

Title: Assessing Generative AI Readiness for Sustainable Digital Transformation in SMEs-A case study of China's Dimension Stone Industry

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Summary: dimension stone industry, vital for construction and global trade, faces resource inefficiency, pollution, and technological lag. With a 2060 carbon neutrality target, generative AI offers potential for sustainable transformation through optimized processes and waste reduction. This paper assesses SME readiness in China's dimension stone industry for generative AI adoption, across technological, economic, and regulatory dimensions, highlighting SME barriers and proposing a mixed-method study to develop a tailored framework. (100 words)

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Body of Paper

Introduction

China's dimension stone industry plays a crucial role in global construction and trade, providing essential materials for infrastructure and architectural projects. However, this sector is grappling with significant challenges, including pervasive resource inefficiency, substantial environmental pollution, and a notable lag in technological adoption (Zhao, 2020). These issues are further exacerbated by China's ambitious commitment to achieving carbon neutrality by 2060 (Chen et al., 2022). In this critical context, generative artificial intelligence (AI) emerges as a transformative force, offering unprecedented opportunities for sustainable digital transformation through the optimization of processes and minimization of waste (Jaiswal & Pandey, 2024; Zhang et al., 2023). The industry's reliance on water-intensive processes and its generation of considerable dust pollution underscore the urgent need for innovative solutions. AI-driven technologies hold the promise of substantial improvements in these areas, leading to enhanced efficiency and reduced environmental impact. Nevertheless, the widespread adoption of such advanced technologies remains a formidable challenge, particularly within the dimension stone sector, which is predominantly composed of small and medium-sized enterprises (SMEs). Many of these SMEs often lack the requisite digital infrastructure, financial resources, and a sufficiently skilled workforce to effectively integrate AI (Wang et al., 2021; Rajaram & Tinguely, 2024). While government initiatives, such as the 2017 AI Development Plan and the Made in China 2025 initiative, aim to foster technological innovation and industrial upgrading, their tangible impact on traditional industries like dimension stone remains ambiguous (Zheng et al., 2021). Furthermore, existing research on AI adoption in manufacturing frequently overlooks the unique and often profound challenges encountered by SMEs in traditional sectors (Wang et al., 2023). These challenges include, but are not limited to, limited capital for technology investment, a scarcity of AI-skilled talent, inherent resistance to change within established business models, inefficient data quality and quantity for robust AI model training, and disproportionate regulatory burdens that can stifle innovation in smaller firms (Moilanen & Laatikainen, 2023; Dumbach et al., 2021). This paper addresses these critical gaps by examining the dimension stone industry's readiness for AI adoption. Specifically, it seeks to answer key questions: What are the primary factors influencing AI adoption in this traditional manufacturing context? How can generative AI specifically contribute to sustainability goals within the industry? And what strategic steps can facilitate this transformative journey? Employing a mixed-method approach, encompassing comprehensive literature reviews, expert interviews, and targeted surveys, this study aims to develop a practical and tailored framework to guide the sustainable digital transformation of China's dimension stone SMEs.

Literature Review

Generative AI in Manufacturing

Generative AI (GenAI) is rapidly reshaping the manufacturing landscape, moving beyond

traditional automation to enable unprecedented levels of innovation and efficiency. Its capabilities extend across various stages of the product lifecycle, from design and simulation to production optimization and quality control (Gao et al., 2024). Studies in high-tech sectors have demonstrated significant inefficiency gains, with some reporting improvements of up to 45% through the strategic application of GenAI (Wang et al., 2023). Predictive maintenance, powered by AI algorithms that analyze sensor data to anticipate equipment failures, has also proven instrumental in reducing waste and downtime across industries (Mo et al., 2023). However, the specific application of GenAI within the dimension stone industry, a sector characterized by its unique material properties and traditional processes, remain largely unexplored.

GenAI's capacity to enhance design and optimize workflows is particularly relevant for industries seeking to improve resource utilization and reduce environmental impact. In design, generative algorithms can explore vast solution spaces, creating novel product geometries and material compositions that are optimized for performance, manufacturability, and sustainability (Abdallah et al., 2019). For instance, in the broader construction and materials sector, GenAI can generate designs for lighter, stronger, and more material-efficient components, leading to reduced raw material consumption and lower embodied energy. This capability is not limited to product design; it extends to process design, where AI can simulate and optimize manufacturing workflows to minimize energy consumption, reduce scrap rates, and improve overall throughput.

