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CONTRIBUTIONS OF SMART MANUFACTURING IN BERNAS TO THE REGIONAL DEVELOPMENT: CASE STUDY IN PAYA KELADI, PULAU PINANG

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Abstract: *The adoption of smart manufacturing technology has become a crucial driver for industrial transformation, particularly in the rice processing industry. This study explores the contributions of smart manufacturing in BERNAS Paya Keladi, Pulau Pinang to the regional development. By integrating automation, digital monitoring systems and data analytics, BERNAS has enhanced production efficiency, minimized operational cost and improved product quality. These advancements have not only benefited the company but have also had significant economic and social implications for the surrounding region. The study adopts a qualitative case study approach, utilizing interviews and observations to assess the impact of smart manufacturing on the local economy and workforce. Findings indicate that the implementation of smart manufacturing has led to increased job opportunities particularly in high-skilled positions while also necessitating reskilling initiatives for workers. Additionally, the technological improvements in rice processing have strengthened local supply chains, creating new business opportunities for small and medium enterprises (SMEs). Furthermore, the adoption of smart manufacturing practices has enhanced sustainability efforts by reducing waste and energy consumption contributing to the environmental well-being of the region. In conclusion, smart manufacturing in BERNAS Paya Keladi has positively impacted regional economic growth, and employment patterns and environmental sustainability. The study provides valuable insights for policymakers and industry stakeholders on leveraging smart technologies to promote sustainable industrial and regional development.*

Keywords: *smart manufacturing, regional development, BERNAS, automation, digital transformation*

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Introduction

The advancement of technology in the manufacturing sector has significantly transformed industrial operations including the rice processing industry. Smart manufacturing which encompasses automation, artificial intelligence (AI), data analytics and the Internet of Things (IoT) is becoming increasingly vital in enhancing efficiency, reducing production costs and improving product quality. Across various industries, the adoption of smart manufacturing technologies has been recognized as a crucial driver of economic growth, sustainability and competitiveness. In Malaysia, the rice processing sector plays a critical role in ensuring food security and economic stability with BERNAS (Padiberas Nasional Berhad) serving as the primary entity responsible for managing the nation's rice supply chain. As Malaysia moves towards Industry 4.0, integrating smart manufacturing into BERNAS operations is expected to enhance production processes, optimize supply chain management and create new economic opportunities at the regional level.

This study focuses on the case of BERNAS in Paya Keladi, Pulau Pinang, an important rice processing hub in Malaysia that has incorporated various forms of technological innovation. Paya Keladi was selected as the case study site due to its strategic role in Malaysia's rice production industry, its rural demographic characteristics and its relevance in national food security planning. The facility's integration of smart manufacturing in a rural setting provides a unique opportunity to examine how technological innovation influences economic and social development outside of major industrial centers. The adoption of smart manufacturing in this facility represents a significant step towards modernizing rice processing and improving overall industry performance. However, beyond operational efficiency, the implementation of these technologies has broader economic and social implications. The transition to smart manufacturing has created demand for high-skilled labor necessitating workforce upskilling and retraining programs. Additionally, the technological transformation has strengthened local supply chains, fostering business opportunities for small and medium enterprises (SMEs) involved in the rice processing ecosystem. Moreover, the environmental aspect of smart manufacturing cannot be overlooked. The integration of advanced monitoring and automation systems has enabled BERNAS to minimize waste, optimize resource utilization and contribute to more sustainable production practices. This aligns with national and global sustainability goals, reinforcing the importance of technological adoption not only for economic growth but also for long-term environmental stewardship. Therefore, this study aims to examine the contributions of smart manufacturing in BERNAS Paya Keladi to regional development with specific focus on:

1. Identifying the impact of smart manufacturing on economic growth and employment patterns in Paya Keladi
2. Analyzing the contribution of smart manufacturing in BERNAS to the regional development

By addressing these objectives, this study seeks to provide insights into how technological advancements in rice processing can drive regional economic development while ensuring the sustainability of the industry. Furthermore, the study will explore the role of government policies in facilitating the transition to smart manufacturing and ensuring that the benefits of technological progress are equitably distributed across the workforce and local communities. The findings of this research will contribute to academic discourse on smart manufacturing and regional development while also offering practical recommendations for policymakers, industry leaders and stakeholders in Malaysia's rice processing sector. As the nation continues to embrace digital transformation, understanding the broader implications of smart

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manufacturing adoption will be essential for shaping policies and strategies that promote industrial competitiveness, economic inclusivity, and environmental sustainability.

