge technologies enables intelligent inventory management, allowing for real-time monitoring of processes, improved resource allocation, responsive communication, etc. Smart and intelligent inventory and logistics management technologies contribute to the supply chain's social, economic, and environmental sustainability. As we emerge from a global supply chain crisis that lasted more than two years, there is a pressing need to make inventory management systems much more resilient, stable, and adaptable so that they can confront similar problems in the future. According to the data presented in Figure 1, the scope of automated solutions and software for inventory and warehouse management is expanding. Therefore, intelligent inventory systems are a potential improvement for reverse logistics that the researcher must investigate. The objectives of this investigation are provided below.

- To understand how intelligent inventory systems can benefit the manufacturing industry.
- To examine the role of reverse logistics in the Manufacturing industry
- To explore how intelligent inventory systems can improve reverse logistics in the manufacturing industry.

The scope of this investigation is restricted to the Saudi Arabian manufacturing sector. The reason for focusing on data acquisition from Saudi Arabia's manufacturing sector is that Saudi Arabia is rapidly advancing and adopting new inventory management and supply chain management technologies. Exploring the scope of intelligent inventory management systems for reverse logistics in Saudi Arabia's manufacturing sector will enable future applications of search solutions in practice. The significance of this study is multifaceted, and it will be helpful in theory, practice, and policymaking. In addition, the study will be essential for future researchers and practical applications. The remainder of the paper is organized into four sections. The first section is the literature review, followed by a section on the methodology that describes the data acquisition techniques, philosophies, and analysis techniques, the results of the analysis, and the discussion of the findings.

## 2. Literature Review

### 2.1 Manufacturing Industry in Saudi Arabia

Saudi Arabia's manufacturing industry is predicated on the production and expansion of petroleum (Faheem et al., 2020). The sector's expansion began in 1976 when the Saudi Arabian government established the Saudi Basic Industries Cooperation (SABIC) (AlTaweel, 2021). The main products of Saudi Arabia's manufacturing sector are petrochemicals, fertilizers, metal products, and rolled steel. Several investigations have attempted to examine the Saudi Arabian manufacturing sector. One study by Almosabbeh and Almoree (2018) examines the relationship between the manufacturing sector's performance and Saudi Arabia's economic growth. The study demonstrates a long-term connection between the two factors. The research methodology was founded on an in-depth examination of data from various sources. In addition to the five-year plans of the Saudi Arabian Ministry of Planning

and national economy, these sources include the World Bank, the Saudi Arabian Monetary Agency, and the Penn World table. To examine the stability of the time series, the researcher employed a co-integration methodology. Kaldor's and Verdoorn's laws were used to interpret data. The causal relationship between growth rates and labor productivity is examined using both laws (Chandra & Sandilands, 2021). In essence, the relationship between input and output is positive. Both laws applied to the relationship between Saudi Arabia's manufacturing industry and economic growth. According to the findings, they have a positive relationship. The author suggested increasing the manufacturing sector's contribution to the country's GDP growth (Almosabbeh & Almoree, 2018).

Recent research has focused on enhancing the standards of Saudi Arabia's manufacturing sector. One of the investigations aimed to assess the safety and health conditions in the manufacturing sector. The study examined the Jeddah manufacturing industry. Twenty years of follow-ups have been divided into two sections for this study. The statistical analysis of safety and health performance has been evaluated in both periods. Both studies indicate that the safety and health performance of the manufacturing sector has improved (Noweir et al., 2013).

In contrast, another study investigates the failure of Total Quality Management in Saudi Arabia's manufacturing sector. The paper describes the International Organization for Standardization (ISO) 9000, which has served as a paradigm for the global manufacturing industry. According to the findings of this study, the Saudi Arabian manufacturing sector faces numerous challenges, including professional and financial obstacles. Alofi and Younes (2019) provided a roadmap for adopting measures that could eliminate obstacles to implementing ISO 9000 in the Saudi Arabian manufacturing sector. There is a lack of qualitative studies involving the opinions and experiences of Saudi Arabia's manufacturing sector personnel, as evidenced by the lack of qualitative data from previous research.