In the context of the dimension stone industry, GenAI offers several promising avenues for process optimization and waste minimization. One critical area is the optimization of cutting techniques. Traditional stone cutting often results in significant material waste due to inefficient path planning. GenAI, particularly through techniques like reinforcement learning, can analyze stone block characteristics (e.g., size, shape, internal flaws) and desired product dimensions to generate optimal cutting paths that maximize yield and minimize waste (Wang et al., 2024; Abu Hanieh et al., 2024; Bai et al., 2016). This not only conserves valuable natural resources but also reduces the energy expended in processing excess material and managing waste. For example, in the marble industry, AI-based systems are being developed to analyze marble blocks for quality assessment and to optimize cutting plans, leading to more sustainable production (Özkaynak et al., 2024).

Beyond cutting, GenAI can contribute to waste reduction through predictive quality control and process parameter optimization. By analyzing real-time production data, AI models can identify deviations that might lead to defects, allowing for proactive adjustments and preventing the production of substandard products that would otherwise become waste. Furthermore, GenAI can optimize machine parameters (e.g., cutting speed, pressure, water flow) to enhance efficiency and reduce energy consumption during processing. This level of precision and adaptability is crucial for an industry that has historically relied on empirical methods and manual adjustments.

Successful integration of GenAI, however, necessitates a certain level of digital maturity within an organization. Many stone-processing businesses, particularly SMEs, currently face significant challenges in this regard, lacking the foundational digital infrastructure, data management capabilities, and skilled personnel required to harness the full potential of AI (Cremonini, 2023; Moilanen & Laatikainen, 2023). This digital divide represents a critical barrier to AI adoption and sustainable transformation within the sector.

Sustainability and Digital Transformation

The escalating global demand for sustainable practices has placed increasing pressure on resource-intensive industries, including the dimension stone sector. The building materials industry has been urged to adopt greener technologies and more sustainable production methods to mitigate its environmental footprint (Chen et al., 2022). Digital transformation, encompassing the integration of digital technologies into all areas of a business, has demonstrated promising results in driving sustainability initiatives across various sectors (Yu & Liu, 2024; Sun et al., 2025).

The principles of the circular economy, which advocate for minimizing waste and maximizing resource utility through design, reuse, and recycling, are intrinsically linked with sustainable digital transformation (Ford & Despeisse, 2016; Careddu, 2019). Generative AI can play a pivotal role in supporting circularity in stone processing by enabling the design of products that are easier to disassemble and recycle, optimizing material flows to reduce waste generation, and facilitating the recovery and reuse of by-products (Lodhi & Zeb, 2025; Oladapo et al., 2024). For instance, AI can analyze waste streams to identify valuable components for repurposing or guide the development of new materials from stone waste (Gomes et al., 2022; Linde et al., 2024).

Furthermore, GenAI contributes to waste and emissions reduction through sophisticated modeling and optimization capabilities. By simulating various production scenarios, GenAI can identify the most energy-efficient processes, predict and prevent material defects, and optimize logistics to reduce transportation-related emissions (Tseng & Lin, 2024; Akter et al., 2024). For example, in other industries, AI-driven production models have achieved substantial waste reductions (e.g., 30%) and emissions cuts (e.g., 25%) by optimizing resource allocation and process parameters (Zhang et al., 2023). These mechanisms directly translate to the dimension stone industry, where AI can optimize quarrying operations to minimize geological waste, improve cutting precision to reduce offcuts, and manage water and energy consumption more effectively.

Despite the clear potential, the effectiveness of national policies, such as China's Made in China 2025 initiative, in reaching and transforming SMEs within traditional industries remains a subject of debate (Feng, 2023; Surindra et al., 2024). While these policies aim to promote advanced manufacturing and digital upgrading, SMEs often face significant hurdles in accessing and implementing the necessary technologies. Moreover, despite global sustainability efforts and technological advancements, infrastructure limitations, particularly in less developed regions, continue to hinder progress in adopting sustainable practices and digital technologies (Market Research Intellect, 2023). This highlights the need for tailored approaches that consider the specific context and challenges of SMEs in traditional sectors.

Dimension Stone Industry Context

China stands as the world's leading producer of dimension stone, a position that underscores its economic significance but also highlights the industry's inherent inefficiency and environmental burdens. The sector is plagued by excessive water consumption, significant dust pollution, and considerable material waste, making it a focal point for environmental concern (Zhao, 2020). A substantial portion of the industry is dominated by SMEs, particularly in provinces like Fujian and

Shandong. These enterprises often rely on outdated production methods, a direct consequence of their limited digital infrastructure and a chronic shortage of skilled labor (Wang et al., 2021).

