Enterprise Information Systems in Manufacturing Industry

Ang Yi Qin
Faculty of Computing
Universiti Teknologi Malaysia
Johor, Malaysia
angqin@graduate.utm.my

Soo Wan Ying
Faculty of Computing
Universiti Teknologi Malaysia
Johor, Malaysia
sooying@graduate.utm.my

***Abstract*— Enterprise Information Systems (EIS) are essential for increasing manufacturing sector competitiveness and efficiency. The integration of Manufacturing Execution Systems (MES) with Enterprise Resource Planning (ERP) systems is examined in this study, with an emphasis on recent developments and ongoing difficulties. This paper also addresses how to improve operational performance by incorporating advanced technologies like artificial intelligence (AI) and business process reengineering (BPR) ideas. The research highlights the potential of EIS in promoting innovation and efficiency in manufacturing companies through case studies and comparative analysis. Adopting these tactics puts manufacturers in a position to grow consistently and remain competitive in the changing industrial market. However, research must continue, and EIS must be used wisely to achieve their full potential and guarantee future success.**

Keywords *- Enterprise Information System (EIS), Automation, Real-time Monitoring, Smart Manufacturing System, Enterprise Resource Planning (ERP), Business Process Reengineering (BPR), Artificial Intelligence (AI)*

I. INTRODUCTION

Enterprise Information Systems (EIS) in the manufacturing Enterprise Information Systems (EIS) in the manufacturing industry refers to integrated software applications and platforms that enable organizations to manage and coordinate their business processes and operations effectively. EIS facilitates innovation by redesigning processes and utilizing data analytics to extract insights. Process design involves introducing new processes, leading to innovative business practices [1]. These systems are specifically designed to support the unique requirements of manufacturing businesses by facilitating the flow of information and data across various functions and departments within the organization.

The primary goals of Enterprise Information Systems in manufacturing are to make procedures run smoother, enhance productivity, improve decision-making, optimize resources wisely, and drive business growth and profitability. By gathering and integrating data from different areas such as production, inventory, sales, and finance, EIS offers stakeholders a comprehensive perspective of the organization's activities, enabling them to make informed decisions and respond immediately to change market demands and business conditions.

Early executive information systems (EIS) were initially designed on mainframe computers to provide senior executives with sales performance metrics and market research data. However, not all executives were adept at using computers, leading to some hesitation in their adoption. Initially focused on executive-level decisions, EIS data accessibility has expanded to encompass the entire enterprise, facilitated by personal computers and LANs. This enables employees to access and contribute to decision-making processes within and beyond their organizational hierarchies [2].

II. COMPARATIVE ANALYSIS OF PREVIOUS STUDIES

TABLE I: COMPARISON OF KEY CONCEPTS IN ENTERPRISE INFORMATION SYSTEM (EIS)

Author(s)	Key Concepts	Weakness of Research
T.S. S95, 2024	Manufacturing Execution Systems (MES) and Enterprise Resource Planning (ERP) systems	The research lacks real-world case studies, comprehensive evaluation, and critical analysis.
Li et al., 2007	Investigate the motivations behind implementing Enterprise Information Systems (EIS)	Insufficient evidence to demonstrate how the manufacturing setup is interconnected before EIS is implemented.
Qu et al., 2018	Proposed comprehensive Enterprise Information System (EIS) framework	Lacks discussion on the technical aspects of software implementation, potential challenges,
M. Zdravković et al., 2021	Implement artificial intelligence (AI) into Enterprise Information System (EIS)	Lacks implementation and validation in real-world practices

According to T. S. S95, the combination of Manufacturing Execution Systems (MES) and Enterprise Resource Planning (ERP) Systems in manufacturing companies [3], has been a big step forward, by aiming to enhance operational efficiency and coordination across numerous functions such as production, quality control, warehouse management, and order processing. Moreover, MES and ERP have grown independently, particularly in functions like production planning and quality control. To address this issue, the ANSI/ISA S95 standard was introduced, aiming to establish a unified model for enterprise-control system integration to delineate the scope and functions of MES and ERP systems within the enterprise architecture. Despite these challenges, ongoing difficulties include the lack of a complete integration framework, challenges in keeping different software from various vendors working smoothly together, and the need for clear rules on how systems should work together and how data should flow. Although the S95 standard is a big step towards making manufacturing more independent and connecting the entire value chain smoothly, more research is needed to address real-world problems, look into actual examples, and use new technologies like artificial intelligence and IoT to fully benefit Enterprise Information Systems in manufacturing [3].

