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Intelligent Spare Parts Management for Medical Equipment: Integration of GenAI with SAP Materials Management

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***Abstract*- This research analyses how to unite SAP MM with AI technology to enhance spare parts buying and predict when parts need repair in healthcare supply chains. The analysis demonstrates how AI systems deliver better predictions while cutting costs and ensuring materials availability. Real-life tests at NHS Trust UK, Siemens Healthineers and GE Healthcare show that AI strengthens SAP systems to benefit healthcare operations. Despite limitations of data sample size and system adoption barriers, here suggest connecting data instantly and making AI systems grow larger. Through this work, here discover ways to use smart inventory systems that reduce healthcare expenses and ensure service reliability.**

***Index Terms*- "SAP Materials Management (SAP MM)," "Generative AI (GenAI)", "Predictive Maintenance", "Healthcare Supply Chain Management (SCM)," "Inventory Optimization," "Spare Parts Procurement."**

I. INTRODUCTION

A. Background to the Study

Inventory management of spare parts of medical equipment is of paramount importance to avoid disruption of service delivery. The problem of properly maintaining stock levels as a growing healthcare organisation turns to more complex medical equipment is a particularly critical issue. "*SAP Materials Management*" *(MM)* is one of the most powerful tools for inventory and procuring processes, but applying traditional approaches usually does not meet the requirements of modern healthcare logistics management [1]. Introducing GenAI is the key opportunity that opens demand forecasting, automated decisions, and accuracy improvements. The AI-integrated Supply Chain Management Market is projected to expand at a CAGR of 36.3% between 2024 and 2030. This signifies the demand for AI-based platforms [2]. By integrating the GenAI solution with SAP MM, those gaps can be mitigated, costs can be driven down; and the growing demands of the healthcare industry for more efficient, sophisticated solutions can be met.

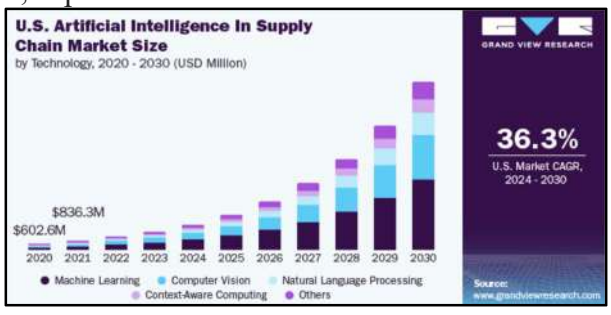

Figure 1: growing market of AI-driven Supply chain management
[2]

B. Overview

This research focuses on applying GenAI in coordinating with SAP Materials Management for efficient spare part management of medical equipment. Therefore, this study identifies and discusses how the GenAI, including data analytics, demand and asset management, and predictive upkeep, can complement SAP MM's functions. Its purpose is to create a strategy for the management and organisation of stocks, minimise equipment non-availability time and adhere to the requirements of the industry legislation. In this respect, the research aims to add to defined relevant studies by addressing current logistic problems and seeking to enhance the dependability of healthcare delivery.

C. Problem Statement

The real-time planning capabilities of SAP MM systems are not advanced enough to incorporate modelled responses to overstocked or stockout spare parts inventory [3]. This research focuses on the issue of poor inventory management of medical equipment through the application of GenAI in an attempt to achieve accurate stock forecasting, low operational costs and functionality of such equipment.

D. Objectives

The key objectives of this study are; (1) *To identify the weaknesses of current SAP Materials Management systems in the MM process of medical equipment spare parts.* (2) *To understand how Generative AI can be used to improve inventory and predictive maintenance techniques.* (3) *To implement GenAI for spearheading an intelligent spare part procurement system integrated with SAP MM.* (4) *To assess the effectiveness of the proposed framework focusing on cost savings, effectiveness and reliability in tactical healthcare-dependent operations.*

E. Scope and Significance

This research work is concerned with the extension of GenAI functionality to the SAP MM system for the improvement of spare parts of medical equipment in healthcare facilities. The scope of this study includes the review of AI-based practices in inventory management, predictive analysis, and regulatory compliance. Thus, this research can significantly fill gaps in supply chain management (SCM) more conveniently in achieving healthcare-related services with reduced operational costs. This can be used by current healthcare service providers, technology creators, and policymakers in the health sector to embrace new technologies that meet current market needs [4].