While the potential for AI to optimize specific processes, such as cutting techniques, has been acknowledged (Yang & Zhou, 2022; Abu Hanieh et al., 2024), the economic instability and the high initial investment costs associated with new technologies often discourage SMEs from adopting such innovations. Research from other regions, such as Portugal's ornamental stone sector, suggests that digital twins and AI applications can significantly benefit the industry by improving efficiency and sustainability (Cremonini, 2023; da Silva & Cardoso, 2024). However, the feasibility and successful implementation of these advanced technologies in the Chinese context, particularly within its fragmented SME landscape, remain uncertain.

SMEs in the dimension stone industry face a unique set of challenges that often go unaddressed in broader discussions of AI adoption in manufacturing (Wang et al., 2023). These challenges are multifaceted and deeply rooted in the operational realities of smaller enterprises within a traditional sector - Limited Capital for Investment: SMEs typically operate with tighter budgets, making the substantial upfront investment required for AI infrastructure, software, and specialized machinery a significant barrier (Rajaram & Tinguely, 2024). Unlike larger corporations, they may not have access to extensive capital markets or internal funding for large-scale technological overhauls.

Scarcity of AI-Skilled Talent: The highly specialized nature of AI development and deployment demands a workforce with advanced skills in data science, machine learning, and AI engineering. SMEs often struggle to attract and retain such talent due to competitive salaries offered by larger tech firms and a general lack of awareness or perceived need for these roles within traditional industries (Moilanen & Laatikainen, 2023).

Resistance to Change and Traditional Business Models: Many SMEs in the dimension stone industry have long-established operational practices and a conservative business culture. There can be a strong resistance to adopting new technologies, driven by a fear of disruption, a lack of understanding of AI's benefits, or a preference for familiar, albeit less efficient, methods (Dumbach et al., 2021). Entrepreneurial resilience, while crucial, needs to be fostered to overcome such inertia (Shore et al., 2024).

Insufficient Data Quality and Quantity: Effective AI models are data-hungry. SMEs often lack the sophisticated data collection systems, standardized data formats, and the sheer volume of high-quality, clean data necessary to train and deploy robust AI algorithms. Their data might be fragmented, inconsistent, or simply insufficient for meaningful AI analysis (Maganga & Taifa, 2023).

Disproportionate Regulatory Burdens: While government policies aim to promote innovation, regulatory compliance costs and bureaucratic hurdles can disproportionately affect smaller firms. Navigating complex regulations related to data privacy, intellectual property, and environmental standards can be resource-intensive for SMEs, diverting attention and funds away from AI adoption (Xia et al., 2019).

These unique challenges highlight why a generic approach to AI adoption, often tailored for large, digitally mature enterprises, is inadequate for the dimension stone industry's SMEs. A tailored framework, as proposed by this study, is essential to address these specific hurdles and facilitate a

truly sustainable digital transformation (Martínez-Peláez et al., 2024).

Generative AI for Sustainability

Generative AI holds immense promise for advancing sustainability goals, particularly in resource-intensive industries like dimension stone processing. Its ability to analyze complex data, identify patterns, and generate optimized solutions makes it a powerful tool for reducing waste, minimizing emissions, and fostering circular economy principles (Jaiswal & Pandey, 2024; Lodhi & Zeb, 2025). The mechanisms by which generative AI can significantly reduce waste and emissions are multifaceted:

Optimized Resource Utilization: GenAI algorithms can analyze raw material characteristics (e.g., stone block dimensions, internal defects) and production requirements to generate optimal cutting patterns, thereby maximizing material yield and minimizing offcuts and waste (Wang et al., 2024; Abu Hanieh et al., 2024). This precision reduces the amount of raw material needed and the volume of waste generated, leading to lower energy consumption associated with processing and waste disposal. For instance, in the context of granite cutting, AI-driven selection of sustainable technologies can significantly improve efficiency and reduce waste (Bai et al., 2016).

Predictive Maintenance and Anomaly Detection: By continuously monitoring machinery and production lines, GenAI can predict equipment failures before they occur, enabling proactive maintenance. This reduces downtime, prevents costly breakdowns, and minimizes waste from defective products caused by malfunctioning equipment (Mo et al., 2023). Furthermore, AI can detect anomalies in production processes that indicate potential inefficiency or material waste, allowing for immediate corrective action.