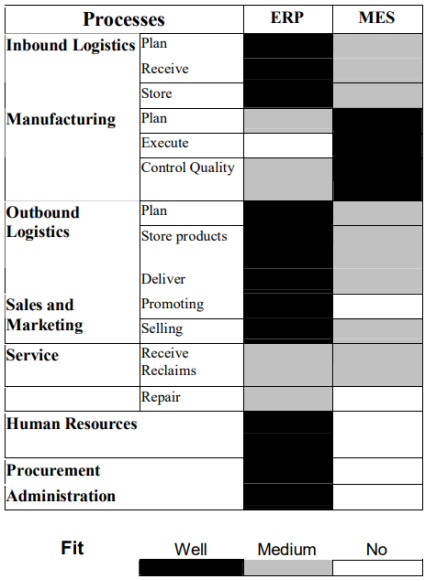

Figure 1: General application fit comparison [3]

According to Li et al., it explores the driving force behind the implementation of Enterprise Information Systems (EIS) in manufacturing companies, particularly focusing on their impact on business planning and customer focus. By involving a survey of 210 professionals from manufacturing firms in the US who have implemented EIS, the study investigates the readiness of manufacturing infrastructures before EIS implementation, focusing on aspects related to business planning and customer focus. Therefore, the data analysis revealed a significant correlation between the need for better business planning and increased infrastructure readiness, as well as the influence of external e-business practices on infrastructure readiness. Nevertheless, the study has limitations which include a low response rate and lack of comprehensive empirical validation for part of aspects of the conceptual framework.

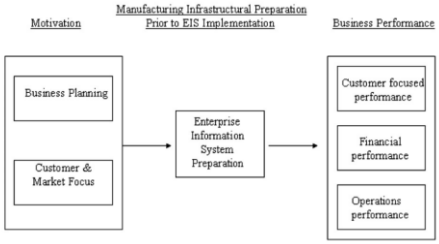

Figure 2: Conceptual model [4]

According to Qu et al., the importance of Enterprise Information Systems (EIS) in the context of smart manufacturing systems (SMS), particularly in the industry 4.0 and Internet of Things era. Traditional manufacturing companies must restructure their EIS to meet the criteria of SMS to enhance their competitiveness and agility, because simply having smart equipment is insufficient for achieving SMS [5].

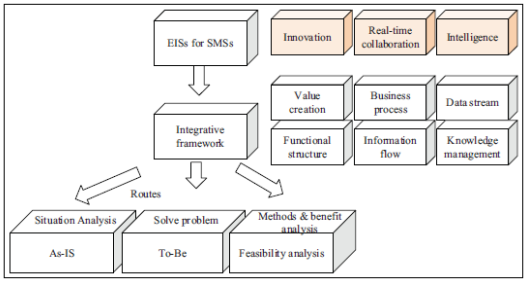

Figure 3: Six dimensions for improving the efficiency of EIS [5]

According to M. Zdravković et al., they highlight the transformative impact of AI enabled Enterprise Information System (EIS) across various functions within an enterprise, including customer relationship management, supply chain management, inventory and logistics, production planning and scheduling, finance and accounting, and product lifecycle management. It emphasizes how AI services enhance enterprise observance, autonomy, and intelligence by leveraging data analytics, predictive modelling, and automation capabilities [6].

