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Abstract

Purpose: The aim of the study was to assess the impact of project scheduling tools on resource optimization in manufacturing projects in the Rwanda.

Methodology: This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low cost advantage as compared to a field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

Findings: The study found that the use of project scheduling tools significantly enhances resource optimization in manufacturing projects by improving efficiency and reducing waste. These tools enable project managers to allocate resources more effectively, allowing for better tracking of tasks and timelines, which minimizes idle time and maximizes productivity. Research indicates that project scheduling software facilitates real-time data sharing and communication among team members, leading to informed decision-making and timely adjustments to project plans. By analyzing workload distribution, these tools also help identify bottlenecks and underutilized resources, allowing managers to redistribute tasks and optimize labor utilization. Ultimately, the integration of project scheduling tools in manufacturing not only streamlines operations but also contributes to cost savings and improved overall project outcomes.

Implications to Theory, Practice and Policy: Resource-based view (RBV) theory, theory of constraints (TOC) and agile project management theory may be used to anchor future studies on assessing the impact of project scheduling tools on resource optimization in manufacturing projects in Rwanda. Manufacturing firms should invest in customized training programs for project managers and teams to maximize the effectiveness of project scheduling tools. Policymakers should consider creating frameworks that encourage the adoption of advanced project scheduling tools in the manufacturing sector.

Keywords: *Project, Scheduling, Tools, Resource Optimization, Manufacturing Projects*

INTRODUCTION

Project scheduling tools play a crucial role in optimizing resource allocation in manufacturing projects, ultimately influencing overall productivity and efficiency. Resource optimization in developed economies such as the USA and Japan is increasingly crucial for enhancing productivity and sustainability. In the USA, a significant trend in labor efficiency has emerged, with advanced automation technologies improving productivity by 20% over the past decade. According to a study by Bessen (2019), the introduction of robotics in manufacturing has led to a 30% increase in machine utilization rates, reducing idle time and operational costs. Moreover, material usage has been optimized through lean manufacturing principles, which have resulted in a 25% reduction in waste generation in the automotive sector. These advancements reflect a broader commitment to maximizing resource efficiency, driving economic growth while minimizing environmental impact.

Similarly, Japan's focus on resource optimization is evident in its society initiative, which aims to integrate cyberspace with physical space to enhance productivity. For instance, Japanese manufacturers have reported improvements in labor efficiency by 15% due to smart factory technologies that utilize IoT (Internet of Things) for real-time monitoring of production processes. A report by Yoshino and Taghizadeh-Hesary (2020) highlights that machine utilization in Japanese factories has increased to an average of 85%, showcasing the effectiveness of innovative technologies. Additionally, Japan's commitment to reducing material usage has led to a 30% reduction in energy consumption across industries, demonstrating a holistic approach to resource optimization. These examples illustrate the effectiveness of integrating advanced technologies and methodologies in enhancing resource efficiency in developed economies.

In developing economies, resource optimization presents unique challenges and opportunities. For instance, in India, labor efficiency has improved by approximately 10% over the past five years due to the adoption of skill development programs aimed at enhancing workforce capabilities. According to a study by Ghosh (2021), machine utilization in the textile industry has reached around 70%, reflecting an increase in productivity as manufacturers invest in modernizing equipment. Additionally, material usage optimization has gained traction through initiatives focused on sustainable practices, leading to a reported 15% decrease in water consumption in textile production. These improvements indicate that even in developing economies, strategic resource management can significantly impact productivity.

In Brazil, resource optimization is evident in the agricultural sector, where precision farming techniques have led to enhanced labor efficiency. A study by Silva and Lima (2022) reported that farmers utilizing precision agriculture technologies have increased their crop yields by up to 30% while simultaneously reducing input costs. Furthermore, machine utilization in Brazilian agriculture has improved to approximately 75%, as farmers adopt modern equipment and farming practices. Efforts to optimize material usage have also been seen, with a reported 20% reduction in fertilizer usage through data-driven decision-making processes. These examples highlight that developing economies can achieve substantial resource optimization through targeted investments and the adoption of modern technologies.

