Platform Engineering in Manufacturing: Role, Effect, Challenges and Opportunities

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A R T I C L E   I N F O

A B S T R A C T

This research is focusing on platform engineering systems in manufacturing. It's a trial to uncover the role, effect, opportunities and threats in this field. The research used qualitative approach, where 3 cases have been thoroughly investigated. Relevant interviews with open ended questionnaires were used to enrich the theory and have a practical flavor of best practices and local cases. The research recommends that manufacturing businesses invest in effective platform engineering processes. This can involve building a flexible and adaptable platform ecosystem that can support collaboration, experimentation, and innovation across the entire supply chain. The research concludes that in addition to that Platform engineering is also ensuring efficiency, adaptability, and security.

1. INTRODUCTION

In the manufacturing industry, digital platforms have become increasingly important for businesses seeking to streamline their operations and increase their competitiveness [1]. The process of platform engineering involves the design, development, and maintenance of software platforms that enable the creation of various applications and services. In this research paper, we will explore the challenges faced by manufacturing businesses and the ways in which platform engineering can help address these challenges [2][3]. Platform engineering has become increasingly important in recent years as companies seek to build and maintain digital platforms that support their business operations [4]. The platform engineering process involves the design, development, and maintenance of software platforms that enable the creation of various applications and services.

1.1. Problem Statement

One of the main challenges facing manufacturing businesses is the need to connect different processes and systems across the entire supply chain [5]. Many manufacturing processes involve complex interactions between machines, people, and data, and these interactions must be coordinated and optimized to ensure maximum efficiency and quality [6][7]. However, the disparate nature of these processes and systems can make it difficult to achieve the necessary level of coordination and optimization. Platform engineering can help address this challenge by providing a common infrastructure that connects different processes and systems, enabling more efficient and effective collaboration [8]-[10]. Another challenge facing manufacturing businesses is the need to adapt to changing market conditions and customer demands. In today's fast-paced business environment, manufacturing businesses must be able to quickly pivot to new opportunities and respond to changing customer needs [11]-[15]. However, traditional manufacturing systems can be inflexible and slow to adapt. Platform engineering can help address this challenge by providing a flexible and adaptable infrastructure that can support rapid prototyping and experimentation, as well as enable businesses to scale up or down as needed [16]-[18].

Finally, manufacturing businesses must also contend with the challenge of managing complex data sets and ensuring data privacy and security [19]-[23]. With the increasing amount of data generated by manufacturing processes and systems, businesses must be able to effectively manage and analyze this data in order to identify opportunities for improvement and optimize their operations [24]-[28]. However, traditional data management systems can be cumbersome and difficult to secure. Platform engineering can help address this challenge by providing a scalable and secure data infrastructure that can support real-time analytics and enable businesses to make more informed decisions [29][30]. Based on such challenges, this research intends to explore the significance of platform engineering for manufacturing businesses, seeking to address the challenges of connecting disparate systems, adapting to changing market conditions, and managing complex data sets [31][32]. By investing in effective platform engineering processes, manufacturing businesses can build flexible and adaptable platform ecosystems that support collaboration, experimentation, and innovation while also ensuring data privacy and security.

1.2. Research Question
The main research question that can be developed for this paper is,
"How platform engineering will benefit the manufacturing sector?"

1.3. Research Aim and Objectives
The main aim of this research aim is to investigate the potential of platform engineering to enhance the performance and profitability of the business in the manufacturing sector and its impact on the efficiency, adaptability, and security of manufacturing operations.

The primary objectives of this study are:
- To explore the concept of platform engineering
- To identify the benefits of platform engineering in the manufacturing sector

1.4. Research Hypotheses
The hypothesis developed for this research is provided below:
H1: Platform Engineering can bring several crucial benefits to the manufacturing sector
H2: Platform Engineering will not bring any benefit to the manufacturing sector.

