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CHAPTER I INTRODUCTION

I.1 Background

Chemical manufacturing firms play an important role in global industries (Bauer & Fuenfschilling, 2019). They make a wide range of substances that act as basic materials for multiple uses. These chemicals are needed to make many daily and special products, from scents to beauty items and high-tech materials (Artiushenko et al., 2023). The size and variety of chemical making give it a crucial place in the business world. It has a big impact on many fields that need certain compounds to create and improve their goods (Rissman et al., 2020).

The core of this industry lies in making raw materials into chemical products (Feng et al., 2019). Chemical firms get raw materials and process them utilizing specific tools and methods (Schulz et al., 2020). They modify these materials into substances with specific chemical traits, which other companies use afterwards as an ingredient in their own making. Take pharmaceutical companies, for instance. They use chemical compounds to make drugs (Kar et al., 2022). Chemical firms, on the other hand, need specific chemicals to produce final products, ranging from consumer goods to cosmetics (F.G. Reis et al., 2021). The fact that chemical makers supply to many industries shows how vital they are to the global supply chain (Kätelhön et al., 2019).

Because the production efficiency affects both product quality and cost-effectiveness, it is crucial for chemical makers (Teymouri & Shekarchizadeh, 2022a). Chemical firms need to process quality materials that are according to industry requirements, such as purity, uniformity, and its content, to stay competitive (N. Wang et al., 2020). This needs to be counterbalanced, though, by effective manufacturing techniques that optimize productivity, minimize waste, and regulate costs (Kätelhön et al., 2019). This balance is becoming more crucial as industries hunt both quality and sustainability, which cry out for creative

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solutions and updated procedures to keep quality at its best without using too many of the resources (Teymouri & Shekarchizadeh, 2022b).

Inefficient or delayed production processes in the chemical industry directly affect the ability of chemical processes to help more efficient production processes, which is important for competing in the market. Chemical manufacturers are also required to consistently produce materials with high standards of purity, uniformity, and composition while controlling waste, productivity, and costs. This is an ever growing challenge as worldwide expectations increase in regards to both operational excellence and environmental sustainability. Manufacturing operations performance and competitiveness can be affected by the lagging manufacturing process, which requires manufactures to implement, smarter solutions in order to remain aligned with the increasing demands of industry as well as the need for sustainability.

PT Mandiri Inovasi Bersama (PT MIB) makes a broad range of chemicals by processing raw materials and making them into substances used across industries such as cosmetics. Yet, PT MIB depends greatly on manual labor and methods for carrying its manufacturing processes which then leads to human error such as miscommunication between divisions regularly happening, causing time wasting and setbacks to the company's capability to meet industry demands for swift and effective production (Wang & Jia, Yanhui, 2021).

A further serious obstacle PT MIB bumps into is the absence of an organized system to forecast machinery maintenance. Without the help of technologies such as AI, keeping an eye on equipment health has become a reactive process and not a proactive one (Pech et al., 2021). The outcome for machinery maintenance often occurs only after a breakdown, causing unforeseen production stops and costly machinery fix up (Singh, Vikram, Sharma, Nirbhay, & Sharma, Somesh Kumar, 2024). This reactive approach not only enlarges downtime and operational

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disorganization but also unwanted effects towards timely product delivery schedules and business reliability in general (Accorsi, R., et al., 2019).

Manual operation as well as reactive attitude toward machinery maintenance results in many issues for PT Mandiri Inovasi Bersama. First, the efficiency of an operation is negatively affected due to manual processing of the work and machine breakdowns that result in unscheduled downtimes thus lowering the level of the amount of work done (Tian, Vanderstraeten, Johanna, Matthyssens, Paul, & Shen, Lei, 2021). Further, absent predictive systems, customer costs are high due to the expensive emergency repairs as well as inefficient allocation of labor (Shamayleh et al., 2020). This issue also relates to the quality and the standard of the product since most of them are handled in a manner that involves manual labor which may lead to human error. (Moutsatsou, P., Ochs, J., Schmitt, R. H., Hewitt, C. J., & Hanga, M. P., 2019). Moreover, these challenges lessen the PT MIB's competitiveness in the market, as downtime production schedules and unpredictable product quality makes it hard to meet customer expectations, opening opportunities for various technologically boosts competitors to have the upper hand (Ku, Chien, Chen-Fu, & Ma, Kang-Ting, 2020).