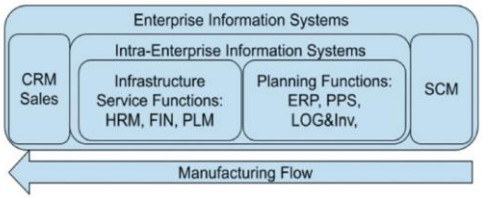

Figure 4: EIS function [6]

III. Opinion

A. *Implement the combination of Manufacturing Execution Systems (MES) and Enterprise Resource Planning (ERP) Systems [3]*

The article from T.S. S95 presents a thorough examination of EIS integration within the manufacturing industry, particularly focusing on the integration of Manufacturing Execution Systems (MES) and Enterprise Resource Planning (ERP) Systems. It effectively elucidates the functionalities of both the Functional Model and Object Information Model, providing readers with a clear understanding of how information flows and is organized within the enterprise architecture.

The inclusion of a case study featuring a Paper Mill Enterprise offers valuable practical insights into the implementation of the ANSI/ISA S95 standard, demonstrating how MES and ERP systems facilitate diverse manufacturing processes. The system framework diagram provides a visual representation of the hierarchical arrangement of EIS components and their respective contributions to supporting various business operations.

Nevertheless, the article could be improved by having a deeper exploration of the interconnections between different system components and their collective impact on overall system performance. Moreover, the reliance on a functional approach within the Object Information Model may potentially obscure entity relationships, necessitating further clarification.

Overall, while the article establishes a solid foundation for understanding EIS integration in manufacturing, there is room for additional research to delve deeper into the complexities of system interconnections and to explore alternative modelling methodologies that could enhance clarity and effectiveness [3].

In the previous sections, the scope of MES and ERP system products was explained, along with an analysis of how each supports different types of manufacturing processes. Additionally, the solution provided by the S95 standard for integrating these systems was discussed. To better illustrate these concepts, a thorough examination of the processes at a Paper Mill Enterprise was conducted to propose a system framework aligned with the S95 hierarchy function model. The selection of the paper production process was based on its intricate nature, involving a combination of continuous, discrete, and batch processes within the production chain.

B. *Explores the driving force behind the implementation of Enterprise Information Systems (EIS) in manufacturing companies [4]*

The article thoroughly examines why manufacturing businesses use Enterprise Information Systems (EIS) and how they impact business strategies and customer focus. By having interviews with manufacturing professionals, the study uncovers links between effective business planning and the preparedness of manufacturing systems for EIS integration. Additionally, it investigates how online business practices affect this readiness, deepening on our understanding of modern manufacturing dynamics.

Not only as stated above, but the article also emphasizes the importance of validating the proposed framework with real-world evidence. While the study successfully identifies important connections, addressing concerns about response rates and empirical validation could strengthen the credibility of its findings. By addressing these issues, future research can enhance our understanding of how EIS adoption influences manufacturing systems, leading to improvements in operational efficiency and customer-centric approaches in the industry [4].

C. *Implement Business Process Reengineering (BPR) for Enterprise Information Systems (EIS) [5]*

This article introduces a plan to develop a comprehensive framework for Enterprise Information Systems (EIS) incorporating principles of Business Process Reengineering (BPR) for Smart Manufacturing Systems (SMS). The framework aims to tackle the following challenges such as reducing the product lifetime cycle time and addressing the challenge faced by dynamic customer requirements. It also emphasizes the importance of integrating advanced technologies like artificial intelligence (AI) and lean thinking along with BPR methodologies. It outlines three key elements of the proposed framework: value creation, functional structure, and knowledge management. These elements aim to enhance the adaptability and efficiency of EIS in SMS, ultimately enabling autonomous decision-making and innovation. BPR involves a business process to achieve significant improvement in cost, quality, and service. By using BPR along with this framework, the goal is to make the EIS better suited for SMS.

