CROSS-DOMAIN PROJECT MANAGEMENT: RESEARCH ON THE TERNARY RELATIONSHIP BETWEEN ESG PERFORMANCE, SMART MANUFACTURING AND CORPORATE VALUE

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ABSTRACT: This study seeks to investigate the combined effects of Environmental, Social, and Governance (ESG) performance and smart manufacturing on corporate value, with a specific focus on the moderating roles of digital maturity and the adoption of Artificial Intelligence (AI) and Big Data. The study aims to understand how these factors interact within China's manufacturing industry, a vital sector undergoing rapid technological advancements and regulatory changes. A quantitative research approach was adopted, employing a survey-based methodology to collect cross-sectional data from manufacturing firms in China. The survey targeted 800 corporate executives, Chief Information Officers (CIOs), and ESG officers, utilizing structured questionnaires with a 5-point Likert scale. In total, 630 valid responses were received. Data analysis was performed using SPSS, incorporating descriptive statistics, correlation analysis, and regression analysis to explore the relationships between ESG performance, smart manufacturing, digital maturity, AI/Big Data adoption, and corporate value. The results indicate a positive influence of both ESG performance and smart manufacturing on corporate value. Furthermore, digital maturity and AI/Big Data adoption were found to significantly moderate these relationships. Specifically, the interaction between ESG performance, smart manufacturing, and digital technologies contributed to enhanced corporate value, underscoring the importance of integrating technology into sustainability initiatives. This study contributes to the existing literature by exploring the combined impact of ESG and smart manufacturing on corporate value, with a unique emphasis on the moderating roles of digital maturity and AI/Big Data adoption. It offers new insights for researchers, policymakers, and practitioners seeking to enhance corporate sustainability and technological competitiveness within the manufacturing sector.

Keywords: ESG Performance, Smart Manufacturing, Corporate Value, Digital Maturity, AI and Big Data Adoption, Project Management.

1. Introduction

Sustainable practices, evolving consumer preferences, and technological innovations have transformed the manufacturing landscape. Corporate ethics and sustainability are increasingly shaped by non-financial considerations, including environmental footprint, governance structures, and social responsibility (Peng & Isa, 2020). Stakeholders such as regulators, investors, and customers are progressively evaluating companies based on their environmental and societal impacts. Consequently, firms demonstrating strong ESG (Environmental, Social, and Governance) performance are more likely to achieve a competitive advantage through enhanced brand reputation, the attraction of socially responsible investors, and long-term viability (Zheng, Khurram, & Chen, 2022).

The integration of ESG principles necessitates considerable capital investment and organisational restructuring, which may temporarily influence financial returns, operational efficiency, and overall corporate valuation. Concurrently, the advent of smart manufacturing is altering business operations. This model incorporates IoT, robotics, and AI to improve product quality, reduce operational costs, and increase output (Friederich et al., 2022). The deployment of real-time data analytics and automation enhances manufacturing speed, efficiency, and productivity. Intelligent production methodologies offer a competitive edge in an ever-evolving industrial environment (Wang et al., 2021). Integrating ESG considerations within smart manufacturing systems has demonstrated positive economic and environmental results. To address contemporary industrial challenges, it is imperative for organisations to comprehend how ESG performance and advanced manufacturing technologies collectively influence firm value (Zhang, Zhang, & Zong, 2023). Realising these benefits necessitates a robust foundation in AI, data analytics, and digital proficiency. An organisation's digital maturity significantly determines its capacity for innovation, operational performance, and strategic growth. Digitally mature entities are

better equipped to respond to market dynamics, adopt emerging technologies, and make evidence-based decisions (Kotsiopoulos et al., 2021).

Technologies such as AI and Big Data enable customisation of user experiences, streamline industrial workflows, and process extensive datasets. They also facilitate the identification of environmental risks, measurement of carbon emissions, and enhancement of supply chain transparency (Dubey et al., 2022). However, the precise influence of digital maturity, AI, and Big Data on ESG outcomes, smart manufacturing capabilities, and firm valuation remains insufficiently explored. China's manufacturing sector presents an optimal context for investigating the interplay between ESG performance and smart manufacturing in relation to business value. As the leading global industrial hub and integral component of international supply chains, China is advancing in sustainability and technological adoption. The government has implemented a range of incentives, regulatory policies, and legal frameworks to promote energy efficiency, environmental stewardship, and corporate social responsibility (Li, Yin, & Liu, 2022). To maintain global competitiveness, Chinese firms are increasingly focused on enhancing ESG performance and adopting intelligent manufacturing solutions.