Energy Efficiency Optimization: GenAI can analyze energy consumption patterns across the production process and identify opportunities for optimization. This includes fine-tuning machine operating parameters, optimizing production schedules to leverage off-peak energy rates, and even designing more energy-efficient machinery components (Tseng & Lin, 2024).

Emissions Reduction: By optimizing processes for energy efficiency and reducing material waste, GenAI indirectly contributes to lower greenhouse gas emissions. Furthermore, AI can be used to model and predict emissions from various stages of production, allowing for targeted interventions to reduce the carbon footprint (Akter et al., 2024). For example, AI-driven solutions can help firms reduce carbon costs by optimizing operational efficiency (Tseng & Lin, 2024).

Beyond waste and emissions reduction, GenAI actively supports circularity in stone processing by facilitating the transition from a linear to a circular economy model. This involves:

Design for Circularity: GenAI can assist in designing stone products with their end-of-life in mind, making them easier to disassemble, repair, or recycle. This includes optimizing material combinations and structural designs to facilitate material recovery (Abdallah et al., 2019).

Waste Valorization: AI can analyze stone waste streams to identify potential for reuse or conversion into new products, such as artificial stone (Gomes et al., 2022). It can also optimize the sorting and processing of waste materials, making recycling more efficient and economically viable (Linde et al., 2024).

Resource Tracking and Management: GenAI can enable more precise tracking of materials

throughout the supply chain, from quarry to end-of-life, facilitating better resource management and promoting closed-loop systems (Oladapo et al., 2024). This supports the broader principles of the circular economy in the dimension stone industry (Careddu, 2019).

Despite these significant potentials, SMEs face considerable challenges in data collection and integration, which are fundamental prerequisites for effective AI adoption. The lack of standardized data formats, fragmented data sources, and insufficient data quality make it complex for SMEs to implement and leverage AI solutions for sustainability (Moilanen & Laatikainen, 2023). This underscores the need for practical frameworks that guide SMEs through these initial hurdles.

Policy Ecosystem

China's government has proactively implemented various policies aimed at fostering technological advancements and promoting industrial upgrading, particularly in the realm of artificial intelligence. Initiatives such as the 2017 AI Development Plan and the Made in China 2025 strategy underscore a national commitment to becoming a global leader in AI innovation (Zheng et al., 2021). These policies often include provisions for research and development funding, tax incentives, and the establishment of AI pilot zones, all designed to accelerate the adoption of advanced technologies across industries. However, despite these supportive policy frameworks, the practical impact on SMEs, especially those operating in traditional sectors like the dimension stone industry, remains uneven. A significant barrier for these smaller firms is the burden of regulatory compliance costs (Xia et al., 2019). While larger enterprises may have dedicated departments and resources to navigate complex regulatory landscapes, SMEs often find themselves overwhelmed by the administrative and financial demands of adhering to new standards and reporting requirements. This disproportionate burden can divert crucial resources away from technology adoption and innovation. Similar challenges are observed globally, where small firms frequently struggle to effectively integrate AI into their operations (Moilanen & Laatikainen, 2023). This is often due to a combination of factors, including limited access to information about available support programs, a lack of understanding regarding the benefits of AI, and the perceived complexity of implementation. Furthermore, regional disparities in policy implementation and enforcement can create an uneven playing field, with some SMEs benefiting more from local government support than others (Wu et al., 2024).

Strengthening supply chain resilience through AI-driven transformation could significantly boost exports and overall economic stability for SMEs (Wu et al., 2024). However, for this to materialize, policies need to be more finely tuned to the specific needs and constraints of SMEs. This includes simplifying regulatory processes, providing targeted financial incentives for AI adoption, and developing accessible training programs to upskill the workforce. The current policy ecosystem, while generally supportive of AI development, needs to address these granular challenges to ensure that the benefits of digital transformation are equitably distributed across all firm sizes and traditional industries.

Readiness Assessment

Assessing an organization's readiness for AI adoption is a critical precursor to successful

implementation. This readiness is typically contingent upon several interconnected factors, including technological infrastructure, data availability and quality, human capital (skills and culture), and the regulatory environment (Castelo- Branco et al., 2019; Yang et al., 2021). While existing Industry 4.0 frameworks have provided a foundational understanding for assessing technological readiness, their direct applicability to traditional industries, particularly those dominated by SMEs, is often limited. These frameworks frequently assume a baseline level of digital maturity that many traditional manufacturing SMEs have yet to achieve, necessitating the development of more tailored approaches (Deloitte, 2025).