II. LITERATURE REVIEW

Challenges of SAP Materials Management Systems

SAP MM helps industries dramatically interact and manage the whole supply chain and inventory in an integrated approach to procurement, inventory management, and distribution. However, several issues arise when integrating SAP MM with modern technologies including Artificial Intelligence (AI), and Machine Learning (ML) technologies. In the view of research, decision-making and operations may be enhanced by AI integration, yet such integration contributes to challenges in how AI algorithms can be aligned with SAP MM systems leading to integration issues and system implications [5]. The absence of efficient integration between SAP MM and other modules creates operational silos and delays data exchange.

Also, the data volume in SAP MM systems implies inconsistencies in data, making real-time inventory tracking a challenging task. Integration with cross-modules like FICO and SCM is critical for effective financial and SCM reporting [6]. However, it is a critical problem due to inherent data mismatch and transfer delay issues. Errors can be disastrous to strategic choices and can quickly manifest themselves in organisations' notable areas of operation like logistics or other exigent resources within the health care industry.

Moreover, the revolution of the SAP system, referred to below figure from first-generation systems to S/4HANA conversion also poses the challenge of adoption. Based on the Business Analysis Body of Knowledge 2.0, it is indicated that businesses face major impediments during system upgrades since previous systems cannot meet today's technological challenges [5]. Firms must implement sophisticated combination centres of SAP PI/PO or cloud-based application integration middleware as implied by the study [6]. Nevertheless, these challenges should be well controlled by organisations to derive the maximum advantages from SAP MM systems.

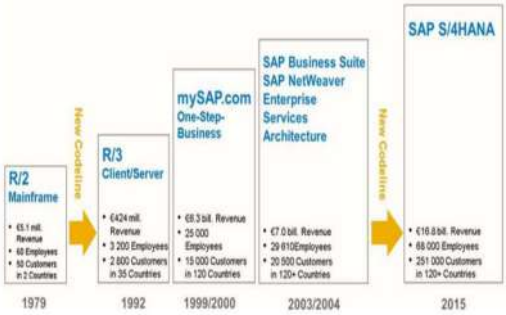

Figure 2: Evolution of SAP System

[5]

SAP Materials Management systems in managing medical equipment spare parts

In critically reviewing the role of SAP MM systems in managing medical equipment spare parts, current studies have discussed the implementation and issues of the healthcare sector. The role of ERP systems especially SAP MM in enhancing the hospitality supply chain management [7]. In their healthcare case study, while integrating SAP ERP systems results in more efficient information flows and better use of resources, many hospitals have difficulty managing the system appropriately. Problems are system delays and processing time that impact inventory management of spare parts of medical equipment. This implies though the adoption of the SAP MM has the potential to enhance spare part management, the resistance to change within the hospital management limits the implementation.

Similarly, the study presented an inventory management system linkage with stock, suppliers, and delivery mechanisms giving an example of what may be implemented in SAP MM systems [8]. Their study underscores the plight of SCM, where the emphasis is placed on visibility as a key to timely supplies wherever they are needed. This supports SAP MM in medical equipment spare parts management since tracking can be done in real-time and order notification can be set to alert the relevant authorities that certain parts are low or out of stock. However, the effectiveness is based on the extent to which the users make use of such systems, and the quality of data fed into such systems which are usually challenges among healthcare institutions [8].

GenAI improves inventory and predictive maintenance techniques.

The application of GenAI in inventory management and predictive maintenance has shown a positive transformative impact. The supply chain gains leverage from GenAI which makes better

forecasts concerning demand and inventory, refer to Figure 3 [9]. Businesses can adapt to market changes earlier than when they notice the changes are essential to cost savers and players in the enhancement of operational efficiency. Additionally, predictive maintenance methodologies are enhanced by GenAI when it comes to performing data analysis on a large scale, enabling real-time decision-making.

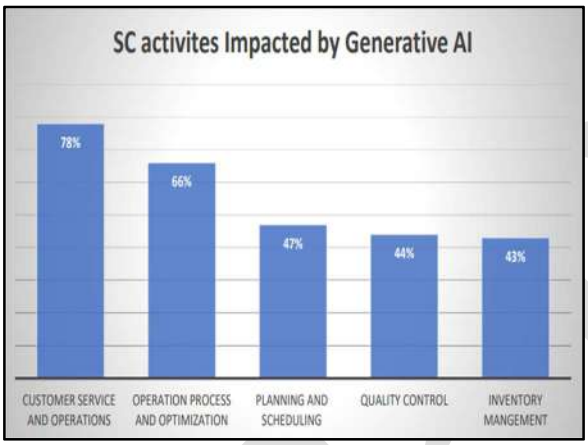

Figure 3: Generative AI Applications in diverse areas
[9]

A study explains how GenAI offers real-time processing of data to improve decisions by automating features like anomaly detection and trending. In predictive maintenance [10]. This makes it easier for companies to predict when they are likely to experience failure, enhancing the operation's reliability. However, complexities like data quality and limitations in infrastructure should be overcome for GenAI to bring in full effect [9]. Also, the practical issues when deploying AI technologies are not evacuated but are issues that organisations should consider keenly.