Resource optimization in developing economies is vital for fostering sustainable growth and improving overall productivity. For instance, in Vietnam, the introduction of lean manufacturing practices has resulted in significant gains in labor efficiency, with recent reports indicating a 15%

increase in productivity across the textile and garment sectors. According to Nguyen and Tran (2022), machine utilization rates have improved to approximately 80%, thanks to investments in modern machinery and automation technologies. Furthermore, initiatives aimed at optimizing material usage have been successful, with the country achieving a 20% reduction in fabric waste through more efficient cutting and sewing techniques. These advancements showcase how resource optimization can enhance competitiveness in developing economies.

In the context of Bangladesh, the textile industry serves as a prime example of resource optimization efforts. The implementation of energy-efficient technologies has led to an impressive 25% increase in labor efficiency, as highlighted by Rahman (2021). Additionally, machine utilization in the garment sector has reached around 75%, aided by the adoption of just-in-time production systems that minimize idle time. Material usage has also been optimized, with manufacturers reporting a 30% decrease in water usage per unit of production through sustainable practices and better resource management. These efforts demonstrate that developing economies can leverage resource optimization to achieve substantial gains in productivity while addressing environmental concerns.

In South Africa, resource optimization initiatives have gained momentum in the mining and manufacturing sectors. A report by Mpofu and Nkosi (2022) noted a 12% improvement in labor efficiency driven by skills training programs and safety protocols that enhance worker productivity. Moreover, machine utilization in the mining sector has risen to about 85%, primarily due to investments in advanced equipment and technology that facilitate better operational planning. Additionally, South African manufacturers have focused on material usage optimization, achieving a 20% reduction in raw material costs through recycling initiatives and waste reduction strategies. These trends highlight the potential for resource optimization to drive economic growth and competitiveness in developing economies.

In Indonesia, resource optimization strategies have also been implemented in the agricultural sector. A study by Widiastuti (2023) reported that labor efficiency has improved by 10% due to the adoption of mechanized farming techniques and training programs for farmers. The utilization of agricultural machinery has increased to approximately 70%, with many farmers embracing modern tools to enhance productivity. Furthermore, material usage has been optimized, with a reported 15% reduction in fertilizer usage thanks to precision agriculture practices that utilize data analytics for better decision-making. These initiatives illustrate the importance of resource optimization in supporting sustainable agricultural growth in developing economies.

In the Philippines, resource optimization is gaining traction, particularly in the agriculture and manufacturing sectors. A recent study by Castillo and Bayani (2022) reported a 12% improvement in labor efficiency in rice production due to the implementation of modern farming techniques and training programs. Furthermore, machine utilization in Philippine agriculture has risen to approximately 65%, as farmers increasingly adopt mechanized tools and equipment to improve productivity. Efforts to optimize material usage have also been notable, with a reported 20% reduction in pesticide application due to integrated pest management practices. These developments illustrate how targeted strategies can enhance resource efficiency and promote sustainable agricultural practices in developing economies.

In Egypt, resource optimization has become critical in the textile and garment sector, where labor efficiency has improved by 10% over the past few years. According to El-Sayed (2021), machine

utilization rates in this sector have reached about 75%, driven by the adoption of automated processes and better production scheduling. Material usage has also seen significant optimization, with manufacturers achieving a 15% reduction in water and energy consumption through the implementation of sustainable production techniques. The focus on resource efficiency not only enhances competitiveness but also aligns with Egypt's broader goals of sustainable development. These trends emphasize the potential for resource optimization to drive economic growth and environmental sustainability in developing economies.

In Sub-Saharan economies like Morocco, the renewable energy sector serves as an excellent example of resource optimization. A report by M'barek (2023) indicated that labor efficiency has increased by 15% in solar energy projects due to specialized training programs and enhanced project management practices. The utilization of machinery in the renewable sector has improved to 80%, driven by investments in modern technologies and infrastructure. Moreover, material usage has been optimized through the use of sustainable materials and recycling initiatives, leading to a reported 20% decrease in waste generated during production. These efforts underscore Morocco's commitment to harnessing renewable energy while optimizing resources effectively.

Similarly, in Ghana, resource optimization strategies have been notably successful in the cocoa industry, a vital economic sector. A study by Owusu and Agyeman (2022) revealed a 10% increase in labor efficiency due to the implementation of better agricultural practices and farmer training programs. Machine utilization in Ghana's cocoa farms has also improved, with rates reaching around 70% as farmers adopt mechanized harvesting methods. Furthermore, material usage optimization has been achieved through better post-harvest management practices, resulting in a 15% reduction in cocoa spoilage. These initiatives highlight the significance of resource optimization in enhancing productivity and sustainability in developing economies.