### 2.2 Intelligent Inventory System

Intelligent inventory systems are also known as clever inventory systems (Saha & Alam, 2022) in the literature. The method by which manual tasks are automated to save time and labor (Dey et al., 2021). Utilizing cutting-edge technology, the system also reduces the possibility of human error. An intelligent inventory system analyzes and captures real-time data (Kurdi et al., 2022). The data may contain information regarding the availability, location, and shipment status of commodities and products. An intelligent inventory system has several advantages, such as automating the entire process, providing real-time updates on the status of products, monitoring supply chain disruptions, and increasing consumer satisfaction (Mondol, 2021).

Numerous studies attempt to define and evaluate the intelligent inventory system. The digital economy emphasizes the adoption of advanced systems by industries. A study investigates the issues facing the manufacturing sector. The availability and acquisition of inventory data were the most frequent obstacles identified. The study seeks to implement a vendor inventory system based on technologically sophisticated methods in the manufacturing sector. The research proposes two models for effective intelligent inventory systems in manufacturing (Fang & Chen, 2022). The results were found to reduce costs and improve inventory management in the manufacturing sector. The traditional inventory management system cannot adapt to the changing enterprise and product demands to remain competitive. The structure and operation

of an intelligent inventory management system are described in a study by 90. The study outlines various benefits associated with the intelligent inventory management system. According to the research (Paul, Chatterjee, & Guha, 2019), the emergence of intelligent inventory systems has caused companies to enter the global market. There is a need to examine the effects of the intelligent inventory system on the manufacturing industry, despite the abundance of literature on intelligent inventory management from previous research.

### 2.3 Reverse logistics

Reverse logistics is a supply chain management procedure. It entails all processes that transfer goods or products from customers to manufacturers. Reverse logistics involves the movement of products upstream. Reverse logistics consists of five R's: returns, recalls, repairs, repackaging, and recycling (Shuang, Diabat, & Liao, 2019). Due to environmental concerns, industries and academic institutions are paying more attention to reverse logistics. There is a large body of literature on reverse logistics. A literature evaluation is conducted on reverse logistics. The research employed an abductive methodology and a comprehensive content analysis of the literature. The researcher has examined 449 articles explaining reverse logistics (Prajapati, Kant, & Shankar, 2019). The articles are organized into eleven sections that enable future researchers to analyze the voids in the studies of reverse logistics and conduct research on new dimensions of reverse logistics.

Another study describes the practices of take-make-discard that have negatively impacted the environment. These practices have created a need for sustainable alternatives. The study found reverse logistics to be expensive and difficult to manage. Sixty-six articles were reviewed to examine the complexities of reverse logistics. In addition, the study identified five critical success factors for reverse logistics, including Material Planning and Management, Life Cycle Assessment, Industrial Sustainability, Information and Communication Technology, and Promoters and Relationships. Julianelli et al. (2020) suggest adopting these factors to achieve effective reverse logistics in various industries. Numerous studies have examined the literature and provided the foundation for reverse logistics; however, a quantitative approach that provides empirical evidence for reverse logistics in the manufacturing sector is lacking.

### 2.4 Impact of Intelligent Inventory System on Reverse Logistics

The studies demonstrate that intelligent inventory management systems significantly impact reverse logistics. Numerous studies seek to answer this query. A study attempts to explain the reverse logistics process's technological obstacles. Several disruptive technologies impact reverse logistics. Still, this study focused on a few of the most significant disruptions, namely the Internet of Things, Blockchain, Cloud computing, and Artificial intelligence. These technological disruptions enhance the reverse logistics chain's information flow. The study describes the use of disruptive technologies in reverse logistics management. Jović et al. (2020) note that the study has limitations, including rising costs and accuracy issues in the reverse logistics chain.