High-quality data is paramount for effective AI implementation, serving as the lifeblood for training robust AI models and deriving meaningful insights (Maganga & Taifa, 2023). For SMEs in the dimension stone industry, challenges related to data collection, standardization, and integration can significantly impede their AI readiness. Many operate with legacy systems or manual processes, resulting in fragmented, inconsistent, or insufficient data for AI applications. Furthermore, the lack of data governance strategies and skilled personnel to manage and analyze data exacerbates this issue.

Beyond technological and data considerations, human factors play a crucial role. The availability of a skilled workforce capable of developing, deploying, and maintaining AI systems is a significant determinant of readiness. This includes not only technical experts but also employees who are adaptable, open to new technologies, and possess a basic understanding of AI's potential and limitations. Organizational culture, including leadership's commitment to digital transformation and employees' willingness to embrace change, also profoundly impacts the success of AI adoption (Dumbach et al., 2021).

Regulatory frameworks and policy support, as discussed previously, also shape the readiness landscape. While supportive policies can incentivize AI adoption, overly complex or burdensome regulations can deter SMEs. Therefore, a comprehensive readiness assessment must consider the interplay of these diverse factors, recognizing that a one-size-fits-all approach is unlikely to succeed in the heterogeneous landscape of traditional manufacturing SMEs.

Research Gaps

Despite the growing body of literature on AI applications in manufacturing and sustainability, several critical research gaps persist, particularly concerning the specific needs and contexts of traditional industries like dimension stone. Existing studies often adopt a high-level perspective, assuming a degree of digital maturity that is not representative of the reality for many SMEs (Deloitte, 2025). This oversight leads to a disconnect between theoretical models and practical implementation challenges. The unique confluence of factors affecting SMEs in this sector—including limited capital, skill shortages, cultural resistance, data deficiencies, and regulatory burdens is frequently overlooked in mainstream AI adoption research (Wang et al., 2023; Rajaram & Tinguely, 2024). These gaps underscore the urgent necessity of this study, which aims to develop a nuanced understanding of AI readiness within China's traditional manufacturing sector, using the dimension stone industry as a critical case study.

To provide a structured overview of the current state of research and the identified gaps, the

following table synthesizes the key findings from the literature review. This table highlights the disconnect between the general potential of generative AI and the specific, unaddressed challenges within the dimension stone industry, thereby reinforcing the rationale for this research.

Table 1: Synthesis of Literature Review on Generative AI Adoption for Sustainability

Aspect	Key Findings from Literature	Gaps Identified for the Dimension Stone Industry
Generative AI Applications	Demonstrates significant efficiency gains in design, process optimization (e.g., cutting paths), and waste reduction in various manufacturing sectors (Gao et al., 2024).	Limited sector-specific studies and concrete examples of GenAI application in stone processing; lack of empirical evidence on feasibility for SMEs.
Sustainability Benefits	Proven potential for energy savings, emissions reduction, and enhanced resource efficiency through AI-driven optimization and circular economy models (Lodhi & Zeb, 2025).	Lack of empirical evidence and specific mechanisms detailing how GenAI can achieve these benefits in the unique context of traditional stone processing.
China's Stone Industry	Characterized by high resource consumption, significant pollution, SME dominance, and low levels of technological adoption (Zhao, 2020).	Few AI-focused readiness assessments; insufficient understanding of the specific, multifaceted challenges (financial, skills, cultural) faced by SMEs.
Policy and Ecosystem	Supportive national AI policies and pilot zones exist, but regulatory costs and implementation hurdles often hinder SME adoption (Zheng et al., 2021; Xia et al., 2019).	Uneven readiness across regions and firm sizes; policies are often not tailored to the specific needs and constraints of traditional industry SMEs.
Readiness Frameworks	Existing frameworks emphasize data, infrastructure, skills, and compliance as key factors, but are often generic (Castelo-Branco et al., 2019).	Generic models may overlook or misrepresent industry-specific nuances and the unique barriers faced by SMEs in the dimension stone sector.