2. LITERATURE REVIEW
2.1. Concept of Platform Engineering
[2][33] have written extensively on the topic of platform engineering. In their article, the researchers argued that platform engineering is a critical component of modern systems engineering [34]-[38]. They emphasized the importance of designing a platform that is both modular and scalable so that it can be adapted to meet the changing needs of customers and the market [39][40]. They also stressed the importance of using standard interfaces and architectures to enable compatibility across different subsystems and platforms [41]-[44]. By following these principles, the authors argued, platform engineering can reduce the cost and time-to-market for new products while improving their reliability and maintainability [45]-[49]. It is argued that platforms are not just a collection of components but a holistic approach to product development that emphasizes the reuse of components across different products and applications [50]-[55]. The authors note that platforms can take many different forms, from physical platforms like engines or chassis to software platforms like operating systems or middleware [56]-[60]. By adopting a platform-based approach, manufacturers can reduce their design and development costs while also improving the quality and performance of their products [3][61]. By adopting these principles, manufacturers can reduce costs, improve quality, and stay competitive in an increasingly dynamic and fast-paced market [62]-[66].
Annighoefer, Johannes Reinhart, Matthias Brunner, and Bernd Schulz are authors who have also contributed to the understanding of platform engineering in manufacturing [67]-[70]. In their article, the authors argued that platform engineering is a critical enabler of manufacturing innovation and competitiveness. They note that platform engineering can enable manufacturers to reduce costs, improve quality, and create new business models [71]-[77]. They also emphasize the importance of a customer-centric approach to platform engineering, in which customer needs and feedback are integrated into the design and

development process [78][79].

[80] also highlight the challenges that manufacturers may face when implementing a platform-based approach. These challenges include the need for a significant investment in research and development, the need for cross-functional collaboration and coordination, and the need for effective project management and risk management strategies [81]-[86]. However, they note that the benefits of platform engineering can outweigh these challenges and that many leading manufacturers have already adopted platform-based approaches to product development and manufacturing [4][87][88][89].

The work of [90] highlights the importance of platform engineering in manufacturing and the potential benefits that it can bring to manufacturers. Their research underscores the need for a customer-centric approach to platform engineering and emphasizes the challenges that manufacturers may face when implementing a platform-based approach [91]-[96]. By adopting a platform-based approach, manufacturers can reduce costs, improve quality, and create new business models that can help them stay competitive in an increasingly dynamic and fast-paced market [97]-[102].

A leading global consulting and technology services company, has also published research on the importance of platform engineering in the context of the cloud [103]-[109]. In their article, it is argued argues that platform engineering can enable organizations to leverage the benefits of cloud computing while also ensuring flexibility and agility in their development processes [5][110][111].

The article emphasizes the importance of a platform-based approach to cloud engineering, in which organizations leverage pre-built components and services to accelerate the development process [112]-[117]. Infosys notes that this approach can help organizations to reduce costs, minimize time-to-market, and improve the quality and scalability of their cloud-based applications [118]-[124]. They also highlight the importance of a DevOps approach to platform engineering, in which developers and operations teams work closely together to ensure that applications are delivered quickly and reliably [125]-[130].

Infosys also notes the challenges that organizations may face when implementing a platform-based approach to cloud engineering [131]. These challenges include the need for a significant investment in research and development, the need for effective governance and risk management strategies, and the need for strong partnerships with cloud service providers [132]-[135]. However, they argue that the benefits of platform engineering can outweigh these challenges and that many leading organizations have already adopted platform-based approaches to cloud engineering [136]-[138].

2.2. Benefits of Platform Engineering in Manufacturing Sector

[5] In their study, the authors found that platform engineering in the manufacturing sector can provide several benefits, such as reducing product development time, improving product quality, and increasing product variety [139]-[142]. They also found that platform-based development can help to reduce costs and enhance customer satisfaction. The authors note that platform engineering allows manufacturers to leverage common components and processes across different products, enabling them to develop new products more quickly and efficiently [143]-[146]. They also found that platform-based development can improve product quality, as common components are often tested and validated in multiple products, reducing the likelihood of defects [6][147][148]. Additionally, platform-based development can increase product variety, as manufacturers can quickly and easily create new product variants by combining existing components in new ways [149]-[152].