Artificial intelligence has penetrated virtually every market sector. Several studies investigate the function of artificial intelligence in reverse logistics management. The influence of artificial intelligence on the reverse logistics chain is investigated by

Wilson, Paschen, and Pitt (2022). The literature has been utilized to investigate the effects of artificial intelligence on reverse logistics. The researcher identified different types of artificial intelligence, such as mechanical, analytical, and intuitive, as impacting the reverse logistics process. Previous research on the impact of intelligent inventory management systems on reverse logistics has relied solely on secondary sources (Zhang et al., 2022). However, the relationship between intelligent inventory management systems and reverse logistics is rising. Improving an intelligent inventory system would increase the efficiency of the reverse logistics chain.

## 3. Methodology

### 3.1 Research Design

Such a study employs qualitative data collection and analysis techniques, such as action research, to address a particular research problem (Maxwell, 2012). In the current study, the scope of using intelligent inventory systems to enhance reverse logistics in the manufacturing industry is the focus of the research problem. This study employs qualitative semi-structured interviews for exploratory analysis as its methodology. The researcher analyzed previous research on intelligent inventory systems and reverse logistics and then mapped out both concepts' manufacturing benefits. The concept of reverse logistics, reverse logistics issues, and the impact of the Intelligent Inventory System on the reverse logistics system in the Saudi Arabian manufacturing industry were evaluated using a qualitative approach. This strategy is justified because qualitative methodology will enable the researcher to "evaluate" the value of using inventory systems in reverse logistics and the applicability of using intelligent inventory systems for reverse logistics in the Saudi Manufacturing industry.

Interpretivism is the philosophical paradigm followed in the current investigation. Interpretivism enables researchers to employ an exploratory strategy that facilitates comprehension of social realities. It is a subjective interpretation of certain phenomena that must be evaluated in their natural environment (Durant, 2022). A researcher conducting interviews must adhere to the Interpretivism philosophy and use human subjects as data-generating instruments. This study's research design is based on an inductive methodology (Liu, Xu, & Fan, 2020). An inductive approach permits the researcher to record a series of observations and use them to extract patterns from collected data to compare them to a proposed study or develop a new theoretical concept. In addition to the research design, the researcher must consider the time available for data collection and analysis.

Regarding behind-the-scenes support, various tasks must be completed during the research process; therefore, selecting an appropriate time horizon is an essential consideration for any study (Qutoshi, 2018). In the present study, the researcher has adopted a cross-sectional time horizon because the data is collected through a single interview with each respondent over the same period. In addition, the researcher must identify the nature of the study. The nature of the research influences a study's data collection instruments, techniques, and data analysis strategies (Jiangyu, 2019).

### 3.2 Population and Sampling

The population selected for the current research consists of Saudi Arabian

manufacturing industry employees. Only employees with experience in reverse logistics and inventory management systems will be included in the sample of Saudi Arabian manufacturing industry workers. The chosen sample size for this research is five experts. These five specialists were chosen using a convenience sampling method that allows the researcher to select respondents who meet sampling criteria and can be contacted easily for data collection.

### 3.3 Data Collection and Analysis

Primary or secondary data acquisition methods may be utilized (Zhang, 2018). In primary data collection, the researcher gathers information directly from respondents. Regarding secondary data collection, researchers gather information from preexisting data sources. For the current study, the researcher employed a primary data collection method, as responses were gathered directly from respondents through an interview. Interviews with a semi-structured format are used to acquire data. Instead of a fully structured interview, a semi-structured interview is used in the current study because it allows the respondent to have some freedom, and there are no stringent rules for data collection other than sticking to the main topic of the interview. Furthermore, the semi-structured interview is preferable to the unstructured interview because it allows both the respondent and the interviewer to remain on topic and achieve the interview's objectives. The following queries served as the primary data collection drivers in the semi-structured interview.

1. What are the characteristics of an intelligent inventory system?
2. What are the benefits of using an intelligent inventory system, especially manufacturing?
3. What is the purpose of Reverse Logistics in the Manufacturing Industry?
4. How can inventory systems aid in reverse logistics?
5. How can intelligent Inventory systems improve reverse logistics in the manufacturing industry?