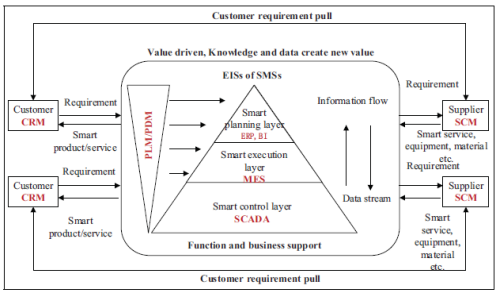

Figure 5: Framework of EIS in SMS [5]

Business Process Reengineering (BPR) procedure specifically adapted for Enterprise Information Systems (EIS) in Smart Manufacturing Systems (SMS). The procedure consists of three stages: building the AS-IS model, constructing the TO-BE model, and analysing the feasibility

of the TO-BE model. Each stage involves specific tools and methods such as Delphi analysis, UML, SPIOC, SWOT analysis, and lean thinking. The AS-IS model focuses on analyzing current processes and identifying key issues, while the TO-BE model aims to design improved processes aligned with strategic objectives and customer requirements. Feasibility analysis involves assessing the efficiency and effectiveness of the proposed model through quantitative analysis methods and validation by end-users. Overall, the procedure aims to optimize EIS in SMS to reduce economic input and enhance profitability.

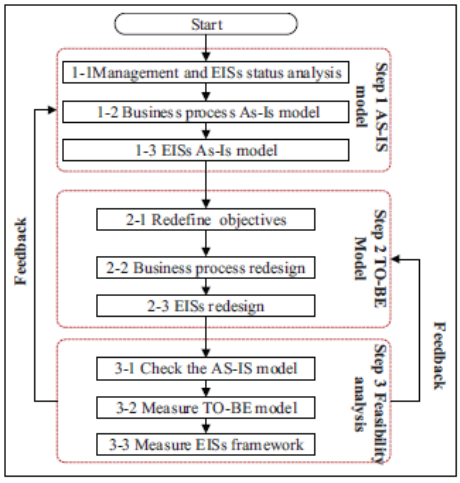

Figure 6: The procedure of EIS in SMS via BPR [5]

D. Implement Artificial Intelligence (AI) Into Enterprise Information Systems (EIS) [6]

Machine learning (ML) used in manufacturing for tasks such as predictive maintenance, anomaly detection, and sales forecasting. Deep learning architecture such as Convolutional Neural Networks (CNN) and Recurrent Neural Network (RNN) address quality control and process monitoring challenges. Transfer Learning enables the application of pre-trained models to new domains, showcasing the adaptability of ML algorithms. Logic-based methods, including deductive logic systems and Multi-Agent Systems (MAS), enable autonomous decision-making and reasoning over enterprise functions in manufacturing. They facilitate interoperability among enterprise information systems and support complex adaptive systems. Explainable AI (XAI) methods address concerns about bias and model transparency, ensuring trustworthiness and compliance with regulations.

In manufacturing, AI enables EIS to optimize various processes by improving efficiency, enabling autonomous decision-making, and addressing complex challenges like predictive maintenance and automated transportation. These systems leverage AI techniques to enhance quality control, supply chain management, and decision-making processes, ultimately driving innovation and competitiveness in manufacturing enterprises.

IV. Conclusion

In conclusion, Enterprise Information Systems (EIS) represents an important component in the case for improved efficiency within the manufacturing sector. While the integration of Manufacturing Execution Systems (MES) and Enterprise Resource Planning (ERP) systems marks progress, challenges surrounding integration and validation persist. We should understand the motivations behind businesses' adoption of EIS, for example, the desire for enhanced planning capabilities and the ability to respond effectively to evolving market dynamics, is fundamental. Last but not least, leveraging advanced technologies like Artificial Intelligence (AI) and embracing principles of Business Process Reengineering (BPR) offer avenues for further enhancing operational effectiveness. Through these strategies, manufacturers not only tackle current challenges but also position themselves for continuous growth and competitiveness in the evolving landscape of the manufacturing industry. Therefore, while EIS holds significant promise for driving innovation and efficiency, it's important to keep investigating and using them wisely to ensure they reach their full potential and keep bringing success in the future. Ultimately, confronting the challenges posed by heterogeneity will drive the development of new EIS architectures and enable inter-organizational information infrastructures that hold the potential for significant business transformation as envisaged approximately 30 years ago [7].

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