Resource optimization in Sub-Saharan economies is crucial for driving growth and addressing development challenges. In Nigeria, the agricultural sector has seen a 12% increase in labor efficiency through the introduction of mobile technology that provides farmers with real-time market information and agricultural advice. According to a study by Adeyemo and Afolabi (2023), machine utilization rates in Nigerian farms have improved to 60%, particularly in regions where mechanization has been promoted. Moreover, initiatives to optimize material usage have led to a 25% reduction in post-harvest losses, significantly benefiting smallholder farmers. These developments illustrate the potential for resource optimization to enhance agricultural productivity and food security in Sub-Saharan economies.

Similarly, in Kenya, resource optimization strategies have been implemented in the horticultural sector, leading to notable improvements. A report by Nyang'aya (2021) indicated that labor efficiency has increased by 15% due to the training of workers in modern farming techniques. Machine utilization in Kenyan horticulture has reached 65%, with investments in efficient irrigation systems enhancing productivity. Additionally, material usage optimization has been achieved through better supply chain management, resulting in a 30% decrease in wastage. These efforts demonstrate that Sub-Saharan economies can leverage resource optimization to foster economic growth and improve living standards.

Project scheduling tools such as Microsoft Project, Primavera, Asana, and Trello play a pivotal role in enhancing resource optimization across various industries. Microsoft Project is renowned for its robust features that facilitate detailed planning and monitoring of project timelines, allowing

managers to allocate labor efficiently and maximize machine utilization. According to Khamis, Mohammedm& Ahmad (2020), its Gantt chart functionality enables users to visualize task dependencies, helping to optimize labor allocation by ensuring that team members are engaged effectively at all stages of the project. Primavera, on the other hand, is favored in large-scale construction and engineering projects due to its advanced capabilities in handling complex schedules and resource allocation, which directly impacts material usage efficiency (Bourne, 2019). By providing in-depth analytics, Primavera assists project managers in identifying potential bottlenecks and reassigning resources proactively, thereby enhancing overall productivity.

Asana and Trello (2020) represent more user-friendly, collaborative tools that are gaining traction among teams seeking to optimize their workflows and improve labor efficiency. Asana's task management features promote clear communication and accountability, allowing team members to prioritize tasks and manage their time effectively, which can lead to a 20% increase in labor efficiency as reported by Le, Nguyen & Tran (2021). Trello, with its intuitive Kanban board design, enables teams to visualize their progress and allocate resources dynamically, ensuring that machine utilization is maximized as tasks are completed efficiently. The integration of these scheduling tools with existing workflows facilitates better material usage by allowing teams to track resource consumption in real-time, thereby reducing waste and enhancing sustainability (López & Vargas, 2022). In summary, project scheduling tools are crucial for achieving resource optimization through improved labor efficiency, enhanced machine utilization, and better material management.

Problem Statement

In the manufacturing industry, effective resource optimization is crucial for enhancing productivity and ensuring competitive advantage. However, many organizations struggle to fully leverage project scheduling tools, such as Microsoft Project, Primavera, and Asana, which can significantly impact labor efficiency, machine utilization, and material usage. Despite the availability of these tools, research indicates that a substantial number of manufacturing projects still experience delays and resource wastage due to inadequate scheduling practices (Khamis, 2020). Furthermore, the integration of these scheduling tools into existing workflows often presents challenges, leading to underutilization or mismanagement of available resources (López, 2022). Therefore, understanding the impact of project scheduling tools on resource optimization in manufacturing projects is critical for identifying best practices and improving overall operational efficiency (Bourne, 2019).

Theoretical Review

Resource-Based View (RBV) Theory

The resource-based view (RBV) theory, developed by Wernerfelt (1984), emphasizes that a firm's resources and capabilities are fundamental to achieving a competitive advantage. This theory suggests that effective utilization of project scheduling tools can enhance a company's resource efficiency, ultimately leading to superior performance. In the context of manufacturing, the RBV underscores the importance of optimizing labor, machine, and material resources through effective scheduling, allowing firms to leverage their unique capabilities for improved operational outcomes (Harrison, 2020).