After collecting data, the researcher analyzed the collected responses using content analysis techniques. The motifs of the responses were identified using a mind map. The researcher then used a tabular framework to compare and contrast similar and unique responses for each theme. In addition, word clouds were utilized to support each theme's findings.

## 4. Results and Analysis

This project aimed to assess the viability of employing an intelligent inventory system to enhance reverse logistics processes in the Saudi Manufacturing sector. According to the methodology, five primary questions were posed to the respondents during the interview. The information for the qualitative analysis was gathered through interviews. The information was transcribed and imported into the NVIVO software to assess the data's predominant themes. The researcher initially organized the data according to the respondents. The information was then compiled, and themes were generated by examining the details of the transcription. After careful examination, it was determined that the dataset contained five themes. Then, these motifs were also incorporated into the framework-based and word cloud analyses. The data generated the five themes listed below.

*Table 1. Five themes and their key points*

| Themes | Key points |
|---|---|
| Characteristics of an intelligent inventory system | Keep track of inventory levels, Security and Backups, Scalability, Accuracy, Barcoding and Scanning, Configurability |
| Benefits of using an intelligent inventory system | Inventory optimization, Automation, Higher customer satisfaction, and detection of supply chain disruptions. An effective inventory system shapes positive client experiences |
| Purpose of Reverse Logistics | It ensures a smooth flow of commodities. The procedure ends the product life cycle, lowers costs, adds value, and lowers risk. It also ensures sustainability. Numerous manufacturers created goods that can be demolished and rebuilt due to the relevance of reverse logistics techniques. This is done within the context of sustainable development. |
| Use of inventory systems in reverse logistics | Reverse logistics can assist a business in reducing costs from returns by developing methods to reintroduce them into the distribution network. An essential component of how businesses manage their logistics is their inventory system. Inventory management systems are necessary for logistics to operate. |
| Impact of Intelligent Inventory Systems on the reverse logistics | Effective logistics systems enhance operational and warehousing activity. By prolonging the product life cycle, reverse logistics encourages resource replacements that can be both affordable and environmentally sustainable. |

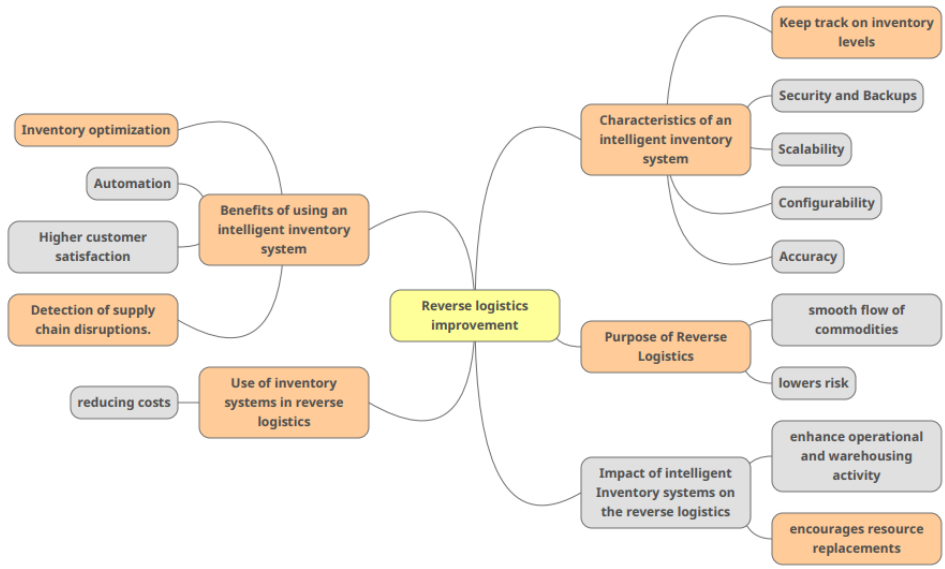


*Figure 1. Mind map*

During the preliminary analysis phase, the transcriptions were imported into NVivo to assess the significant themes. Once the main themes were identified, the information was codified so that the framework-based method could be used to analyze it. The researcher can present the findings using this method's structured approach to reviewing the data associated with the main themes. The themes and responses of each respondent are enumerated in the following table. To provide a summary of the topic as a whole, the responses have been presented as both similar and distinct responses.