Literature Review

The integration of smart manufacturing technologies has been widely studied in various industries including food processing and agriculture. As industries transition toward automation and digitalization, the impacts of these advancements on productivity, economic growth, employment and sustainability have become key areas of research. Hence, there are five points will be discussed in literature review which are Smart Manufacturing and Industrial Transformation, Smart Manufacturing in Rice Processing, Smart Manufacturing and Regional Development, Challenges and Opportunities of Smart Manufacturing in Regional Development and Research Gap

Smart Manufacturing and Industrial Transformation

Smart manufacturing refers to the application of advanced digital technologies such as automation, artificial intelligence (AI), machine learning, data analytics and the Internet of Things (IoT) to optimize manufacturing processes. This approach enhances decision-making, improves efficiency, reduces operational costs, and enables real-time monitoring of production activities (Kusiak, 2018). The concept of smart manufacturing is closely associated with Industry 4.0 which emphasizes interconnectivity, data-driven decision-making and self-optimizing production systems (Shi et al., 2020). The adoption of Industry 4.0 principles has been proven to increase productivity, enhance supply chain efficiency and improve overall product quality (Zheng et al., 2018). In the agricultural and food processing sectors, smart manufacturing plays a crucial role in addressing challenges such as resource wastage, inconsistent product quality and labor shortages. Studies have shown that digital transformation in food processing has led to improved operational efficiency by automating tasks such as sorting, grading, and packaging (Barrett & Rose, 2022). Furthermore, smart sensors, data analytics and cloud computing enable manufacturers to optimize resource utilization, predict maintenance needs and enhance food safety standards (Assad et al., 2020; Haddara & Elragal, 2015; Jambrak et al., 2021).

Specific to the rice processing industry, automation and AI-driven systems have improved rice milling yield (Chen et al., 2014), enhanced grain quality (Younas et al., 2019) and minimized production losses (Namjoshi & Rawat, 2022). Research by Lim et al., (2014) highlights that automated control systems in rice mills help regulate milling pressure, moisture levels and storage conditions resulting in a more consistent final product. In addition, advanced monitoring technologies such as IoT-enabled grain storage systems have been introduced to prevent spoilage and contamination ensuring better inventory management (Sishodia et al., 2020). Despite the potential benefits, the implementation of smart manufacturing in food processing industries requires significant investment in infrastructure, training and technological expertise. Studies have pointed out that the transition to smart manufacturing can be challenging for traditional rice mill operators due to the high cost of automation (Othman & Zaidi, 2021) and the need for specialized knowledge (Sishodia et al., 2020). Therefore, understanding how these technologies are being adopted and their impact on regional development is essential for guiding future policy decisions.

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Smart Manufacturing in Rice Processing

The rice processing industry has traditionally relied on labour-intensive methods with many mills still using conventional equipment that requires manual intervention. However, with the increasing global demand for high-quality rice and the need for more efficient production processes, the industry has begun adopting smart manufacturing solutions. Smart rice processing involves the use of automation, robotics and real-time data analytics to enhance every stage (Fauzi Ahmad et al., 2022; Litvinova, 2021) of the supply chain, from harvesting to milling, packaging and distribution. One of the most significant technological advancements in rice processing is the introduction of AI-driven sorting machines which use high-resolution imaging and machine learning algorithms to detect and remove defective grains (Namjoshi & Rawat, 2022; Younas et al., 2019). This ensures a higher quality final product while reducing waste. Additionally, automated milling systems have replaced traditional manual mills leading to higher efficiency, consistent grain size and better yield. Research by Kim et al. (2020) highlights that IoT-enabled moisture control systems in rice storage facilities help maintain optimal storage conditions preventing fungal contamination and spoilage.