Despite this, limited research has examined the combined effects of ESG initiatives, smart manufacturing, and digital technologies on firm value within China's rapidly developing industrial environment (Li et al., 2023). This study aims to bridge that gap by analysing the impact of digital maturity and the use of AI and Big Data on corporate value. The interrelationship between digital innovation, smart manufacturing systems, and ESG implementation remains under-researched. Existing literature often fails to address the complexity and synergistic effects of these elements on organisational success (Li, Zhang, & Gao, 2024a). Although various studies have explored ESG strategies and intelligent manufacturing practices, their strategic implications are still not fully delineated. Moreover, the moderating role of AI, Big Data, and digital maturity in these relationships is yet to be clarified. Kar and Kushwaha (2023) explored the influence of digital maturity on organisational performance; however, the interaction between digital maturity, ESG compliance, and smart manufacturing as contributors to firm value is yet to be fully understood. Prior research in AI and Big Data adoption has prioritised sustainability over operational efficiency and innovation (Cudia & Legaspi, 2024). This study addresses these limitations by investigating how ESG practices, intelligent manufacturing technologies, and digital innovations influence firm value. In doing so, it examines the moderating roles of AI, Big Data, and digital maturity.

Previous studies have predominantly centred on Western contexts or broad international surveys, often neglecting China's unique industrial dynamics (Khan, 2022). In response to competitive pressures, Chinese enterprises are increasingly investing in ESG and smart manufacturing initiatives. Accordingly, the nation's dynamic legal and economic landscape provides a pertinent setting for exploring how ESG frameworks, technological advancement, and digital maturity interact. The complexity of China's regulatory system and the rapid pace of technological progress necessitate a comprehensive understanding of how digital capability and advanced tools such as AI and Big Data influence ESG implementation and corporate outcomes.

While extant literature acknowledges both the opportunities and challenges presented by ESG and smart manufacturing for Chinese firms, empirical evidence linking these practices to increased firm value remains scarce. This research addresses this deficiency by focusing on Chinese manufacturing enterprises positioned at the intersection of sustainability, technological progress, and regulatory reform. Specifically, the study investigates how digital maturity and AI/Big Data affect ESG performance and smart manufacturing strategies in shaping corporate value. It aims to elucidate how these variables interact within the Chinese industrial sector, which is undergoing significant technological and policy transformations. Through this lens, the study evaluates the extent to which ESG and intelligent manufacturing can enhance the value of industrial firms. It further examines the role of digital maturity and data-driven technologies in supporting this transition and fostering strategic advancement.

This research is important for several reasons. First, it contributes to the academic discourse by exploring the integrated effects of ESG performance, smart manufacturing, and digital transformation on business valuation. Although the literature extensively covers ESG initiatives and smart manufacturing technologies, the combined impact of these components on a firm's financial and operational achievements remains ambiguous. This study proposes a unified framework to assist organisations in aligning ESG efforts with technological advancements to achieve sustainable competitive advantage. Second, by assessing the moderating influence of digital maturity and AI/Big Data, the study addresses a notable gap in existing scholarship. The effect of digital maturity on ESG performance, smart manufacturing efficiency, and firm value has not been sufficiently investigated. This research highlights how these digital elements condition the effectiveness of ESG and intelligent manufacturing strategies, enabling firms to better synchronise their sustainability objectives with technological progress. The specific focus on the Chinese manufacturing context enhances the study's relevance, given China's strategic emphasis on digitalisation, ESG compliance, and intelligent manufacturing as means to elevate industrial competitiveness. Accordingly, the findings are anticipated to offer contextual insights for Chinese manufacturers concerning regulatory adherence, sustainability ambitions, and digital integration. Furthermore, this research has potential implications for scholars, industry professionals, and policymakers seeking to comprehend the evolving nature of China's manufacturing sector within global markets.

2. Literature Review

2.1. ESG Performance and Corporate Value

ESG considerations increasingly influence corporate value due to evolving regulatory frameworks, stakeholder demands, and investor decision-making. According to Huang et al. (2023), the adoption of ESG policies enhances profitability while mitigating environmental, social, and governance-related risks. Investors are progressively recognising high ESG ratings as indicators of long-term corporate resilience. Liu et al. (2022) argue that initiatives such as the adoption of renewable energy and carbon reduction strategies can elevate firm value by reducing operational costs, enhancing efficiency, and securing regulatory incentives. Fair employment practices and transparent corporate governance structures contribute to improved financial outcomes by strengthening brand reputation, fostering customer loyalty, and enhancing risk mitigation. Superior ESG performance enhances investor confidence and reduces exposure to risk, thereby increasing corporate value in capital markets (Sun et al., 2024). The integration of ESG principles also supports sustainable development and innovation, further amplifying organisational value. Financial instruments like green bonds and socially responsible investment options are demonstrating profitability, with firms that prioritise ESG frequently benefiting from increased earnings and reduced capital expenditures (Tan & Zhu, 2022).

Proactively addressing environmental challenges and ensuring transparent governance frameworks enables companies to avert unforeseen liabilities and reputational damage, particularly during periods of economic instability. Consequently, the implementation of robust ESG practices is essential for meeting stakeholder accountability expectations, fostering competitive differentiation, and securing sustainable long-term growth (Broadstock et al., 2021). ESG performance thus serves as a strategic mechanism to align corporate objectives with broader societal interests, creating a cyclical relationship between financial performance and sustainable development. A solid ESG foundation not only enhances short-term firm value but also positions companies as frontrunners in sustainability-driven markets, where investor and consumer preferences continue to evolve (Zheng et al., 2022).

H1: There is a positive and significant relationship between ESG performance and corporate value.