*Table 2: Framework-based analysis*

| Theme | Similar response | Unique response |
|---|---|---|
| Characteristics of an intelligent inventory system | This system's capability to monitor and keep track of the inventory levels in the business is its main point of attention. If you do this, you won't be unaware of how the company is managed. Scalability is one of its essential features. It also includes security and backup measures. An accurate inventory control system shows the quantity of goods available in the store. | Securely storing inventory goods is a crucial component of an intelligent inventory control system that complies with the basic premise. The more complete systems are effectively used without customization across businesses and goods. An intelligent inventory control system must disclose the precise location of the substance you need and the number of units in stock. |
| Benefits of using an intelligent inventory system | Since it frees up money to allow a company to reach its full potential while still satisfying consumer demands, an intelligent inventory system is crucial. One can estimate demands and make more informed choices that result in a quicker turnover of the inventory and improved company profits if you have the correct tools. Gaining the consumers' trust through a practical discussion regarding their orders leads to higher customer satisfaction. | Automation is also one of its essential benefits. An automated inventory system replaces human record keeping with a quick cellphone scan to digitize the information. Automated inventory management solutions decrease web searches and operator mistakes by automating manual activities and scanning data precisely. |
| Purpose of Reverse Logistics | Reverse logistics, a crucial aspect of services lifecycle management may be made more effective and economical with proper planning, governance, and implementation. Reverse logistics enable the reintroduction of commodities into the supply chain. Products are reused rather than thrown away, which reduces waste. | Reductions in several production expenses are also mainly owing to optimized reverse logistics procedures. Businesses can cut these costs while better tracking and analyzing them by creating an effective reverse logistics strategy. Reverse logistics allows businesses to deal with returns and recalls rapidly and effectively, which helps them provide better customer service. |
| Use of inventory systems in reverse logistics | For businesses to control their logistics, inventory systems are essential. There is a reciprocal interaction between inventory control and reverse logistics. Inventory management is required for logistics to operate. | Growing awareness of and attention to reverse logistics procedures, such as recovering returned goods, has recently emerged as one strategy enterprises use to maintain and boost the company's global competitiveness. |

| Theme | Similar response | Unique response |
|---|---|---|
| Impact of Intelligent Inventory Systems on the reverse logistics | Effective logistics systems improve warehousing and operational activities. Reverse logistics promotes resource alternatives that can be simultaneously reasonably priced and eco-friendly by extending the product's lifespan. | Reverse logistics has been crucial to these procedures, from recovering personal items to removing municipal garbage. |

Characteristics of an intelligent inventory management system comprised the initial research query and theme. Scalability, Keeping Track, Security, Barcoding, Configurability, Accuracy, Scanning, and Backups are the most prevalent terms highlighted in the word cloud depicted in Figure 2. These key phrases underscore the primary topics and threads of conversation followed by survey respondents. Most aspects of the inventory management system require customer service (Kilic, Tunc, & Tarim, 2018; Tavaghof-Gigloo & Minner, 2021). An intelligent inventory system is essential for customer service to increase demand for any product. Each company provides various services, such as a work plan, free shipping, customer support, and many others (Dey & Seok, 2022). According to Yuan (2020), each phase must maintain an Inventory system to increase customer satisfaction, reduce costs, and ensure the distribution network operates effectively and efficiently.