To support the operational excellence and effectively contribute to the target market, PT Mandiri Inovasi Bersama has developed the following KPI's. The company has defined annual sales as the key indicator of its financial performance and competitiveness on the market. Another significant set of KPI is effectively managing the relationship with customers through such essential parameters as customer satisfaction degree. PT MIB also tracks the number of orders completed on time, which directly impacts its reputation and customer trust (Khan et al., 2022). Furthermore, the company pursues the development of customer and partner networks to cover new markets and implement extensive strategic relationships. Lastly, product innovation is an important part of its strategy, measured by the number of new products developed within a specific period,

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showcasing PT MIB's commitment to staying ahead in the competitive chemical manufacturing industry (Awan, Arnold, Marlen Gabriele, & Gölgeci, Ismail, 2021).

Generative artificial intelligence (GenAI) is the class of artificial intelligence technologies that create new content, predictions, or decisions based on patterns detected in existing data(Filz & Thiede, 2024). GenAI refers to systems that can produce new content such as text and code, recommendations or system settings, based on large and complex sets of data. Its flexibility make it very well suited to moving environments such as manufacturing. From a business perspective, organizations are using GenAI to drive efficiency in operations and make better decisions (Konrad & Professor, 2024). In Chemical manufacturing for example, GenAI can assist maintenance by predicting machinery failures before they occur, and allow for minimized downtime of chemical production. It also improves process planning with accurate demand forecasting, faster product development and better overall production quality by less manual processes (Jamwal et al., 2021). These efficiencies also translate into greater customer satisfaction and competitiveness in a rapidly changing industrial landscape.

Integrating Generative AI (GenAI) in PT Mandiri Inovasi Bersama's (PT MIB) operations directly aligns with its KPIs, driving improvements across multiple metrics. By using GenAI in the area of the prediction of machinery failures, there will be less unpredictable breakdowns meaning efficiency in the cycle of production and timely delivery of products to the customers (Krä et al., 2020). This contributes to a larger number of on-time order completions, which directly impacts customer satisfaction and fosters stronger partnerships (Khan et al., 2024). Furthermore, considering market trends and past orders, GenAI can predict the demand accurately, which in turn helps to plan and organize the production process for achieving annual revenue increase and the growth of the number of customers. In addition, GenAI quickens the development of new products by

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enhancing the efficiency of the research and development processes in PT MIB. These advancements not only enhance operational efficiency but also strengthen the company's competitive edge in the chemical manufacturing industry (Dhumale et al., 2024).

Applying generative AI at PT Mandiri Inovasi Bersama is useful as it suggests improvements to the company's operations and challenges that can be met in the future. The specific application of GenAI will allow the company to work faster with business flow and save time costs. GenAI can also help to speed up production processes by automating routine operations and effective management of production workflows (Berthon et al., 2024). Using predictive analysis, GenAI is able to look at previous data in an effort to help forecast and recommend the right strategy in manufacturing to match production requirements with customer needs (Surovi et al., 2024). This not only serves to minimize wastage of time and physical resources but also helps to tighten the flow of manufacturing in proportion with the specific business requirement.

In addition to optimizing production, GenAI can revolutionize machinery maintenance at PT MIB through predictive capabilities (Serradilla et al., 2022). With real-time data integration from equipment sensors, GenAI can help the company keep away from pipeline cases by predicting when an equipment part is probably going to malfunction or break and indicate for maintenance (Garcia-Perez et al., 2024). This does not only reduce unwanted pauses but lessen maintenance costs by avoiding equipment failures too (Allen et al., 2024). Furthermore, the consistency and precision offered by GenAI can strengthen product quality to meet industry standards and reducing human error (Riesener et al., 2024). These advancements also contribute towards improving the operational reliability of PT MIB as well as increasing the PT MIB competitiveness in the market by satisfying the customer's needs more effectively and produce high quality outputs (Sundaram & Zeid, 2023).

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This research looks into the optimization of PT MIB production processes by the integration of GenAI into its operations. By examining and labeling inefficiencies in existing workflows, the research focuses on suggesting enhancements that smoothen the business processes and reduce production downtime(Rojek et al., 2023). Furthermore, the thesis aims at working on predictive maintenance where GenAI performs analysis and provides insights about potential failures of equipment and maintenance schedules (Sandu, 2023). This approach makes sure that the machinery operates fluently, decreasing unwanted downtime and strengthening overall production reliability (Li et al., 2022).Through addressing these critical areas, the thesis aims at offering a holistic framework particularly TOGAF to turn the operations of PT MIB to a system of efficiency and cost effectiveness (Konrad & Professor, 2024).

TOGAF is a proven enterprise architecture framework which plans to line up business goals with IT systems and operational processes (Kotusev, 2018). To PT Mandiri Inovasi Bersama, TOGAF is beneficial because it offers a blueprint to solve the organization's operational problems, especially the overuse of manual patterns and maintaining only reactive-solutions approaches (Amalia & Supriadi, 2017). Since TOGAF provides an extensive approach to organization's architecture, PT MIB can use it as a foundation to develop, deploy, and sustain the effective AI system that will improve production and, at the same time, enable efficient predictive maintenance along with quality control (L. Wang & Zhao, 2024b). For PT MIB, which aims to transform into an automated business entity, this characteristic makes the approach ideal for the company. In addition, this framework ensures that the implementation would be properly aligned to the goals and objectives of the business (L. Wang & Zhao, 2024a).