The case of BERNAS which is Malaysia's leading rice industry demonstrates how smart manufacturing is reshaping the local rice processing sector. In its processing facilities, including the one in Paya Keladi, Pulau Pinang, BERNAS has integrated automated monitoring systems and AI-driven quality control mechanisms. These innovations have allowed BERNAS to reduce labor dependency, improve processing speed and ensure that rice produced meets the highest quality standards. However, the adoption of smart manufacturing in rice processing is not without its challenges. Several studies have pointed out that small and medium-sized rice mill operators often face difficulties in transitioning to automation due to financial constraints and lack of technical expertise (Othman & Zaidi, 2021; Rauch et al., 2019; Won & Park, 2020). Resistance to change among traditional mill workers, concerns over job displacement and issues related to data security also present obstacles to widespread adoption (Klerkx et al., 2019).

Comparatively, countries such as Thailand, Vietnam and Indonesia have also integrated smart technologies into their rice processing sectors although the scale and sophistication vary. For example, in Thailand, automated sorting and moisture monitoring systems are increasingly used to ensure consistent quality. Vietnam has implemented blockchain-based traceability systems for rice exports, enhancing transparency and trust. Indonesia, meanwhile is promoting the use of IoT in its agricultural sector to optimize production in rural areas. These cases highlight regional momentum toward digital transformation in rice processing, providing useful benchmarks to assess Malaysia's progress and contextualize the case of BERNAS in Paya Keladi.

Smart Manufacturing and Regional Development

Smart manufacturing is not only transforming industries but also reshaping regional economies. As industrial modernization progresses it brings about several positive changes including increased productivity (Younas et al., 2019), job opportunities (Kaur et al., 2020) and improved income distribution (Böhm et al., 2023; Olivares-Aguila et al., 2022). In the context of regional development, the adoption of smart technologies has been found to stimulate local economies by attracting investment, enhancing supply chain efficiency and fostering collaboration between industries and research institutions. For regions like Paya Keladi, Pulau Pinang where rice processing is a key economic activity, the implementation of smart manufacturing has had significant socio-economic implications. Studies have shown that automation in agriculture and food processing industries leads to the creation of high-skilled job opportunities particularly in

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areas such as AI programming, robotics maintenance and data analysis (Schultz-Wild & Köhler, 1985; Vrchota et al., 2020). However, these advancements also pose challenges as low-skilled workers may face job displacement unless reskilling initiatives are implemented (Olivares-Aguila et al., 2022). Additionally, the adoption of smart manufacturing in Paya Keladi has strengthened local business networks particularly for SMEs that provide machinery, logistics and technical support services to the rice processing sector (Zambon et al., 2019).

Challenges and Opportunities of Smart Manufacturing in Regional Development

The adoption of smart manufacturing in BERNAS Paya Keladi presents both challenges and opportunities for regional development. As the rice industry integrates automation, IoT and AI-driven systems, various obstacles must be addressed to fully realize the benefits of industrial digitalization. One of the primary challenges is the high initial investment cost (Dadpour et al., 2019) as upgrading traditional rice mills requires substantial financial resources. Many small and medium-sized enterprises (SMEs) struggle to secure funding for smart manufacturing adoption in which limiting their ability to remain competitive in the evolving industry (Jun et al., 2017; Matt et al., 2020; Zambon et al., 2019). Another key issue is the skills gap within the workforce. The shift towards automation demands technical expertise particularly in operating and maintaining AI-driven machinery and IoT-based monitoring systems. However, many traditional rice mill workers lack the necessary digital skills (Klerkx et al., 2019), increasing the risk of job displacement. Although reskilling programs have been introduced, their effectiveness in preparing workers for the transition remains uncertain. Additionally, infrastructure limitations in rural areas such as Paya Keladi pose a significant challenge. Reliable internet connectivity and stable digital infrastructure are essential for smart manufacturing, yet many industrial zones in rural Malaysia face technological constraints that hinder efficient implementation.

Despite these challenges, smart manufacturing presents significant opportunities for regional development. Automation and digitalization enhance productivity, efficiency and rice quality, enabling BERNAS to meet increasing market demands with reduced waste and operational costs. The adoption of smart technology also creates new job opportunities in specialized fields such as data analytics, robotics engineering and system maintenance, encouraging workforce upskilling and career advancement (Olivares-Aguila et al., 2022; Sulaiman et al., 2022). Moreover, smart manufacturing can attract investments and strengthen supply chains positioning BERNAS as a competitive company in the global rice industry. With advanced traceability and quality control mechanisms, BERNAS can enhance its market presence while fostering regional economic growth. Furthermore, the integration of smart technology supports sustainability and eco-friendly practices. IoT-based monitoring systems optimize resource usage, reducing energy consumption and environmental waste. As sustainable practices become increasingly important in the global food supply chain, BERNAS's commitment to smart manufacturing can enhance its reputation and encourage wider adoption of green initiatives in the industry.