Additionally, these keywords demonstrate the qualities of a clever inventory system. One of their primary objectives, according to Kara and Dogan (2018), is the need for an effective inventory management system to improve customer service and give businesses that manufacture perishable products a competitive edge in the current global economy. Essential system characteristics for an intelligent inventory system include supply lead time, purchase price, inventory costs, procurement cost, consumer demands, and retail item price, which influence the inventory management system's dynamism and success.

*Figure 2. Theme 1-word cloud*

The second query and theme identified in the research were the Advantages of utilizing an intelligent inventory management system. Figure 3's word cloud reveals that the highlighted keywords are "Inventory Optimization, Greater Customer Satisfaction, Automation, and Detection of Supply Chain Disruptions." Inventory acts as a buffer against potential upstream and downstream risks, allowing for the rapid satisfaction of consumer demand. An intelligent inventory level that is too high will increase inventory costs, while a smart inventory level that is too low will reduce customer satisfaction. Therefore, inventory must be optimized to reduce costs and enhance customer service (Yuan, 2020). According to Fang and Chen's (2022) definition of "automation," substantial automation accelerates the completion of duties. User productivity increases, and time could be conserved for more valuable tasks such as customer service, inventory management, etc. These keywords indicate the advantages of employing an intelligent inventory management system in manufacturing.


*Figure 3. Theme 2-word cloud*

The third inquiry centered on the Function of Reverse Logistics. Figure 4's word cloud illustrates that the highlighted keywords are "lower costs, smooth flow of commodities, and sustainability" According to Banihashemi, Fei, and Chen (2019), a competitive advantage can be obtained through increased profits, cost savings and customer satisfaction if RL programs are managed effectively. In addition, by paying close attention to rectifying or replacing defective products, RL can significantly contribute to customer satisfaction and maintain their dedication. These keywords illustrate the objective of reverse logistics in the manufacturing sector.

Utilization of inventory systems in reverse logistics was the fourth theme. Figure 5's word cloud reveals that "reducing cost" is among the most prominently displayed keywords. Recent initiatives have been undertaken to incorporate reverse logistics into traditional inventory management systems (Liao & Deng, 2018a, 2018b). The advantages of reverse logistics are increased customer satisfaction, decreased sales volumes, and cost savings. According to Sanni, Jovanoski, and Sidhu (2020), the costs associated with reverse logistics operations directly impact inventory decisions. These findings are consistent with the participants' responses.