2.2. Smart Manufacturing and Corporate Value

Smart manufacturing leverages technologies such as IoT, AI, big data analytics, and automation to enhance productivity, drive innovation, and improve operational efficiency, thereby elevating corporate value. By optimising production workflows, reducing waste, and lowering operational expenditures, smart manufacturing contributes directly to increased profitability. The adoption of digital manufacturing systems enhances adaptability and responsiveness to market fluctuations, meeting customer expectations more effectively and reinforcing corporate value (Wang et al., 2021). Moreover, smart manufacturing facilitates improved energy utilisation and resource management, enabling firms to comply with environmental regulations while benefiting from sustainability-related incentives (Phuyal, Bista, & Bista, 2020). These advanced technologies not only position organisations as frontrunners within their industries but also foster investor confidence through the mitigation of operational risks and the enhancement of strategic foresight. The application of smart manufacturing further supports corporate value by driving continuous innovation and strengthening the resilience of supply chains. The integration of AI and big data analytics plays a crucial role in optimising operational efficiency and reducing unplanned downtime (Oyekanlu et al., 2020).

Predictive analytics capabilities enable firms to remain agile in the face of market uncertainties, preserving their competitive advantage. Through automation and enhanced connectivity, smart manufacturing empowers firms to scale operations rapidly while maintaining

consistent product quality, a key determinant of financial success and brand equity (Suvarna et al., 2020). Furthermore, smart technologies facilitate innovation and strategic differentiation within the Industry 4.0 landscape (Mourtzis, Angelopoulos, & Panopoulos, 2021). Investments in smart manufacturing contribute to sustained financial performance and operational excellence, rendering firms more attractive to both investors and stakeholders in a technology-centric global economy.

H2: There is a positive and significant relationship between smart manufacturing and corporate value.

2.3. Digital Maturity as Moderator

Digital maturity modifies the interaction between ESG performance and corporate value by enhancing an organisation's capacity to effectively implement and capitalise on ESG initiatives. Enterprises with advanced levels of digital maturity are better equipped to generate corporate value through the continuous monitoring, evaluation, and optimisation of ESG outcomes using automation, AI, and big data analytics (Aydoğmuş, Gülay, & Ergun, 2022). These digital capabilities facilitate the accurate assessment of carbon emissions, resource optimisation, and the anticipation of environmental risks, thereby aiding firms in addressing ESG challenges, minimising costs, and reinforcing investor confidence (Choi, Jeong, & Park, 2024). Furthermore, heightened digital maturity contributes to increased market valuation and reputational capital by enabling transparent ESG communication via integrated reporting platforms. Conversely, organisations with limited digital maturity often lack the analytical insights necessary for effective ESG management, thereby weakening the linkage between ESG efforts and corporate value. Enhanced digital capabilities also augment strategic flexibility and reinforce the enduring influence of ESG performance on value creation. Digitally mature firms are capable of embedding sustainability metrics within operational and strategic planning processes, aligning ESG objectives with broader corporate strategies (Li et al., 2024b).

Digital transformation further bolsters organisational resilience, facilitates the anticipation of social and governance-related risks, and ensures that ESG initiatives translate into tangible financial outcomes (Kwilinski, Lyulyov, & Pimonenko, 2023). Enterprises proficient in digital technologies are also more responsive to evolving regulatory conditions and stakeholder demands, which contributes to improved financial results and heightened investor assurance (Broadstock et al., 2021). This digital edge enables firms to differentiate themselves, utilise resources efficiently, and sustain competitiveness. As digital maturity increases, particularly within technology-intensive and rapidly developing sectors, the discrepancy between ESG activity and actual business value diminishes, underscoring the strategic role of digital readiness in maximising both financial and societal returns from ESG initiatives.

In addition, a high level of digital maturity permits firms to apply AI, big data analytics, and IoT sensors within smart manufacturing frameworks. Real-time data acquisition enhances corporate value and profitability by enabling the detection of equipment faults, optimisation of supply chains, and acceleration of inventory processes. According to Luan et al. (2020), digital maturity strengthens financial outcomes and market positioning by equipping firms to adapt swiftly to consumer demands and market transitions. However, technological immaturity may result in disjointed or underutilised smart manufacturing systems, limiting their potential to enhance operational performance and value generation (Ju & Lee, 2020). Innovation and digital competence within supply networks offer smart manufacturing enterprises enduring strategic advantages. As digital maturity advances, firms can update and refine their smart manufacturing systems to maintain industry relevance (Mylonas et al., 2021). Automation and predictive analytics allow for the optimisation of resource utilisation, reduction of production costs, and enhancement of product quality, thereby improving competitiveness and profitability. Digital maturity also enables a comprehensive understanding of both internal operations and external market dynamics, supporting the integration of smart manufacturing initiatives with corporate strategies and ESG objectives (Bai et al., 2022). In contrast, low digital maturity may hinder operational efficiency and weaken the connection between corporate value and smart manufacturing practices. Overall, digital maturity in smart manufacturing is a catalyst for improved efficiency, increased market valuation, and enhanced sustainability.