In conclusion, while the transition to smart manufacturing in BERNAS Paya Keladi presents several challenges, including financial constraints, workforce readiness and infrastructural limitations, the long-term benefits for regional development are substantial. By addressing these barriers through policy support, investment in digital infrastructure and comprehensive training programs, BERNAS can leverage smart manufacturing to drive economic growth, enhance industry competitiveness, and promote sustainable development in the region.

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Theoretical Framework
This study is informed by the Growth Pole Theory which posits that economic development is not uniform over space but instead takes place around specific nodes or 'poles' where innovation and investment are concentrated. In this context, BERNAS Paya Keladi functions as a regional growth pole that drives development through the diffusion of smart manufacturing practices and the stimulation of supporting industries and services in the surrounding rural area.

Research Gap
Although smart manufacturing has been extensively studied in terms of technological advancements and productivity, there is a notable lack of empirical case studies focusing on rural Malaysia. Current literature primarily emphasizes urban industrial zones often overlooking the distinct infrastructural, social and economic dynamics of rural areas. Specifically, regions like Paya Keladi, which are agriculture-dependent, remain underexplored in terms of how smart manufacturing contributes to regional development. This study seeks to fill this gap by offering insights from a real-world, rural case in Malaysia that integrates smart technologies in rice production.

Research Methods
This study employs a qualitative method to gather insights from informants regarding how smart manufacturing in BERNAS can enhance regional development. The study was conducted on 10 BERNAS employees using purposive sampling, targeting individuals with relevant knowledge and experience in smart manufacturing implementation as detailed in Table 1.

This study utilizes a qualitative approach where data collection and interpretation are conducted comprehensively before being analysed to derive conclusions. The qualitative method allows researchers to conduct an in-depth and detailed investigation of the development of an event, situation or individual over a period of time. It focuses on the researcher's understanding of social reality in greater depth concerning the subject under study. Ethical considerations were carefully addressed in this study. All participants provided informed consent prior to interviews and anonymity and confidentiality were assured throughout the research process. No personal identifiers were recorded and the study was conducted in accordance with academic ethical standards under Universiti Sains Malaysia's research guidelines. Given the nature of the qualitative method, it is highly suitable for this study which aims to obtain detailed data and information to gain a deeper understanding of the contributions of smart manufacturing in BERNAS to the regional development of Paya Keladi, Pulau Pinang.

Table 1: List of Informants

Informant Code	Position	Work Experience
R1	Head of Operations Department BERNAS	23
R2	Operations Officer BERNAS	17
R3	Head of Operations at BERNAS Paya Keladi Factory	29
R4	Employee of BERNAS Paya Keladi Factory	9
R5	Employee of BERNAS Paya Keladi Factory	11
R6	Employee of BERNAS Paya Keladi Factory	4
R7	Employee of BERNAS Paya Keladi Factory	6
R8	Employee of BERNAS Paya Keladi Factory	2
R9	Employee of BERNAS Paya Keladi Factory	6
R10	Employee of BERNAS Paya Keladi Factory	8

Source: Field Study

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Ten informants were interviewed using semi-structured interviews which provided flexibility in exploring their perspectives while ensuring that key topics related to the study were covered. Semi-structured interviews allow for open-ended responses enabling informants to express their views and experiences in greater detail. This method is particularly useful in qualitative research as it facilitates a deeper understanding of the subject matter. After interviewing all ten informants, data saturation was achieved meaning that no new significant information emerged from additional interviews. Data saturation indicates that sufficient information has been collected to answer the research questions comprehensively. At this stage, the collected data were considered rich and meaningful, allowing for an in-depth analysis. The data obtained were then systematically analysed using thematic analysis, a widely used qualitative research method that focuses on identifying patterns and themes within the dataset.