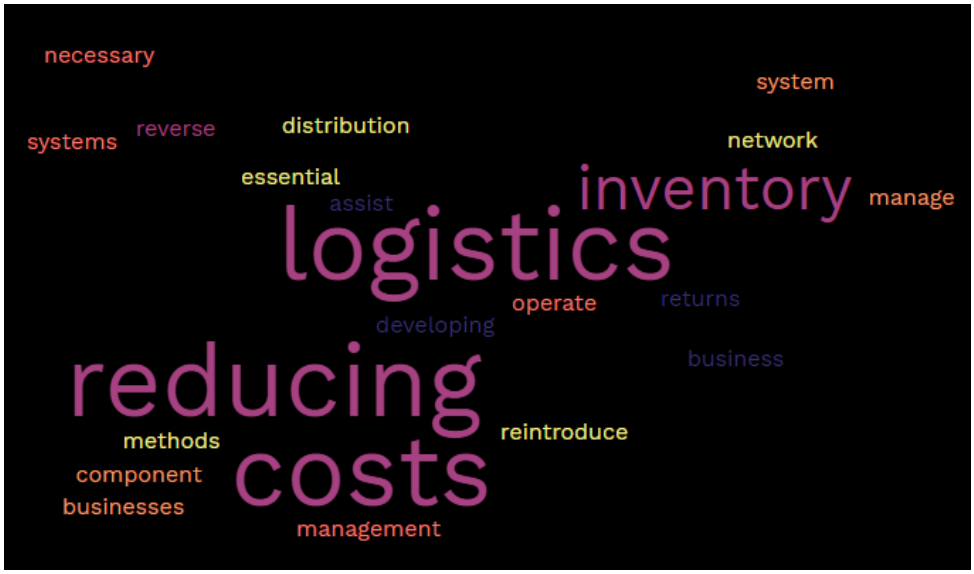


*Figure 5. Theme 4-word cloud*

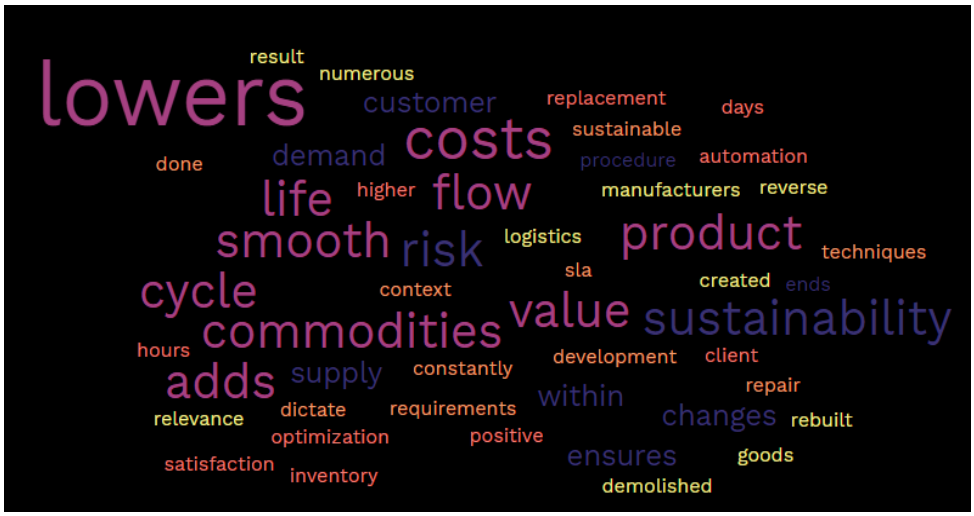


*Figure 4. Theme 3-word cloud*

The impact of intelligent Inventory systems on reverse logistics was the fifth theme. Figure 6's word cloud identifies the principal keywords as "warehousing activity,

operational activity, sustainable development, and resource replacement" According to González-Sánchez et al. (2020), the strategic considerations for the RL system include costs, general performance, customer care, and legal and sustainability issues. In addition, they highlighted the operational activity of this system type. Depending on the organization, the significance of packaging, reprocessing, recycling, shipping, storage, inventory planning, cost comparison, and logistics will vary. These keywords emphasize intelligent Inventory management systems' effect on reverse logistics in the manufacturing industry.


*Figure 6. Theme 5-word cloud*

After analyzing the participants' responses and the relevant literature, it has been determined that RL can lead to improvements in forthcoming products or new service concepts. Due to unavoidable product returns, government regulations, environmental impacts, and sustainability, the significance of reverse logistics has increased in recent years. Reverse logistics in the intelligent inventory system is one strategy for lowering costs, increasing revenue, and preserving market competitiveness. In Saudi Arabia, byproducts and discarded materials can be valuable inputs for various enterprises. Saudi Arabian manufacturers must know their fundamental responsibilities to protect the environment and conserve natural resources. They must prioritize modern initiatives such as ecologically and economically sound reverse logistics in their inventory system.

## 5. Discussion and Conclusion

### 5.1 Discussion

This study aims to define and implement an intelligent inventory system in Saudi Arabia's manufacturing sector to improve the reverse logistics chain. Based on a qualitative methodology, interviews are conducted for this investigation. Interview data indicate that five main themes contribute to the research objective. The first significant motif identifies the primary characteristics of intelligent inventory management systems. According to the research, these characteristics include

precision, barcoding, configurability, scalability, security and backups, scanning, and inventory tracking. In addition to unique responses observed during interviews, the researchers discovered that these factors are crucial for intelligent inventory systems. Also essential for an intelligent inventory system are secure storage, customization, location, and stock availability. The second central theme focuses on the advantages of employing an intelligent inventory management system. The advantages of an intelligent inventory management system include automation, customer satisfaction, and the detection of supply chain disruptions (Ahmad et al., 2020). According to the study, such benefits keep businesses abreast of consumer demands and increase customer confidence. It also indicates that automation is essential for efficiently operating intelligent inventory management systems. The third principle motif describes the function of reverse logistics. The objective of reverse logistics is to facilitate the passage of goods, increase their value, and reduce the associated risk. In a nutshell, it establishes a system for sustainable development (Ho et al., 2021).