The study by [7][153] underscores the potential benefits of platform engineering in the manufacturing sector. By adopting a platform-based approach to product development, manufacturers can reduce product development time, improve product quality, increase product variety, and enhance customer satisfaction [154]-[158].

Platform engineering in the manufacturing sector has several benefits as identified by [8][159]. The authors argue that platform engineering enables mass customization and can lead to a significant reduction in development costs and lead times [160]-[164]. This is achieved by developing a product family platform that can be customized to meet specific customer requirements [165]. The

platform-based approach also allows for easier and faster upgrades, modifications, and maintenance of the products. According to [166] the platform-based approach enables the collection and analysis of data from the manufacturing process [9]. This data can be used to optimize the manufacturing process, reduce waste, and improve product quality [167][168]. The authors argue that this approach can also enable the development of new business models that are more sustainable and environmentally friendly [10][169].

In the modern world of manufacturing, cloud computing has emerged as a powerful tool that can be used to streamline operations and improve efficiency. In their research, [11][170] emphasize the potential of cloud-based platforms to facilitate access to manufacturing IT. They argue that cloud computing can provide manufacturers with a flexible and cost-effective way to access IT resources that might otherwise be too expensive or difficult to obtain [171].

The authors note that cloud-based platforms can be especially useful for small and medium-sized enterprises (SMEs), which may lack the resources to develop and maintain their own IT infrastructure. By using cloud-based platforms, SMEs can access a wide range of IT resources on an as-needed basis without having to invest in expensive hardware and software. This can help to level the playing field for SMEs and allow them to compete more effectively with larger firms [172][173].

Another key advantage of cloud-based platforms is their ability to support collaboration and data sharing among manufacturers. As Stocka et al. note, many manufacturers today operate in complex supply chains that involve multiple partners and stakeholders [174][175]. By using cloud-based platforms, manufacturers can share data and collaborate with partners in real time, improving transparency and reducing the risk of errors or misunderstandings. This can lead to improved quality control, faster time-to-market, and more efficient use of resources.

3. METHODOLOGY

The methodology of the study refers to the approaches utilized in a research study to fulfil the main objectives or test the hypothesis. For this research study, a qualitative approach has been selected, which centralizes on collecting data through open-ended communication. With the application of qualitative research, this study has employed a deductive research approach with the aim of testing the existing theory [12]. Based on such aspects, this research has focused on developing a survey questionnaire with a sample size of 20 participants, and the participants for the survey are different employees working in various organizations in the UAE's manufacturing sector. Moreover, an interview procedure has also been conducted with a particular manufacturing organization from the UAE, i.e., Rawaat International LLC. The interview has been conducted with the manager of the Rawaat International LLC, to know about the application of platform engineering in the manufacturing sector.

3.1. Research Setting

Research setting entails the location in which the overall research occurs, and for this study, we have opted for a virtual setting, which means the survey questionnaire has been sent to the respective participants, primarily the employees working in various organizations in the manufacturing sector in the UAE, through virtual online tools. The interview with the manager of the Rawaat International LLC has been conducted virtually/online.

3.2. Data Collection Tools

Both primary data and secondary data have been collected in this research. The primary data is collected by conducting a survey procedure with 20 participants, whose responses helped us to test the hypothesis or fulfil the research objectives. The primary data has also been gathered by conducting an interview with the manager of the Rawaat International LLC. The secondary data is collected by conducting a systematic literature review by collecting information on platform engineering and its application in the manufacturing sector from different sources of online journals, articles and websites.

4. RESULT AND ANALYSIS

The results obtained from the overall survey procedure are provided below in the form of graphs.
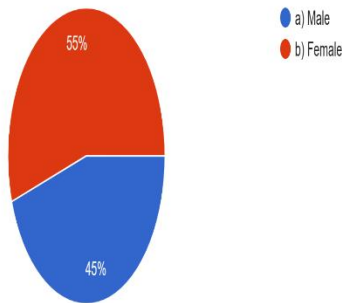
1. What is your age?