Theory of Constraints (TOC)

The theory of constraints (TOC), introduced by Goldratt (1984), posits that every system has at least one limiting factor that constrains its performance. This theory highlights the need to identify and manage constraints effectively to optimize resource utilization. In manufacturing projects, scheduling tools can aid in pinpointing bottlenecks and reallocating resources to mitigate these constraints, thereby enhancing overall efficiency and productivity (Ali & Khamis, 2021).

Agile Project Management Theory

Agile project management theory focuses on flexibility, collaboration, and iterative progress. It was developed in response to the need for more adaptive project management approaches (Beck et al., 2001). In the manufacturing context, the agile approach emphasizes the use of scheduling tools that allow for real-time adjustments, facilitating better resource optimization by quickly addressing changing project demands and enhancing team collaboration (Miller & Lessard, 2021).

Empirical Review

Khamis (2020) examined the effectiveness of Microsoft Project in enhancing resource allocation in manufacturing settings. The study utilized a mixed-methods approach, combining quantitative surveys with qualitative case studies across various manufacturing firms. The findings revealed that the implementation of Microsoft Project led to significant improvements in labor efficiency and a marked reduction in material wastage. Specifically, companies reported an average labor productivity increase of 20% after adopting the tool. Moreover, the analysis indicated that project timelines were better adhered to, resulting in fewer project delays. Recommendations included integrating Microsoft Project with existing Enterprise Resource Planning (ERP) systems to improve resource visibility across departments. This integration allows for real-time tracking of resource utilization and enhances coordination among teams. The study also emphasized the need for tailored training programs for project managers to effectively leverage the features of the software. Overall, the research highlighted the importance of adopting appropriate project management tools to optimize resource use in manufacturing settings. The findings serve as a valuable reference for organizations seeking to improve their project management practices through technology.

Ali and Khamis (2021) explored the application of the Theory of Constraints (TOC) in manufacturing projects using Primavera as a scheduling tool. The researchers employed a quantitative study design, assessing project outcomes before and after implementing the software across several manufacturing firms. Their findings indicated a 30% reduction in project delays and a notable improvement in overall resource utilization. The analysis suggested that Primavera effectively identified bottlenecks in the production process, allowing project managers to allocate resources more strategically. The study concluded that implementing TOC principles in conjunction with Primavera led to significant improvements in labor and material usage. Furthermore, the authors recommended that organizations invest in training project managers on TOC principles to maximize the tool's effectiveness in resource optimization. This emphasis on training ensures that project teams can effectively identify constraints and implement solutions. The findings of this study contribute to the growing body of literature on optimizing manufacturing processes through the integration of project management tools. By focusing on constraints, manufacturers can enhance operational efficiency and reduce costs.

Miller and Lessard (2021) investigated the role of agile project management tools in manufacturing environments, focusing on how these tools can enhance resource optimization. Using a qualitative approach, they conducted in-depth interviews with project managers from various manufacturing firms to gather insights on their experiences with agile methodologies. The study found that the adoption of agile tools, such as Asana, significantly enhanced flexibility and adaptability during project execution. This increased adaptability allowed project teams to respond more effectively to changing project demands and to optimize resource allocation dynamically. Participants noted improvements in team collaboration and communication, which were critical for successful project outcomes. The research highlighted that agile methodologies foster a culture of continuous improvement, which is essential for optimizing labor and material resources in manufacturing. Recommendations included integrating agile practices with traditional project management frameworks to create a hybrid approach that maximizes resource efficiency. By embracing both agility and structure, manufacturing firms can achieve better project outcomes. The study's findings contribute valuable insights into the ongoing discourse on agile project management in manufacturing settings.

Harrison (2020) analyzed the impact of project scheduling software on improving labor efficiency within the manufacturing sector. The study employed a case study methodology, focusing on several firms that had integrated project scheduling tools into their operations. Findings indicated that the effective use of scheduling software led to a 25% increase in labor productivity across the participating firms. The analysis revealed that project scheduling tools enabled better planning and tracking of tasks, reducing idle time and improving workflow efficiency. Furthermore, the study highlighted the role of effective communication facilitated by these tools, which enhanced team coordination and accountability. Recommendations included ongoing training programs to ensure that employees were well-versed in using the scheduling software to its full potential. The research emphasized that companies must invest in not only the tools but also in the human resources needed to operate them effectively. By fostering a culture of continuous learning and improvement, firms can sustain the productivity gains achieved through project scheduling tools. This study serves as an important resource for organizations looking to enhance labor efficiency in manufacturing through technological integration.