This study employs thematic analysis to achieve its research objectives. Thematic analysis aims to identify themes from the data collected from informants (Dwi Kristanto & Sri Padmi, 2020; Maguire & Delahunt, 2017). According to scholars (Braun & Clarke, 2021; Byrne, 2022; Clarke & Braun, 2017; Dwi Kristanto & Sri Padmi, 2020; Maguire & Delahunt, 2017; Scharp & Sanders, 2019), thematic analysis is an approach used to analyse data by identifying recurring themes and patterns within the collected data. This method enables researchers to systematically organize and interpret qualitative data in a way that highlights key insights relevant to the study. Thematic analysis provides flexibility in identifying themes that emerge naturally from the data while allowing researchers to explore participants' perspectives in depth. It is particularly useful in qualitative research as it helps uncover implicit meanings, underlying assumptions and contextual influences within the data. Additionally, thematic analysis supports a rigorous and structured approach to data interpretation, ensuring that findings are well-grounded in the evidence collected. This approach allows researchers to gain a richer understanding of the phenomenon being studied, making it an effective method for investigating the contributions of smart manufacturing in BERNAS to regional development.

The BERNAS factory in Paya Keladi, Pulau Pinang, is a highly suitable site for this research due to its strategic role in Malaysia's rice industry, its adoption of smart manufacturing practices and its impact on regional development. As one of BERNAS's key rice processing facilities, this factory plays a crucial role in maintaining food security and ensuring a stable rice supply chain. Its integration of modern agricultural and manufacturing technologies makes it an ideal location to examine how smart manufacturing contributes to efficiency and productivity in the industry. The factory has incorporated various smart manufacturing technologies such as automated sorting systems, digital monitoring tools and data-driven quality control mechanisms. These innovations are central to understanding the extent to which technological advancements enhance operational performance and improve overall manufacturing efficiency. The research conducted in this setting provides an opportunity to assess how these technologies influence daily operations and the broader supply chain.

Beyond its technological aspects, the factory is also a significant contributor to regional economic development. It provides employment opportunities for the local community and plays a role in supporting small-scale farmers by ensuring a stable market for their produce. The introduction of smart manufacturing not only improves efficiency within the factory but also has a ripple effect on the local economy, strengthening the agricultural sector and fostering economic growth in the surrounding region. By examining how technological advancements influence these dynamics, this research can provide valuable insights into the socio-economic benefits of smart manufacturing. Additionally, studying the workforce's adaptation to

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technological change is a crucial aspect of this research. The successful implementation of smart manufacturing relies on workers' ability to adapt to new systems and processes. Investigating their readiness to embrace automation and digitalization allows for a deeper understanding of the challenges and opportunities they face. This research can help identify the necessary training and skill development programs needed to ensure that workers remain relevant and competent in an evolving industrial landscape.

Given these factors, the BERNAS factory in Paya Keladi serves as an ideal case study for examining the impact of smart manufacturing on regional development. The insights gained from this research will contribute to a better understanding of how technology is transforming the rice production industry and how it influences both economic growth and workforce preparedness.

Findings and discussions

Thematic analysis revealed several key themes including workforce upskilling, automation benefits, supply chain efficiency and technological adaptation. For instance, multiple informants highlighted the need for continuous training to manage AI-based machinery, while others emphasized reduced human error and faster production cycles as primary benefits of automation. These themes underscore the transformative impact of smart manufacturing on both operations and personnel.

Impact of Smart Manufacturing on Economic Growth and Employment Patterns in Paya Keladi

The adoption of smart manufacturing in BERNAS Paya Keladi has brought significant changes to the region, particularly in terms of economic growth and employment patterns. From an economic perspective, the introduction of automation and data-driven processes has increased production efficiency allowing for higher rice output while reducing operational costs. This enhanced productivity has strengthened BERNAS' market competitiveness, attracting more investments and fostering economic growth in Paya Keladi. Additionally, the optimization of resources through smart technology has resulted in cost savings and better profit margins to further boosting economic performance. In terms of employment, smart manufacturing has led to a shift in workforce demand. While the reliance on low-skilled labor has decreased due to automation, new job opportunities have emerged in areas such as machine maintenance, data analytics and process optimization. To accommodate these changes, workers have been provided with reskilling and upskilling programs in which enabling them to adapt to the technological advancements in smart manufacturing. Consequently, there is now a transition towards a more knowledge-based workforce where technical and digital skills are increasingly emphasized.