20 responses

- a) 20 – 29 years
- b) 30 – 39 years
- c) 40 – 49 years
- d) 50 years and above
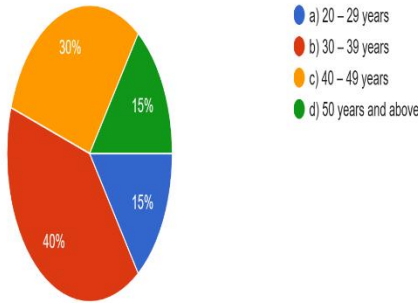
From the above graph, it is identified that among 20 participants, 15 per cent are 20 – 29 years old, 40 per cent are 30 – 39 years old, 30 percent are 40 – 49 years old, 15 percent are 50 years old and above.
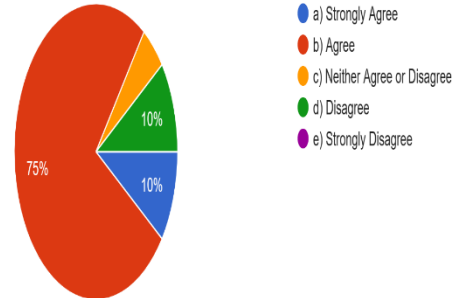
2. What is your gender?

20 responses

- a) Male
- b) Female

From the above graph, it is perceived that among 20 participants, 55 percent are females, and 45 percent are males.

3. Do you believe that new tools and processes are needed to be implemented in the manufacturing sector?

20 responses

- a) Strongly Agree
- b) Agree
- c) Neither Agree or Disagree
- d) Disagree
- e) Strongly Disagree

It is identified from the above graph that among 20 participants, 10 percent have stated strongly agree, 75 percent have stated agree, 5 percent have stated neither agree nor disagree, 10 percent have stated disagree and none of the participants has stated strongly disagree.

4. Do you think that recently there have been certain problems related to manufacturing sector?
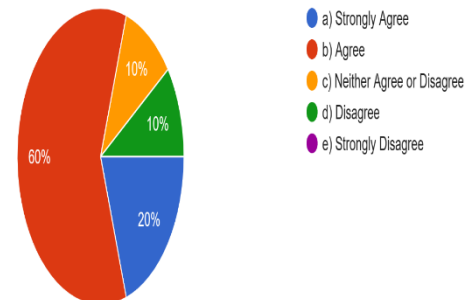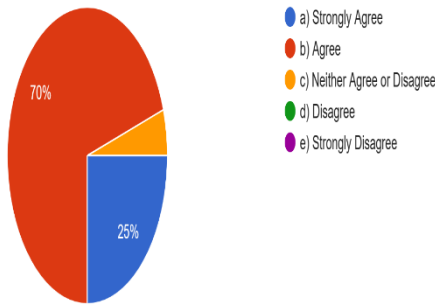
20 responses

- a) Strongly Agree
- b) Agree
- c) Neither Agree or Disagree
- d) Disagree
- e) Strongly Disagree

From the above graph, it is identified that among 20 participants, 20 percent have stated strongly agree, 60 percent have stated agree, 10 percent have stated neither agree nor disagree, 10 percent have stated disagree and none of the participants has stated strongly disagree.

5. Do you agree that platform engineering can make improvement in manufacturing sector?
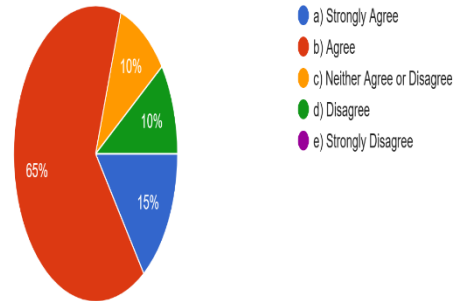20 responses

- a) Strongly Agree
- b) Agree
- c) Neither Agree or Disagree
- d) Disagree
- e) Strongly Disagree

It is identified from the above graph that among 20 participants, 25 percent have stated strongly agree, 70 percent have stated agree, 5 percent have stated neither agree nor disagree, and none of the participants has stated disagree and strongly disagree.