H3: Digital maturity moderates the relationship between ESG performance and corporate value, such that higher digital maturity strengthens this relationship.

H4: Digital maturity moderates the relationship between smart manufacturing and corporate value, such that higher digital maturity strengthens this relationship.

2.4. Adoption of AI and Big Data as Moderator

AI and Big Data enhance ESG programmes by improving precision, efficiency, and value creation through real-time evaluation, monitoring, and reporting. Regona et al. (2022) highlighted that AI analytics can increase company value, reduce costs, identify environmental risks, and save energy. Big Data reveals market trends and stakeholder expectations, enabling firms to align ESG strategies with investor and consumer demands (Zheng et al., 2022). These tools foster transparency and trust but may challenge firms lacking digital capabilities (Nguyen, Sermpinis, & Stasinakis, 2023). AI and Big Data also drive innovation and resilience in ESG operations, support reputation repair, and address social and governance issues (Regona et al., 2022). They help quantify ESG's financial value, offering a competitive edge and supporting long-term success (Naeem, Cankaya, & Bildik, 2022). Without them, ESG efforts may yield limited returns.

AI and Big Data enable real-time data analysis in intelligent manufacturing, enhancing production and resource management. AI-powered predictive maintenance reduces failures, cuts costs, and boosts value (Hasan, Le, & Hoque, 2021). Big Data supports inventory control, demand forecasting, and supply chain optimisation, increasing adaptability and financial performance. Firms neglecting these tools risk inefficiency and losses. AI and Big Data improve product quality by identifying risks, consumer needs, and operational efficiency, thus raising competitiveness (Ram & Desgourdes, 2024). They also align operations with sustainability by detecting energy-saving and waste-reduction opportunities (Hossain et al., 2024). These technologies enhance reputation, investor trust, and corporate value, driving Industry 4.0.

H5: Adoption of AI and Big Data moderates the relationship between ESG performance and corporate value, such that greater adoption of AI and Big Data strengthens this relationship.
H6: Adoption of AI and Big Data moderates the relationship between smart manufacturing and corporate value, such that greater adoption of AI and Big Data strengthens this relationship.

2.5. Conceptual Model

This study posits that AI, big data, and digital maturity significantly enhance ESG performance, smart manufacturing, and overall corporate value. The theoretical underpinning of this investigation integrates the Resource-Based View (RBV), Technology Acceptance Model (TAM), and Innovation Diffusion Theory (IDT). From the RBV perspective, the adoption of advanced manufacturing technologies in conjunction with ESG principles contributes to increased organisational value and sustained competitiveness. ESG performance, as examined in this study, strengthens stakeholder engagement, fosters sustainability, enhances risk management, and generates economic value. Smart manufacturing leverages automation, AI, and IoT to elevate product quality, lower operational costs, and increase production efficiency (Mourtzis et al., 2021). The synergistic implementation of ESG initiatives and smart manufacturing practices contributes to organisational value by improving efficiency, financial performance, and sustainability outcomes.

Zhang et al. (2023) highlight the role of digital readiness and competence in shaping technology adoption, while TAM illustrates how digital maturity moderates these relationships. Elevated digital maturity enables firms to extract greater value from ESG integration and advanced manufacturing technologies. In digitally mature organisations, AI and big data improve industrial operations and ESG performance by facilitating real-time data collection, processing, and evaluation, thus allowing firms to detect market trends and manage risks more effectively (Choi et al., 2024). Consequently, digital maturity not only supports the attainment of ESG and manufacturing objectives but also enhances corporate value. According to IDT, organisational adoption is influenced by the perceived compatibility of innovations with existing systems, the expected benefits, and the organisation's capability to implement AI and big data solutions.

To optimise operational efficiency and environmental outcomes, firms can employ AI and big data analytics to process vast datasets. These technologies aid in understanding consumer behaviours, streamlining production, and managing supply chains, thereby improving both financial performance and manufacturing effectiveness. Furthermore, AI and big data can elevate ESG outcomes by evaluating environmental and social impacts and enhancing stakeholder engagement, thus reinforcing investor confidence and improving market reputation (Bag et al., 2021). As illustrated in Figure 1, the integration of AI, big data, and digital maturity collectively advances ESG and smart manufacturing efforts, leading to sustained corporate value.

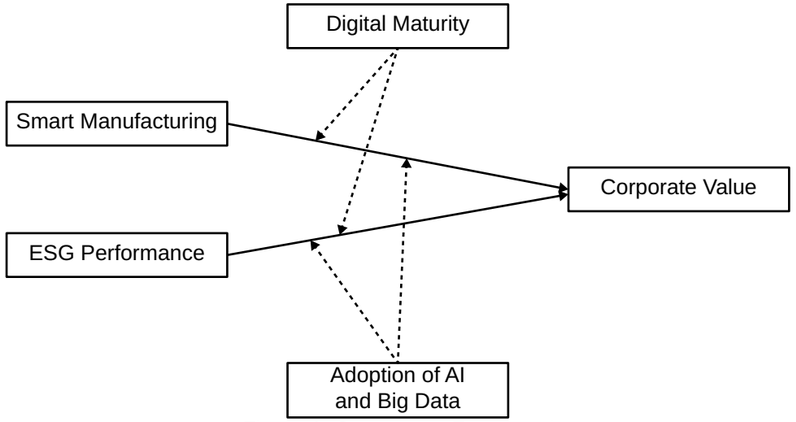

Figure 1: Conceptual Framework.