Contribution of Smart Manufacturing in BERNAS to Regional Development

The integration of smart manufacturing in BERNAS Paya Keladi has played a vital role in the regional development of the area. Firstly, the need for advanced technological facilities has contributed to infrastructure development particularly in logistics, supply chain networks and energy efficiency systems. BERNAS' collaboration with local authorities has also resulted in improved transportation and storage facilities also benefiting not only the rice industry but also other agricultural sectors in the region. Secondly, smart manufacturing has positively impacted local communities and the socioeconomic landscape. The rise of technologically advanced production processes has created economic spill over effects, stimulating local businesses that provide services and supplies to the industry. Additionally, BERNAS has fostered partnerships

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with educational institutions, supporting research and innovation in smart agriculture. These collaborations have helped bridge the gap between academic knowledge and industrial applications further strengthening regional development. The economic prosperity generated by smart manufacturing has also contributed to an improved standard of living among workers and local communities. Thirdly, smart manufacturing has promoted sustainability and environmental conservation. Through the implementation of precision farming techniques and automated monitoring systems, resource utilization has become more efficient. This has resulted in reduced waste, optimized water and energy consumption and a lower overall environmental impact. Such initiatives align with sustainable development goals and ensure that economic growth does not come at the expense of environmental degradation. Lastly, the introduction of smart technology has facilitated knowledge transfer and technological innovation in the region. BERNAS has played a key role in exposing local stakeholders, including farmers and entrepreneurs, to modern agricultural techniques and digital solutions. This exposure has encouraged the adoption of innovative practices beyond BERNAS, fostering a more technologically advanced and resilient agricultural ecosystem.

The findings suggest that smart manufacturing in BERNAS Paya Keladi has been instrumental in transforming the regional economy, driving both economic expansion and workforce evolution. Although automation has led to a decline in traditional low-skilled jobs, this has been counterbalanced by the emergence of higher-skilled positions that require technical expertise. Workforce training programs have been crucial in ensuring a smooth transition allowing workers to adapt to the evolving industrial landscape. Furthermore, the impact of smart manufacturing extends beyond economic gains as it also contributes to infrastructure development, community growth, environmental sustainability and technological innovation. The integration of these elements has strengthened Paya Keladi's position as a hub for modern rice production while simultaneously promoting long-term regional development. As the industry continues to evolve maintaining a balance between automation, workforce development and sustainability will be essential in ensuring that the benefits of smart manufacturing are maximized for both BERNAS and the wider community.

Study's Implication

This study highlights the significant impact of smart manufacturing on industries, policymakers and local communities. The implementation of smart technology in BERNAS Paya Keladi has improved productivity and efficiency, demonstrating its potential for broader adoption in the agricultural and food sectors. However, businesses must ensure that workers receive proper training to operate new technologies reducing job displacement while enhancing workforce capabilities. From a policy perspective, the government should support automation while ensuring workforce readiness. Providing incentives for smart technology investments and funding skill development programs will help industries and workers transition smoothly. Infrastructure improvements such as better digital connectivity and transportation are also essential for the successful implementation of smart manufacturing especially in rural areas. Smart manufacturing also contributes to regional socioeconomic development by creating better job opportunities and improving living standards. However, rural communities need more support in developing digital skills to avoid being left behind. Collaboration between industries, local authorities and educational institutions can help workers and small businesses adapt to technological advancements. Besides economic benefits, smart manufacturing plays a role in sustainability. Automation and precision farming reduce waste, optimize energy use and improve resource management which making industries more environmentally friendly. Future initiatives should continue integrating technology with sustainable practices to ensure long-term benefits. In conclusion, while smart manufacturing offers many benefits, it must be managed carefully. Workforce training, policy support and sustainability efforts should go hand in hand with technological advancements to ensure balanced and inclusive regional development. Future research should continue exploring the long-term impact of smart manufacturing on industries and local economies.

Conclusion

This study highlights the impact of smart manufacturing on economic growth, employment and regional development. Automation in BERNAS Paya Keladi has improved productivity and efficiency but it also requires workers to develop new skills. Training programs are essential to help them adapt to technological changes. Besides economic benefits, smart manufacturing enhances infrastructure, drives innovation and supports sustainability by reducing waste and optimizing resources. Policymakers should support these advancements with incentives and workforce development programs. Overall, smart manufacturing can drive regional growth but a balanced approach is needed. Collaboration between industries, governments and educational institutions is crucial to maximize benefits while addressing challenges. Future research should explore its long-term impact on sustainable development

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