Research Methodology

This study employs a mixed-method approach, integrating both qualitative and quantitative research strategies, to enhance the reliability and validity of its findings. This comprehensive methodology ensures a nuanced and robust assessment of AI readiness within China's dimension stone industry [Bryman, 2008]. The research design is structured into two distinct phases:

Phase One: Literature Review and Conceptual Framework Development. This initial phase involves an extensive and systematic review of existing literature on generative AI, sustainable digital transformation, SME challenges, and the dimension stone industry. The primary objective is to identify key factors influencing AI adoption and to synthesize these insights into a preliminary conceptual framework that will guide subsequent empirical investigations.

Phase Two: Empirical Data Collection and Framework Refinement. This phase is further divided into two stages:

Stage One: Expert Interviews. In-depth qualitative interviews will be conducted with key stakeholders, including industry experts, technology providers, government officials, and SME managers within the dimension stone sector. These interviews aim to refine the understanding of AI readiness factors, validate the conceptual framework developed in Phase One, and uncover specific challenges and opportunities unique to the industry. The qualitative insights gained will provide rich contextual data that quantitative methods alone cannot capture.

Stage Two: Surveys and Factor Analysis. A structured survey will be administered to a larger sample of SME firms operating in the dimension stone industry across China. The survey instrument will be designed to capture their perceptions of AI readiness, current technological capabilities, existing challenges, and attitudes towards digital transformation. Quantitative data collected from the surveys will then be subjected to rigorous statistical analysis, including factor analysis, to empirically validate and further refine the tailored framework for AI adoption. This stage will provide generalizable insights into the industry's readiness landscape.

This structured, mixed-method approach is designed to yield meaningful insights into the barriers and opportunities for generative AI adoption in China's dimension stone industry, ultimately contributing to the development of a practical and empirically grounded framework for sustainable digital transformation.

Development Plans

This developmental paper represents the initial phase of a larger research endeavor. The insights and conceptual framework derived from the comprehensive literature review will serve as the foundation for subsequent empirical investigations. The study will continue to evolve through the rigorous collection and analysis of primary data in Phase Two, as outlined in the Research Methodology section.

Specifically, the empirical data collected through expert interviews and surveys will enable a deeper examination of generative AI applications within real-world industry settings. This includes a detailed investigation into how specific AI technologies, such as cutting optimization algorithms

and process automation tools, are currently being implemented or could be implemented in the dimension stone industry. The research will focus on identifying the practical challenges and opportunities that SMEs encounter during the adoption process, providing granular insights that are often missing from broader studies.

The findings from Phase Two will be instrumental in refining the proposed framework for AI readiness, ensuring its practical applicability and relevance to the unique context of China's dimension stone SMEs. Ultimately, this ongoing study aims to make significant theoretical contributions by advancing the understanding of AI adoption in traditional manufacturing sectors and practical contributions by providing actionable recommendations for policymakers, industry associations, and individual SMEs seeking to embark on a sustainable digital transformation journey. The goal is to bridge the gap between technological potential and practical implementation, fostering a more sustainable and competitive future for SMEs in developing countries.

Conclusion

Generative AI offers a profoundly promising pathway for achieving sustainability and fostering digital transformation within traditional manufacturing industries, particularly the dimension stone sector. The capacity of GenAI to optimize processes, minimize waste, enhance design, and support circular economy principles presents a compelling vision for a more efficient and environmentally responsible future. However, the journey towards widespread adoption is fraught with significant obstacles, including persistent technological gaps, economic instabilities that deter investment, and complex regulatory barriers that disproportionately affect small and medium-sized enterprises.

This paper underscores the critical need for a strategic and nuanced approach to AI adoption, one that is specifically tailored to the unique context and challenges faced by SMEs in traditional industries. By systematically assessing AI readiness across technological, economic, and regulatory dimensions, this study aims to bridge the existing gap between ambitious policy initiatives and the practical realities of implementation on the ground. The proposed mixed-method research, encompassing comprehensive literature reviews, expert interviews, and targeted surveys, is designed to yield a robust and empirically grounded framework. This framework will not only contribute to the academic understanding of AI adoption in traditional manufacturing but also provide actionable insights for policymakers and industry stakeholders.

Ultimately, by facilitating the effective integration of generative AI, this research seeks to pave the way for a more sustainable, resilient, and competitive future for SMEs in China's dimension stone industry and, by extension, for traditional manufacturing sectors in developing countries worldwide. The successful navigation of these challenges will unlock the full potential of AI to drive green innovation and sustainable development.

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