3. Methodology

3.1. Research Design

This quantitative, survey-based study investigates the moderating effects of digital maturity and AI/big data adoption on the relationships among ESG performance, smart manufacturing, and corporate value. A cross-sectional data collection approach is employed to evaluate the extent of ESG integration, implementation of smart manufacturing practices, and levels of digital maturity within manufacturing firms at a specific point in time. This methodology facilitates correlation analysis while accounting for the moderating influence of digital maturity and AI/big data adoption on the linkages between ESG performance, smart manufacturing, and organisational value. The survey-based design is particularly well-suited to this research, as it enables the efficient gathering of substantial data from a broad and diverse sample. Therefore, this methodological approach is appropriate for assessing the moderating effects within a business context.

3.2. Population and Sample

The study targeted corporate administrators, CIOs, and ESG officers from 300 Chinese manufacturing firms engaged in smart manufacturing and ESG initiatives, as they were directly involved in strategy, technology, and sustainability. The sample size, determined using statistical criteria, ensured sufficient power to detect moderate to large effects. Stratified random sampling was applied across regions (eastern, central, western China), industries (automotive, electronics, equipment), and firm sizes to ensure demographic and industrial diversity. This approach enhanced the generalisability of findings and reduced sample bias by preventing disproportionate representation.

3.3. Data Collection

This study employed structured questionnaires as the primary data collection instrument. The questionnaires were designed to assess ESG performance, smart manufacturing, digital maturity, AI/big data utilisation, and corporate value, using five-point Likert scales. Respondents indicated their level of agreement with various statements related to organisational policies and practices, ranging from “strongly disagree” to “strongly agree.” The Likert scale facilitated the quantification and comparison of responses. To ensure both reliability and validity, questionnaire items were developed based on established measures from the existing literature. ESG performance indicators were adapted from ESG evaluation frameworks (Long & Feng, 2024), while smart manufacturing constructs were derived from Industry 4.0 and smart manufacturing literature (Suvarna et al., 2020). Constructs related to AI and big data adoption drew upon technological acceptance and digital transformation research. Corporate value was assessed using models focused on profitability, market valuation, and investor confidence, as outlined by Lee, Yalcinkaya and Griffith (2024).

A total of 800 participants were identified using a defined sampling frame. The target respondents included corporate executives, Chief Information Officers, and ESG officers from manufacturing enterprises across various sectors and regions of China. Questionnaires were distributed electronically via email and online survey platforms to maximise accessibility and respondent convenience. A total of 630 valid responses were received, yielding a response rate of 78.75%. This high response rate indicated substantial engagement with the topic and ensured that the sample was sufficiently large and representative to address the study’s research objectives. The use of structured Likert-scale instruments facilitated consistent and comparable responses. Gathering data directly from decision-makers within China’s manufacturing sector enhanced the credibility and relevance of findings concerning ESG practices, smart manufacturing adoption, and corporate value. Additionally, demographic items were included to categorise respondents based on their role, enterprise size, industry type, and geographical location, thereby enriching the contextual interpretation of the results.

3.4. Data Analysis

Survey data were analysed using SPSS, employing both descriptive and inferential statistics. Descriptive analysis summarised respondent demographics and firm characteristics, including size, industry, region, and digital maturity. Correlation analysis identified initial relationships among ESG performance, smart manufacturing, corporate value, and digital maturity or AI/Big Data adoption. Multiple regression tested hypotheses, examining direct effects and moderation by digital maturity and AI/Big Data via interaction terms. Factor analysis confirmed construct validity, while Cronbach’s alpha (≥0.7) demonstrated internal consistency and scale reliability.

4. Results

Table 1 presents the descriptive statistics for the primary constructs examined in this study: ESG performance, smart manufacturing, corporate value, digital maturity, and AI/Big Data adoption. The constructs exhibited consistently high mean values, suggesting that respondents perceived their organisations as performing strongly across all dimensions. ESG performance recorded an average score of 4.12 (SD = 0.52), indicating robust sustainability practices within the surveyed firms. Scores ranged from 1 to 5. The mean score for smart manufacturing was 4.08 (SD = 0.56), reflecting the widespread implementation of advanced manufacturing technologies. Corporate value received the highest average score of 4.23 (SD = 0.49), signifying that firms assessed their market and financial standing positively. A mean digital maturity score of 4.15 (SD = 0.53) implied that organisations possessed relatively advanced digital capabilities. The average score for AI/Big Data adoption was 4.05 (SD = 0.58), suggesting considerable progress in the integration of these technologies, albeit with some variability in adoption levels. The relatively low standard deviations across all constructs indicated a high degree of consistency in the responses, with limited dispersion around the mean. While the full range of possible ratings (1 to 5) was utilised, the overall trend pointed towards a predominance of favourable evaluations across the measured variables.