GenAI for an intelligent spare part procurement system integrated with SAP MM

Outsourcing AI within spare part procurement systems, especially using SAP MM (Materials Management), has been considered a highly disruptive function within manufacturing and SCM. A case study focused on generative AI for supply chain procurement is a great example of how guided buying could benefit from applying advanced technologies when making it more efficient and compliant, especially in the battery manufacturing industry [11]. The research highlights three key dimensions; strategic, tactical, and operational stakeholders, the four pillars of AI robustness, as well and information management. This has outlined a triangular model for the appropriate implementation of AI-based innovations. This framework like the *Golden Triangle* is people, technologies, and processes integration. Additionally, another study shows how AI will look in future, where robots and all processes are smart [12]. Such conclusions indicate that the deployment of GenAI tools can simplify procurement by enhancing decision-making, diminishing spending, and adjusting to new trends in digital transformations.

III. METHODOLOGY

A. Research Design

This research adopts an *explanatory research design* to examine the integration of GenAI with SAP MM for smart spare parts management in medical equipment industries. The explanatory approach can be used because it aims to specify the connections between *AI technologies* and

supply chain improvement; pointing to a cause-and-effect relationship, which is the key principle of explanatory design [13]. The research design enables an understanding of current systems and their capability through the use of secondary qualitative and quantitative data. The examination of real-life examples by case study analysis serves the purpose of real-life applicability, while numerical values and graphics display quantitative results. This arrangement guarantees adequate coverage of the research topic.

B. Data Collection

The research method adopted in the study entails *secondary data analysis,* which involves both *qualitative* and *quantitative data*. The data collection approach used in this research includes case studies which offer rich descriptions of existing SAP MM deployments and where AI has been employed in healthcare value chains. Secondary quantitative data are obtained from company reports and may include authentic databases, academic and other scholarly articles, market reports, growth trends, cost estimates, and performance data [14]. In the case of such information, graphs, charts or other graphical displays are applied. This mixed-methods approach guarantees strong and firmly grounded findings and provides a comprehensive perspective on how and where GenAI can help SAP MM in managing medical equipment spare parts.

C. Case Studies/Examples

Case Study 1: NHS Trust's SAP MM Integration for Efficient Spare Parts Management

SAP materials management MM was implemented at NHS Trust, a leading healthcare organisation in the UK to manage its sparse spare parts inventory of medical equipment [15]. The system aided in the organisational and enhancement of procurement activities, and control of stock, and assets at different hospitals. Such integration helped to improve forecasting and ensured less stock out and wastage of products [16]. Through implementing SAP MM, NHS Trust minimised costs and ensured that the most crucial medical equipment was always in stock enhancing functionality.

Case Study 2: Siemens Healthineers SAP system for advancing SCM

Currently, Siemens Healthineers employs business adaptors that integrate machine learning with SAP systems for improving the spare parts supply chain and intelligent equipment maintenance. AI technologies extract usage data predict spare parts demand, and schedule maintenance to guarantee vital medical devices are functional [17]. Which in turn minimised operational costs, and optimised the use of resources in healthcare facilities thereby improving the equipment uptime globally.

Case Study 3: GE Healthcare employs AI-enabled SAP MM System

AI is used alongside enterprise resource planning systems like SAP MM at GE Healthcare by partnering with *AWS* to address inventory control of spare parts and lifecycle analysis of medical devices. AI models used in the service industry forecast equipment degradation, avoiding stockout or overstocking of spare parts through procurement on demand [18]. This optimised stock minimises equipment downtime and has a great impact on reducing costs.