Bourne (2019) investigated the integration of Asana as a project scheduling tool within resource management processes in manufacturing. This research utilized a mixed-methods design that combined quantitative surveys with qualitative observational studies to assess the impact of Asana on resource optimization. The findings demonstrated that organizations using Asana experienced significant improvements in communication, accountability, and overall project execution. Specifically, resource wastage decreased by approximately 15%, indicating a more efficient use of materials. The study recommended that firms regularly assess the impact of project management tools on project outcomes to ensure that they align with organizational goals. By conducting periodic evaluations, companies can identify areas for improvement and adapt their project management strategies accordingly. The research contributes to the understanding of how project scheduling tools can facilitate better resource optimization in manufacturing contexts. Additionally, it highlights the importance of selecting tools that fit the specific needs of the organization.

López (2022) evaluated the impact of Trello on project scheduling and resource optimization within small manufacturing firms. The research employed a quantitative survey methodology to

assess the effectiveness of Trello in improving operational efficiency. Results indicated a significant decrease in resource wastage and enhanced team collaboration, leading to a 20% improvement in project completion rates. The study emphasized that visual project management tools like Trello facilitate better task management and communication among team members. Recommendations included encouraging small firms to adopt visual scheduling tools to enhance their resource management practices. The findings suggest that even smaller manufacturing firms can benefit from implementing project management tools to optimize resources. The study contributes to the existing literature by demonstrating that effective scheduling tools can lead to substantial improvements in both project efficiency and resource utilization. By adopting innovative scheduling solutions, firms can remain competitive in an increasingly challenging market.

García and Hernández (2023) investigated the impact of project scheduling tools on overall project performance in the manufacturing sector through a longitudinal study conducted across various manufacturing companies. This research aimed to assess how the adoption of advanced scheduling tools influenced resource allocation and project success rates over time. The results revealed that firms employing project scheduling tools experienced better resource allocation and improved project performance metrics, such as adherence to deadlines and budget constraints. Specifically, companies reported a 30% improvement in project success rates after implementing these tools. Recommendations included the continuous evaluation of the impact of scheduling tools to ensure that they align with organizational objectives and contribute positively to project outcomes. The study emphasized that manufacturing firms must remain agile and responsive to technological advancements in project management to sustain competitive advantages. This research provides valuable insights into the effectiveness of project scheduling tools in optimizing resource utilization and enhancing overall project success. The findings underscore the need for manufacturers to embrace technological solutions that facilitate better resource management practices.

METHODOLOGY

This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low cost advantage as compared to a field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

RESULTS

Conceptual Gaps: While the studies have explored various project scheduling tools, including Microsoft Project, Primavera, Asana, and Trello, there remains a lack of comprehensive frameworks that integrate these tools under a unified theoretical perspective. Most research focuses on individual tools' efficacy rather than a comparative analysis that assesses the strengths and weaknesses of multiple tools in resource optimization contexts. Additionally, existing literature does not thoroughly examine the role of organizational culture in influencing the effectiveness of these tools, despite evidence that culture can significantly impact the success of project management initiatives (Khamis, 2020; López, 2022). Furthermore, while some studies emphasize the importance of training for project managers, there is insufficient exploration of the specific types of training that correlate with improved outcomes in resource optimization. As a result, a

conceptual gap exists in understanding the interrelationship between project scheduling tools, training methods, and overall resource management effectiveness.

Contextual Gaps: In terms of context, most studies focus primarily on medium to large manufacturing firms, leaving a gap in understanding how project scheduling tools impact smaller manufacturing enterprises. López (2022) provides insights into small firms using Trello; however, further exploration is needed across different sectors and types of manufacturing to assess the universality of these findings. Moreover, the studies do not adequately address the varying degrees of technological adoption and resource availability in different types of manufacturing contexts, such as traditional versus advanced manufacturing systems. Understanding these variations is crucial for developing tailored recommendations that consider the specific challenges faced by different manufacturing environments. Additionally, while some studies highlight the integration of project scheduling tools with ERP systems, they do not sufficiently explore the challenges associated with such integrations, particularly in diverse manufacturing settings.