According to the research, this can be accomplished through effective governance, appropriate planning, and implementation. In addition, the procedure conforms to the reuse of products to reduce waste. According to the research findings, the objective can only be achieved by reducing production costs, enabling companies to improve the return and recall process and increase customer satisfaction (Pallathadka et al., 2021). The fourth theme of the study is to analyze the use of an intelligent inventory system based on the assistance of businesses to reduce costs and govern the process. The research discovered a new concept referred to as recovering returned products, which is used as a new strategy to maintain and improve the competitiveness of businesses. The impact of intelligent inventory systems on reverse logistics is the study's final crucial component. The impact can be categorized as improving the warehouse and operational activities (Mostafa, Hamdy, & Alawady, 2019). The intelligent inventory system in reverse logistics provides consumers with eco-friendly and reasonably priced goods. The distinctive aspect of its effect is founded on activities ranging from item recovery to garbage removal. These essential themes have contributed to the results demonstrating the need to introduce and improve the intelligent inventory system in the Saudi Arabian manufacturing sector's reverse logistics chain.

### 5.2 Conclusion

The research has emphasized the need for an intelligent inventory management system in reverse logistics. According to the study, Saudi Arabia's manufacturing sector requires an intelligent inventory system. The research is founded on scholarly literature and qualitative interviews with study participants. During the research, five major themes are identified: the significant characteristics of an intelligent inventory system, the benefits of an intelligent inventory system, the purpose of reverse logistics in the manufacturing industry, as well as the use of an intelligent inventory system, and finally, the impact of an intelligent inventory system on reverse logistics. The study found these five main themes are significant in the Saudi Arabian manufacturing sector's reverse logistics and sustainable development processes.

### 5.3 Implications

Every study is significant due to its literary and practical implications. Similarly, the current research has numerous implications in theory, research, and practice. The current study provides a systematic definition and conceptualization of reverse

logistics and intelligent inventory systems from a theoretical standpoint. Indirectly, the study also establishes a link between intelligent inventory management systems and resolving problems in reverse logistics. This investigation is qualitative and descriptive. Therefore, it provides a comprehensive overview of the advantages of implementing reverse logistics and using intelligent and clever technologies to support such endeavors. Future researchers can use the literary content and theoretical perspectives presented in this paper concerning the scope of intelligent inventory systems to formulate the foundational research for their studies on related topics. Moreover, the conceptual framework examined in the present study enables decision-makers and practitioners in the manufacturing industry to comprehend how sustainability objectives can be attained by adopting technology-driven logistics and inventory management. In addition, the study provides a conceptual mapping between the enablers of technology adoption and implementation of inventory management.

### 5.4 Limitations and Future Research Recommendations

There are several limitations to this investigation. First, this study employs a qualitative approach to data acquisition and analysis. Such data capture and interpretation leave room for researcher bias in the results. Future researchers should incorporate a quantitative approach to establish intelligent inventory systems' positive impact on reverse logistics. In addition, the current study concentrates exclusively on Saudi Arabia's manufacturing sector. In the future, it is essential to incorporate the perspectives of specialists from other disciplines. Thus, the researchers will be able to incorporate the opinions of diverse field experts and determine whether reverse logistics is as essential in other industries as it is in manufacturing. In addition, it will incorporate the opinions of other field experts regarding the scope of intelligent inventory systems. Future research can also investigate the role of intelligent reverse logistics in various industries and increase the methodological integration of intelligent digital reverse logistics to address the challenges in reverse logistics confronted by various industries around the globe.

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