Table 1: Descriptive Statistics.

Variable	Mean	Standard Deviation	Minimum	Maximum
ESG Performance	4.12	0.52	1	5
Smart Manufacturing	4.08	0.56	1	5
Corporate Value	4.23	0.49	1	5
Digital Maturity	4.15	0.53	1	5
AI/Big Data Adoption	4.05	0.58	1	5

Table 2 presents the skewness and kurtosis values for the key variables in the study—ESG performance, smart manufacturing, corporate value, digital maturity, and AI/Big Data adoption—used to assess the normality of the data. Skewness values for all variables were approximately zero, with ESG performance, smart manufacturing, corporate value, digital maturity, and AI/Big Data adoption recording values of -0.08, -0.12, -0.11, -0.09, and -0.10, respectively. These results suggest that the distributions of these variables were nearly symmetrical, indicating no significant skewness in the data. The kurtosis values for ESG performance, smart manufacturing, corporate value, digital maturity, and AI/Big Data adoption were -0.44, -0.38, -0.30, -0.36, and -0.42, respectively. Negative kurtosis values indicated platykurtic distributions, characterised by a flatter peak and lighter tails than a normal distribution. The skewness and kurtosis values suggest that the data for each variable were approximately normally distributed, which supports the use of parametric statistical techniques.

Table 3 presents key correlations among ESG performance, smart manufacturing, corporate value, digital maturity, and AI/Big Data adoption, revealing mostly significant positive relationships. ESG performance was moderately correlated with smart manufacturing, corporate value, digital maturity, and AI/Big Data use.

Smart manufacturing correlated strongly with corporate value (r = 0.60), digital maturity (r = 0.62), and AI/Big Data adoption (r = 0.55). Corporate value also showed positive links with digital maturity (r = 0.61) and AI/Big Data use (r = 0.58). Digital maturity correlated highly with AI/Big Data adoption (r = 0.67), indicating that progress in one domain tends to enhance others. These results support further analysis of moderating effects.

Table 2: Normality Assessment.

Variable	Skewness	Kurtosis
ESG Performance	-0.08	-0.44
Smart Manufacturing	-0.12	-0.38
Corporate Value	-0.11	-0.30
Digital Maturity	-0.09	-0.36
AI/Big Data Adoption	-0.10	-0.42

Table 3: Correlation Analysis.

Variable	ESGP	SM	CV	DM	AIBDA
ESG Performance	1.00				
Smart Manufacturing	0.42**	1.00			
Corporate Value	0.55**	0.60**	1.00		
Digital Maturity	0.47**	0.62**	0.61**	1.00	
AI/Big Data Adoption	0.43**	0.55**	0.58**	0.67**	1.00

Table 4 presents the reliability analysis using Cronbach's alpha for ESG performance, smart manufacturing, corporate value, digital maturity, and AI/Big Data adoption. All constructs showed high internal consistency, with alpha values above 0.70. ESG performance had an alpha of 0.89, while smart manufacturing, corporate value, and AI/Big Data adoption scored 0.87, 0.85, and 0.88, respectively. Digital maturity showed the highest reliability at 0.90. Each construct comprised eight items, ensuring comprehensive coverage. These results confirm scale reliability and support further statistical analysis of the relationships among the study variables.

Table 4: Reliability Analysis.

Variable	Cronbach's Alpha	Number of Items
ESG Performance	0.89	8
Smart Manufacturing	0.87	8
Corporate Value	0.85	8
Digital Maturity	0.90	8
AI/Big Data Adoption	0.88	8

Table 5 presents the outer loadings for each variable in the study, indicating the degree to which each item effectively measures its associated construct. All components demonstrate strong to exceptionally high relationships with their respective constructs, as evidenced by the outer loadings for ESG performance, which range from 0.77 to 0.85. ESG4 (0.85) and ESG7 (0.84) exhibit the highest loadings, reflecting their significant role in assessing ESG performance. ESG8 (0.77) also contributes strongly, albeit at a slightly lower rate. The loadings for smart manufacturing range from 0.76 to 0.84, with SM7 (0.84) and SM4 (0.83) showing the highest values, confirming these items as reliable indicators of smart manufacturing design. SM8 (0.76), though lower, still meets the model's inclusion criteria. Corporate value demonstrates substantial item loadings, with CV2 (0.88) showing a particularly strong connection to the corporate value construct. The loadings for this construct range from 0.82 to 0.88. Digital maturity loadings are uniformly high, with DM5 (0.89) serving as the strongest predictor, and loadings ranging from 0.84 to 0.89. Other components of the digital maturity construct maintain loadings above 0.80, highlighting the robustness of the assessment scale. The outer loadings for AI/Big Data adoption range from 0.79 to 0.85, with AIBDA2 (0.85) and AIBDA4 (0.84) achieving the highest values. These items are highly effective in assessing the AI/Big Data adoption framework. AIBDA6, with the lowest loading at 0.79, remains within an acceptable range, indicating that all factors substantially contribute to the evaluation of AI/Big Data adoption. Overall, the outer loadings for all variables affirm that the items are strong indicators of their respective constructs, confirming the reliability and validity of the measurement model.