But while advanced technology is required for GenAI to enter manufacturing operations, so there is a need to implement it in a systematic way. This is where TOGAF and its Architecture Development Method (ADM) comes into play.

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TOGAF provides a phased and systematic approach for aligning GenAI capabilities with the organization's business objectives and is not only about deploying technology but about embedding it into enterprise processes. By using TOGAF ADM as the framework, the adoption of GenAI in this paper becomes a more controlled, traceable, and long-term aligned activity to make the transformation not just technically manageable, but also strategically sound.

This research offers a solution where GenAI will enhance efficiency and implement the best practices in PT MIB. Therefore, the designed new system to be integrated into the TOGAF framework, is to prevent such inefficiencies of the work process as a low machine time and more time is spent on equipment failures. In this area, GenAI will empower predictive maintenance to determine when the machinery needs to be serviced or when it has to be used to meet specific chemical manufacturing production orders (Konrad & Professor, 2024). It is expected that integration of GenAI will lead to increased efficiency, an increase in the quality of products developed and schedule handling. Moreover, the advanced enterprice architecture enables a progressive design that is more scalable than the current system, and therefore, the fabrication of chemical manufacturing plants should embrace the use of artificial intelligence in improving their operations (Badenko et al., 2024).

The entire manufacturing industry and the chemical industry in particular has been affected by the rapid pace of development in AI technology. Although the advantages of AI such as for predictive maintenance, quality assurance, or process improvements have been subject to many studies, these less often provide an structured approach to a real-world implementation. Single technical applications are studied rather than studying technical applications in the context of the enterprise as a whole. This creates a gap in how AI, in specific Generative AI (GenAI), can be adopted in a practical and scalable way for operational workflows.

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In contrast, this research outlines a holistic, validated enterprise architecture model to enable the adoption of GenAI in chemical manufacturing. The architecture is developed for PT Mandiri Inovasi Bersama, using the TOGAF ADM proces and ArchiMate modeling language. Different from previous researches, this research highlights the organized approach to integrate AI technologies with business functions, in addition to the technical solution. It tackles the technological and organizational hurdles and represents a useful reference model for companies interested in deploying GenAI.

This study helps to fill the background literature gap between the developing technologies GenAI and the structured technology implementation in manufacturing. While previous works discuss AI capabilities in performing specific tasks, this research contributes with a practical enterprise architecture implementing GenAI into the core processes of manufacturing, such as predictive maintenance, quality control, and production optimization. Through the application of the TOGAF ADM and ArchiMate, this research provides a structured and flexible approach which organizations in general, and Chemical industry in particular, can use to execute GenAI in a way that furthers their business objectives.

I.2 **Problem Formulation**

The problem formulation underlying this research:

1. What is the current IT architecture landscape of the manufacturing processes at PT MIB, including its challenges?
2. How should a target IT architecture that integrates GenAI into the production process to improve the efficiency of manufacturing processes at PT MIB be designed?
3. How should the target architecture for PT MIB be implemented?

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I.3 Research Objective

This research aims to:

1. Analyze the current IT architecture landscape of the manufacturing processes at PT MIB, including identifying its challenges.
2. Design a target IT architecture that integrates GenAI into the production process to improve the efficiency of manufacturing processes at PT MIB.
3. Develop an implementation plan for the target IT architecture at PT MIB.

I.4 Research Limitation

1. This research focuses on specific production processes within PT MIB that are most impacted by inefficiencies and stand to benefit from GenAI.
2. This research focuses on the application of GenAI technologies that are capable of generating insights and predictions, chemical readings, and process optimization.
3. The research primarily addresses the phases of the TOGAF ADM in designing the target architecture and uses the ArchiMate modeling language.
4. The validation of the proposed architecture is conducted through expert interviews with experts relevant in the field of technology.

I.5 Research Benefits

Benefit of research is:

1. For PT. MIB, this research is useful for its vision towards creating a clear architecture in the business manufacturing process which is also integrated with GenAI.

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2. For the Research field, this research can be used as a reference for those seeking knowledge and a proof of the usage of GenAI being beneficial in the implementation of business processes in a chemical firm.
3. For Telkom University, this research is expected to serve as an opportunity to strengthen collaboration with PT MIB, building on the outcomes of student internships conducted at the company.
4. This research not only delivered a clear understanding and practice in achieving solutions of PT MIB's business manufacturing process, but has also opened many doors towards how other frameworks and GenAI could be implemented in other business cases.