IV. RESULTS

A. Data presentation

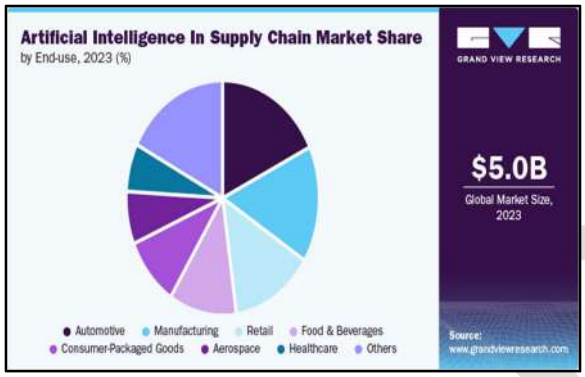

Figure 4: Market Share of AI in Supply Chain Management

[2]

The marketplace share of artificial intelligence (AI) across various supply chains in 2023 is depicted in the pie chart. This reveals that the industries with the biggest shares are Production and automobiles and consumer products, while the industries with the least holdings are healthcare and aerospace. This is projected that the SCM AI market will reach $5 billion in 2023.

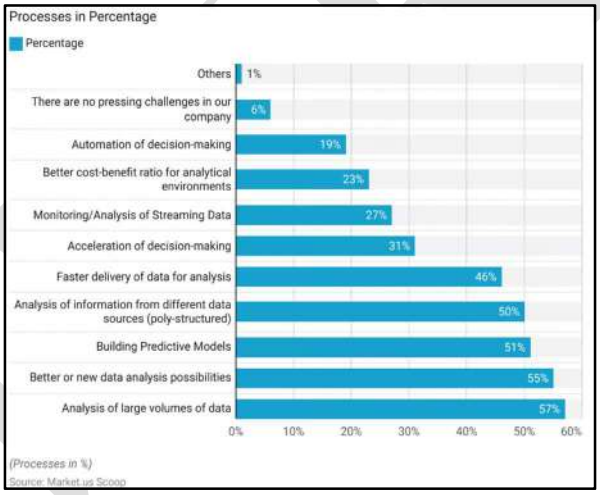

Figure 5: Benefits of AI in Predictive Maintenance

[19]

The expected advantages of using AI in predictive upkeep are depicted in the graphic. Improved cost-benefit ratios (23%), quicker transmission of data (46%), and the capacity to evaluate massive data (57%), are some of the main advantages. These results demonstrate how AI has the potential to greatly increase the efficiency of predictive maintenance.

Figure 6: SAP Plant Maintenance
[20]

Global SAP Electronic Service Network Marketing Income by location in 2019 is depicted in the graphic above. At $24.26 billion, Europe had the biggest share, next to Asia Pacific and North America. During 2019 and 2027, this market is anticipated to expand at a CAGR of 7.9%, suggesting substantial growth opportunity.

B. Findings

The quantitative evaluation underlines the increasing SAP and AI integration, which is essential to the goals of this research. AI's 5 billion dollar market cap in SCM (2023) highlights its application in industries such as production and automobiles which is pertinent to the purchase of spare parts. Using AI for predicting spare part purchases has advantages such as massive data (57%) and quicker transmission of data (46%). Additionally, SAP's ecosystem expansion (CAGR 7.9%) highlights how well it can assist the goals of the digital shift.

C. Case study outcomes

Case study	***Key Outcomes***	***Relevance to the study***
NHS Trust's SAP MM Integration for Efficient Spare Parts Management	Enhanced procurement and stock control, improved forecasting, reduced stockouts, and minimised wastage of spare parts in healthcare equipment [15].	Demonstrates how SAP MM optimises spare part inventory management, ensuring critical equipment availability and reducing operational inefficiencies.
Siemens Healthineers SAP System for Advancing SCM	AI-integrated SAP systems improve spare parts demand forecasting and intelligent maintenance, reducing costs and enhancing global equipment uptime [17].	Illustrates the integration of AI with SAP systems for predictive maintenance and resource optimisation, supporting the study's objectives of combining GenAI with SAP MM to

		enhance spare part procurement.
GE Healthcare Employs AI-enabled SAP MM System	AI-enabled forecasting prevents overstocking or stockouts minimises equipment downtime and reduces the lifecycle management costs of medical devices [18].	Highlights the role of AI-enabled SAP MM in improving inventory control and lifecycle analysis, emphasizing how GenAI can complement SAP MM for real-time procurement decisions.

Table 1: Case Study Outcomes

(Source: Self-Created)

The case studies demonstrate how SAP MM alongside AI improves spare component management by better forecasting, lower costs, fewer stockouts, and optimum resource usage to ensure the functioning and productivity of essential supplies for medical supply networks.