Table 5: Outer Loadings.

Variable	Item	Outer Loading
ESG Performance	ESG1	0.80
	ESG2	0.83
	ESG3	0.78
	ESG4	0.85
	ESG5	0.81
	ESG6	0.79
	ESG7	0.84
	ESG8	0.77
Smart Manufacturing	SM1	0.82
	SM2	0.79
	SM3	0.81
	SM4	0.83
	SM5	0.80
	SM6	0.78
	SM7	0.84
	SM8	0.76
Corporate Value	CV1	0.85
	CV2	0.88
	CV3	0.84
	CV4	0.87
	CV5	0.83
	CV6	0.82
	CV7	0.85
	CV8	0.84
Digital Maturity	DM1	0.86
	DM2	0.88
	DM3	0.84
	DM4	0.87
	DM5	0.89
	DM6	0.85
	DM7	0.84
	DM8	0.86
AI/Big Data Adoption	AIBDA1	0.83
	AIBDA2	0.85
	AIBDA3	0.80
	AIBDA4	0.84
	AIBDA5	0.81
	AIBDA6	0.79
	AIBDA7	0.82
	AIBDA8	0.80

Table 6 presents the R-squared (R^2) value for the dependent variable, corporate value. This represents the proportion of variance in corporate value explained by the independent variables and moderating factors in the model. ESG performance, digital maturity, smart manufacturing, and AI/Big Data adoption collectively account for 78% of the variance in corporate value (R^2 = 0.78). This indicates a high level of explanatory power, suggesting that the model effectively captures the primary drivers of corporate value. The remaining 22% of fluctuations in corporate value may be attributed to unaccounted factors or random error. The significant R^2 value underscores the considerable influence of digital capabilities, innovative manufacturing practices, and ESG initiatives on corporate value. This finding provides a strong basis for further exploration of the relationships between these components and corporate value.

Table 6: R-Square.

Dependent Variable	R^2 Value
Corporate Value	0.78

Table 7 presents the regression analysis of ESG performance and smart manufacturing on corporate value. ESG performance had a positive regression coefficient of 0.32 (t = 5.75, p = 0.001), indicating a significant positive impact on corporate value. Smart manufacturing showed a stronger effect, with a coefficient of 0.40 (t = 6.10, p = 0.001), also significant at the 0.05 level. These results confirm that both ESG performance and smart manufacturing enhance corporate value, with smart manufacturing having a greater influence.

Table 7: Regression Analysis.

	(B)	T-Value	P-Value	Decision
ESG Performance -> Corporate Value	0.32	5.75	0.001	Accepted
Smart Manufacturing -> Corporate Value	0.40	6.10	0.001	Accepted

The moderation analysis in Table 8 highlights how digital maturity and AI/Big Data adoption enhance the effects of ESG performance and smart manufacturing on corporate value. Specifically, digital maturity significantly strengthens the relationship between ESG performance and corporate value (β = 0.15, t = 2.85, p = 0.004), indicating that firms with advanced digital capabilities derive greater value from ESG initiatives. Similarly, AI/Big Data adoption positively moderates the ESG–corporate value link (β = 0.18, t = 3.10, p = 0.002), suggesting that technological integration amplifies the benefits of sustainable practices. In the context of smart manufacturing, digital maturity also has a significant moderating effect (β = 0.20, t = 3.50, p = 0.001), meaning that firms with higher digital sophistication can more effectively leverage smart manufacturing technologies to enhance corporate value. Moreover, AI/Big Data usage strengthens the smart manufacturing–corporate value relationship (β = 0.17, t = 3.00, p = 0.03), underscoring the synergistic impact of advanced analytics and intelligent production on firm performance. Collectively, these findings confirm that digital maturity and AI/Big Data adoption are critical enablers that magnify the positive impact of ESG initiatives and smart manufacturing on corporate value.

Table 8: Moderation Analysis.

	(B)	T-Value	P-Value
ESG × Digital Maturity -> Corporate Value	0.15	2.85	0.004
ESG × AI/Big Data Adoption -> Corporate Value	0.18	3.10	0.002
SM × Digital Maturity -> Corporate Value	0.20	3.50	0.001
SM × AI/Big Data Adoption -> Corporate Value	0.17	3.00	0.003

5. Discussion

This study illuminates the intricate links between corporate value, ESG performance, digital maturity, smart manufacturing, and AI/Big Data. It reveals that these elements—AI, Big Data, digital maturity, ESG performance, and smart manufacturing—strengthen the relationships between them, contributing positively to corporate value. These findings offer valuable insights into how companies in the 21st century can address challenges, particularly in the areas of sustainability, technology, and performance. The positive correlation between ESG performance and corporate value suggests that sustainability can bring financial advantages. Research by Al Amosh and Khatib (2023) shows that firms with strong ESG performance tend to outperform the stock market, a finding consistent with the views of investors and consumers who increasingly recognise that ESG programmes focused on environmental responsibility, social accountability, and governance are crucial for long-term success. This study supports the idea that organisations with robust ESG practices experience higher corporate value. The positive outcomes indicate that ESG performance is integral to a company's strategic approach, influencing its financial success. Sustainability leads to an enhanced reputation, better operational efficiency, improved risk management, and greater innovation, all of which increase corporate value (Junius et al., 2020).