7. Do you believe that all manufacturing organizations in manufacturing sector must implement platform engineering?
20 responses

- a) Strongly Agree
- b) Agree
- c) Neither Agree or Disagree
- d) Disagree
- e) Strongly Disagree

It is identified from the above graph that among 20 participants, 15 percent have stated strongly agree, 65 percent have stated agree, 10 percent have stated neither agree nor disagree, 10 percent have stated disagree and none of the participants has stated strongly disagree.

6. Do you consider platform engineering to provide faster software development in manufacturing industry?
20 responses

- a) Strongly Agree
- b) Agree
- c) Neither Agree or Disagree
- d) Disagree
- e) Strongly Disagree
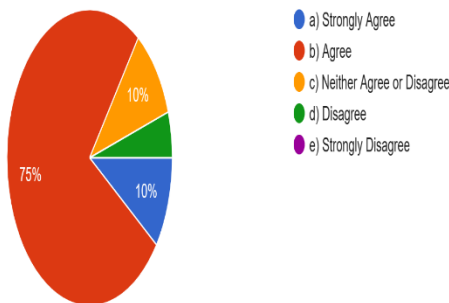
It is perceived from the above diagram that among 20 participants who have been surveyed, 10 percent have stated strongly agree, 75 percent have stated agree, 10 percent have stated neither agree nor disagree, 5 percent have stated disagree, and none of the participants has stated strongly disagree.

8. Do you agree that platform engineering will bring positive impact on business analytics by lowering operational complexity?
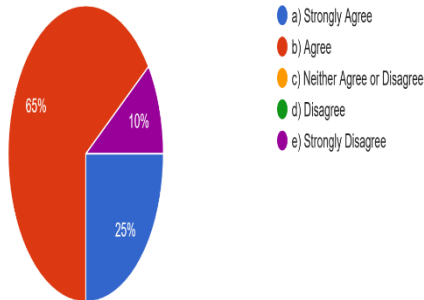20 responses

- a) Strongly Agree
- b) Agree
- c) Neither Agree or Disagree
- d) Disagree
- e) Strongly Disagree
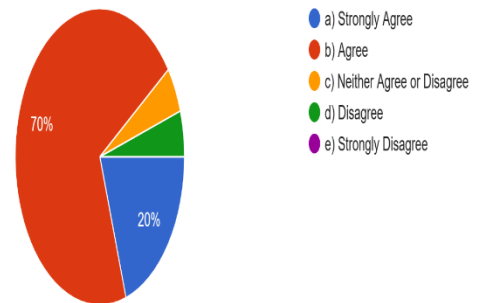
From the above diagram, it has been identified that among 20 participants, 20 percent have stated strongly agree, 70 percent have stated agree, 5 percent have stated neither agree nor disagree, 5 percent have stated disagree and none of the participants has stated strongly disagree.

9. Do you think that platform engineering will improve the security procedure in the manufacturing sector?
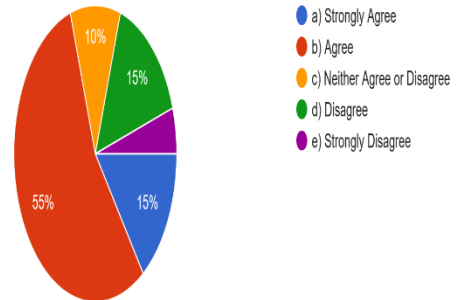
20 responses

It is identified from the above graph that among 20 participants, 25 percent have stated strongly agree, 65 percent have stated agree, none of the participants have stated neither agree nor disagree as well as disagree, and 10 percent have stated strongly disagree.