D. Comparative analysis

Author	***Focus***	***Key Findings***	***Gaps***
[5]	Integration of SAP, AI, and Data Analytics for Enterprise Management	SAP, AI, and Data analytics improve enterprise management by enhancing decision-making and streamlining operations.	Lack of focus on real-time data management and its integration into decision-making processes.
[6]	Optimising SAP FICO Integration with Cross-Module Interfaces	Optimisation of SAP FICO integration with cross-module interfaces leads to better financial and operational management.	Limited exploration of the challenges in cross-module data synchronisation.
[7]	SAP ERP Implementation for Hospital Management System	SAP ERP supports digital transformation in hospital management systems, improving operational efficiency.	No focus on the challenges of implementing SAP ERP in smaller institutions or non-hospital sectors.
[8]	Inventory Management System to Connect Stock, Suppliers, and Deliverers	An inventory management system that enhances connectivity between stock, suppliers, and	Not address scalability or adaptability of the system in different industries.

		deliverers, leading to improved supply chain management.	
[9]	Transforming Supply Chain Operations with Generative AI	GenAI can optimise supply chain operations by automating decision-making and enhancing operational efficiency.	Lacks a detailed analysis of the implementation challenges and risks in integrating GenAI into existing systems.
[10]	Harnessing GenAI for Real-Time Data Analytics with Google Cloud	GenAI is effective in processing and analyzing real-time data streams, offering enhanced predictive analytics capabilities.	Focuses on a specific technology (Google Cloud), but doesn't address cross-platform compatibility or security concerns.
[11]	Generative AI for Guided Buying Efficiency in Procurement	GenAI enhances procurement processes by streamlining decision-making, improving compliance, and reducing maverick spend.	Data management responsibilities are not clearly defined, especially in terms of cross-departmental collaboration.
[12]	Digital Transformation and Digital Twins in the Factory of the Future	Digital transformation and AI, including digital twins, are revolutionizing production processes in the automotive sector, improving sustainability and efficiency.	The study doesn't address the adaptability of digital twins and AI in non-automotive industries or smaller-scale operations.

Table 2: Comparative Analysis

(Source: Self-Created)

Together, the articles highlight how AI, the SAP system, and digital evolution may be taken together, which is compatible with the study on GenAI for smart spare part sourcing that integrates with SAP. According to Gupta (2024) and Mohamed (2023), GenAI can improve decision-making and simplify acquisition, which is compatible with the study goal of increasing spare part supplier effectiveness through the use of AI in architecture for digitisation.

V. DISCUSSION

A. Interpretation of results

The results showcase the transformative frontiers in optimising spare part procurement through the enhanced forecast of predictive maintenance in healthcare through AI-enabled SAP-MM. As

for the importance of the industrial relevance of a $5 billion market share of AI in the year 2023, benefits an application of 57% efficiency in terms of data analysis upgradation in predictive maintenance objectives [2]. Case studies, such as those with the NHS trust, Siemens Healthineers, and GE Healthcare, illustrate cost savings, improved forecasting, and reduced challenges of stockouts. Thus, providing case support for the application of the framework as GenAI for intelligent SAP-MM-driven inventory management, reducing costs, and ensuring operational reliability in healthcare.

B. Practical Implications

In the future, GenAI-enhanced SAP-MM systems could lead to a transformation in healthcare's parts inventory procurement culture. Improved forecast capabilities aside, real-time inventory control and predictive maintenance brought by AI will introduce cost-effectiveness and minimise downtime of equipment. Integrating AI across sectors with tailored frameworks has become very important in boosting decision-making and driving innovation within digital SCM.

C. Challenges and Limitations

The limitations faced by this study lie in data reliability, as secondary information is being used in the analysis, thereby rendering high shortcomings in its accuracy and applicability. Moreover, the integration of GenAI with SAP-MM in real-world settings might encounter technical and organisational problems.

D. Recommendations

In order to establish the reliability of data, further may use primary sources, like case studies and survey data collection within healthcare settings. Additionally, practical trials of GenAI-SAP-MM integration for this kind of research are recommended to identify the implementation challenges.

VI. CONCLUSION AND FUTURE WORK

The potential of synergy between Generative AI and SAP MM to improve spare parts procurement and predictive maintenance efficiencies in healthcare is outlined in this research paper. Future developmental and practical applications are required in assessing the efficiency of this framework since initial consequences have illustrated that it significantly reduces costs, improves efficiency, and boosts reliability. Future research initiatives will possibly aid in ensuring a real-time feed with SAP MM and GenAI systems should be examined to ensure better precision in predictive maintenance.

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