Geographical Gaps: Geographically, the existing research predominantly reflects data from developed economies, such as the USA and Western European nations, with limited studies examining the impact of project scheduling tools in developing or Sub-Saharan economies. As manufacturing practices and technological adoption differ significantly across these regions, it is essential to investigate how project scheduling tools can be effectively leveraged in these contexts. The cultural, economic, and infrastructural differences that characterize these regions may influence the adoption and efficacy of project management tools, presenting an opportunity for more extensive research that addresses these geographical disparities. Additionally, research focusing on how local factors, such as labor market conditions and resource availability, interact with project management tool effectiveness is currently lacking. Overall, addressing these gaps will enhance the understanding of project scheduling tools' impact on resource optimization in diverse manufacturing contexts globally (García and Hernández, 2023).

CONCLUSION AND RECOMMENDATIONS

Conclusion

The impact of project scheduling tools on resource optimization in manufacturing projects is both significant and multifaceted. Research consistently demonstrates that tools such as Microsoft Project, Primavera, Asana, and Trello enhance resource allocation, improve labor efficiency, and minimize material wastage across various manufacturing environments. These tools facilitate better planning and tracking of tasks, enabling project managers to respond dynamically to changing project demands and thereby optimizing resource utilization. Furthermore, the integration of project scheduling tools with existing systems, such as Enterprise Resource Planning (ERP), fosters real-time visibility into resource use and enhances interdepartmental coordination.

Despite the positive outcomes associated with these tools, gaps in the literature highlight the need for further investigation into the contextual, conceptual, and geographical aspects of their application. The effectiveness of project scheduling tools can vary based on organizational culture, size, and industry type, necessitating tailored approaches to their implementation. Additionally, there is a pressing need to explore the role of training and support in maximizing the benefits of these tools, especially in smaller manufacturing firms and emerging economies. By addressing these gaps, future research can contribute to a deeper understanding of how project scheduling tools can be optimized for diverse manufacturing contexts, ultimately leading to improved resource

management practices and enhanced operational efficiency. Overall, the evidence suggests that strategically leveraging project scheduling tools can significantly bolster resource optimization, thereby offering manufacturers a competitive edge in an increasingly complex and dynamic market.

Recommendations

The following are the recommendations based on theory, practice and policy:

Theory

Future research should expand on existing project management theories by incorporating the dynamics of project scheduling tools within different manufacturing contexts. For instance, theories such as the Theory of Constraints (TOC) can be further explored to assess how scheduling tools identify and alleviate bottlenecks in real-time, enhancing overall resource optimization. Researchers should aim to create a more comprehensive framework that combines various project management methodologies with technological advancements in scheduling tools. A unified model that integrates different project scheduling tools, considering their specific functionalities and applicability to various manufacturing scenarios, can contribute to theoretical frameworks. This model should evaluate how different tools can work synergistically to enhance resource optimization. Developing such a model will provide a theoretical foundation for future studies on project scheduling and resource management.

Practice

Manufacturing firms should invest in customized training programs for project managers and teams to maximize the effectiveness of project scheduling tools. Training should not only focus on software usage but also on the strategic application of these tools to enhance resource allocation and operational efficiency. By developing competencies in utilizing these tools, organizations can foster a culture of continuous improvement. Regular assessments of the impact of project scheduling tools on resource optimization should be institutionalized within manufacturing organizations. Establishing feedback mechanisms will allow firms to evaluate the effectiveness of their scheduling tools and adjust their strategies accordingly. This iterative process can lead to continuous improvements in resource management practices and project outcomes.

Policy

Policymakers should consider creating frameworks that encourage the adoption of advanced project scheduling tools in the manufacturing sector. This can include offering incentives for small and medium-sized enterprises (SMEs) to invest in technology and training that enhance resource optimization. Policies that support technological integration can lead to greater efficiency and competitiveness in the manufacturing industry. Government and industry stakeholders should promote collaborative research initiatives aimed at exploring the impact of project scheduling tools across diverse manufacturing contexts. Funding and support for interdisciplinary studies can drive innovation in project management practices, ultimately benefiting resource optimization strategies. Encouraging partnerships between academic institutions and manufacturing firms can facilitate knowledge transfer and practical application of research findings.

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