10. Do you agree that platform engineering's feature of faster software development will bring evolution on manufacturing sector?

20 responses

From the above graph that among 20 participants, 25 percent have stated strongly agree, 60 percent have stated agree, 5 percent have stated neither agree nor disagree, 10 percent have stated disagree, and none of the participants has stated strongly disagree.

11. Do you agree that platform engineering will promote focus and specialization to the manufacturing sector?
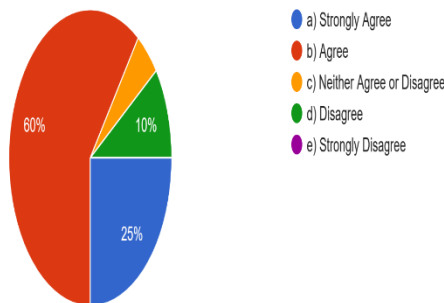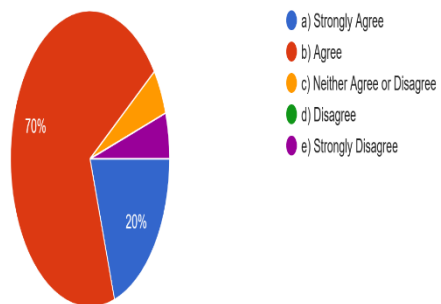
20 responses

From the above graph it has been identified that among 20 participants, 15 percent have stated strongly agree, 55 percent have stated agree, 10 percent have stated neither agree nor disagree, 15 percent have stated disagree, and 5 percent of the participants have stated strongly disagree.

12. Do you believe that adaptive AI's application in business analytic will increase the efficiency and profitability in the business?

20 responses

It is identified from the above graph that among 20 participants, 20 percent have stated strongly agree, 70 percent have stated agree, 5 percent have stated neither agree nor disagree, 5 percent have stated strongly disagree, and none of the participants has stated disagree.

Discussion

Case analysis and interview demonstration

The overall interview procedure conducted with the manager of the Rawaat International LLC has been illustrated in this section. The interview process goes as:

1) What do you know about platform engineering?

Answer:

Platform engineering is mainly regarded as the discipline of developing and designing the internal developer toolchains, and platforms which enable certain self-service capabilities various organizations.

2) Why platform engineering is significant in this modern world?

Answer:

Platform engineering helps in improving the productivity of the developer by improving the experience of the developer.

3) Why Rawaat International LLC implemented the technology of platform engineering?

Answer:

Rawaat International LLC implemented in order to improve the productivity of the organization by giving self-service capabilities with vital automated infrastructure.

4) What are benefits of platform engineering that Rawaat International LLC is facing in the manufacturing sector?

Answer:

After implementing the technology of platform engineering, Rawaat International LLC has witnessed improved security and lower operational complexity in their manufacturing related processes.

5) Is there any challenge in the platform engineering in the manufacturing sector? If so please highlight them.

Answer:

Yes, platform engineering has certain challenges that need to be mentioned. A major challenge of platform engineering is that this technology is way too expensive. Moreover, the employees find to difficult to master this new technology.

Case analysis and interview interpretation

A case study has been produced Rawaat International LLC, to see how platform engineering has benefitted this organization [13]. Rawaat International LLC is a major global firm located in Dubai which has been involved with the development of few remarkable sites at Dubai. It is perceived that recently the organization has opted to implement the technology of platform engineering in order to enhance their operations. For that purpose, an interview has been conducted with one of the managers of the Rawaat International LLC in order to gain detailed knowledge about what benefits does platform engineering has done to them. From the interview, it is perceived that platform engineering has helped the organization in several domains. Although there are few challenges in the platform engineering, like the cost of its implementation, and providing the employees with the necessary training to gain every knowledge and skill about platform engineering. However, Rawaat International LLC has opted for the platform engineering despite its challenges, because this technology provides significant benefits and can boost the operations of them in the manufacturing sector.

Case analysis and interview results

Platform engineering has become increasingly important for manufacturing businesses seeking to address the challenges of connecting disparate systems, adapting to changing market conditions, and managing complex data sets. By investing in effective platform engineering processes, manufacturing businesses can build flexible and adaptable platform ecosystems that support collaboration, experimentation, and innovation while also ensuring data privacy and security. A case study is formed by selecting one of the major manufacturing firms of the Dubai, i.e., Rawaat International LLC. An interview has been conducted with the manager of the Rawaat International LLC and from the entire interview it is identified that the organization has witnessed some significant benefits in their operations by implementing the technology of platform engineering. One of the main benefits of platform engineering that Rawaat International LLC has witnessed in manufacturing is increased efficiency. Effective platform engineering processes can help connect disparate manufacturing systems and processes, enabling more efficient collaboration and coordination. This has led Rawaat International LLC to reduced downtime, faster production cycles, and lower costs. Another benefit of platform engineering that the organization has witnessed is increased adaptability. Manufacturing

businesses must be able to quickly pivot to new opportunities and respond to changing customer needs. Platform engineering has helped Rawaat International LLC to address this challenge by providing a flexible and adaptable infrastructure that can support rapid prototyping and experimentation, as well as enable businesses to scale up or down as needed.

Finally, platform engineering can also help address the challenge of managing complex data sets in manufacturing for Rawaat International LLC. With the increasing amount of data generated by manufacturing processes and systems, businesses must be able to effectively manage and analyze this data in order to identify opportunities for improvement and optimize their operations. Platform engineering has also helped Rawaat International LLC by providing a scalable and secure data infrastructure that can support real-time analytics and enable businesses to make more informed decisions.

From the data collected from the survey, it is identified that integrating platform engineering into the manufacturing sector can bring several important benefits to an organization. Most of the participants have agreed that platform engineering plays a major role in improving the performance of an organization within the manufacturing sector through the enhancement of security procedures, faster software development, and promoting focus and specialization, and thus it enhances the efficiency and adaptability. Therefore, based on these findings, we can conclude that platform engineering can produce major benefits to the manufacturing sector, which proves our hypothesis (H1).

- ***Recommendations and Implications***

Based on the benefits of platform engineering in manufacturing discussed above, we recommend that manufacturing businesses invest in effective platform engineering processes. This can involve building a flexible and adaptable platform ecosystem that can support collaboration, experimentation, and innovation across the entire supply chain. It is also important to prioritize data privacy and security by implementing scalable and secure data infrastructure that can support real-time analytics and enable businesses to make more informed decisions. Furthermore, businesses should prioritize investing in technology and infrastructure that supports platform engineering

processes. This can involve investing in cloud computing, data analytics, and other digital technologies that can help connect disparate systems and enable more efficient collaboration and coordination.

The implications of effective platform engineering processes in manufacturing are far-reaching. Manufacturing businesses that invest in effective platform engineering processes can expect to see increased efficiency, adaptability, and security in their operations. This can lead to reduced costs, faster production cycles, and more responsive customer service. However, there are also potential risks associated with platform engineering in manufacturing. Businesses must be careful to prioritize data privacy and security, as well as ensure that platform engineering processes are implemented effectively and efficiently. Poorly implemented platform engineering processes can result in decreased efficiency, adaptability, and security in manufacturing operations. Another implication of platform engineering in manufacturing is the potential for increased collaboration and innovation. By building a flexible and adaptable platform ecosystem, businesses can collaborate more effectively with suppliers, partners, and other stakeholders, as well as experiment and innovate more quickly.

5. CONCLUSION

In conclusion, effective platform engineering processes have become increasingly important for manufacturing businesses seeking to address the challenges of connecting disparate systems, adapting to changing market conditions, and managing complex data sets. By investing in technology and infrastructure that supports platform engineering processes, and prioritizing data privacy and security, manufacturing businesses can build flexible and adaptable platform ecosystems that support collaboration, experimentation, and innovation while also ensuring efficiency, adaptability, and security.

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