Additionally, the study identifies a strong link between smart manufacturing, a key technological advancement, and corporate value. The regression analysis confirms that smart manufacturing is a significant predictor of corporate value, further emphasising the need for more research on the positive impacts of advanced manufacturing technologies on organisational performance. Smart manufacturing, which integrates IoT, AI, robotics, and big data analytics, boosts product quality, reduces costs, and enhances productivity (Sujood, Bano, & Siddiqui, 2022). The findings suggest that smart manufacturing can improve operational efficiency and profitability, supporting previous research that indicates smart manufacturing drives efficiency, creativity, and competitiveness, thereby increasing corporate value (Qin & Lu, 2021). These technological advancements not only optimise internal processes but also position firms as leaders in both sustainability and innovation, attracting investors and consumers alike.

Moreover, the study found that digital maturity has a significant impact on corporate value and ESG performance. Both ESG performance and digital maturity—which reflects how effectively a company harnesses digital technology—are shown to enhance corporate value. According to the RBV, companies with advanced digital capabilities are better positioned to leverage these assets for competitive advantage (Bi et al., 2024). For firms with strong ESG practices, higher digital maturity can enhance transparency, sustainability, and resource management. The use of AI and big data further improves governance, supply chain efficiency, environmental assessments, workplace monitoring, and regulatory compliance. As digital maturity improves, these technologies can boost both ESG goals and corporate value. Chen, Wang and Seidle (2024) also found that digital maturity is a vital strategic resource for sustaining business practices.

AI, Big Data, and digital maturity significantly influence corporate value, smart manufacturing, and ESG performance. The integration of AI and Big Data enhances ESG performance and facilitates the moderation of corporate value, demonstrating their statistically significant and positive impact. This aligns with the view that AI and Big Data have the potential to drive improvements in company performance. By offering real-time data analysis, these technologies enhance operational efficiency, forecasting, and decision-making (Ghaleb et al., 2023). They enable firms to track progress, make data-informed sustainability decisions, and effectively manage ESG-related activities. Furthermore, AI and Big Data support smart manufacturing processes such as product design, supply chain optimisation, and production efficiency, thereby contributing to corporate value.

This study explores the influence of modern technologies on sustainability. The findings indicate that digital technologies and ESG performance work together to enhance corporate value. Previous research has shown that both smart manufacturing and ESG performance are key drivers of corporate value. The moderation analysis reveals that a combination of technical and sustainability efforts, AI/Big Data, and digital maturity offers a cohesive framework for value creation. Companies that focus on sustainability and smart manufacturing can reap substantial benefits. According to Ding et al. (2020), "sustainability-driven innovation" suggests that businesses can increase value by achieving sustainability goals through technological advancements, such as smart manufacturing, while ensuring long-term profitability and making a positive environmental and social impact. The study highlights the growing importance of digital transformation for business success. As organisations increasingly adopt digital technologies, digital maturity becomes a critical factor. Firms that achieve digital maturity can leverage advanced technologies, such as AI, Big Data, and IoT, to enhance both ESG performance and smart manufacturing. This research demonstrates that digital maturity plays a crucial role in boosting corporate value, particularly in the areas of technology adoption and sustainability. Digitally mature organisations, which are more capable of adapting to market shifts, managing resources, and fostering innovation, are better positioned to thrive in today's competitive, technology-driven landscape.

The analysis underscores the effects of ESG performance, smart manufacturing, digital maturity, and the use of AI/Big Data on corporate value. While both ESG performance and smart manufacturing contribute to corporate value, the integration of smart manufacturing and advanced technologies exerts a more substantial impact. The findings emphasise the central role of digital transformation in corporate strategy, as well as the importance of integrating technology into sustainability efforts. As businesses navigate digital challenges, these insights can help executives incorporate innovative manufacturing technologies and sustainability practices to enhance corporate value. This study advances research on the relationship between sustainability, technology adoption, and corporate performance, and sets the stage for future inquiries into the moderating effects of AI/Big Data and digital maturity on corporate value.

5.1. Theoretical and Practical Implication

This study offers both theoretical and practical insights. It enhances the Resource-Based View by showing how ESG performance and smart manufacturing serve as strategic assets that drive long-term value. The role of AI/Big Data and digital maturity in supporting technological and environmental improvements is highlighted, suggesting that digital transformation is key to competitive advantage. For practitioners, it recommends prioritising ESG and smart manufacturing to improve operational efficiency, reputation, and investor appeal, positioning them as complementary drivers of corporate value. Future research should explore how these factors impact business outcomes across different contexts. Strategic assets, such as ESG performance, and technological capabilities, like smart manufacturing, play a significant role in enhancing a company's long-term value, as outlined in the RBV. The findings of this study further illustrate how the integration of AI/Big Data and digital maturity accelerates technological and environmental advancements. These elements suggest that digital resources can be leveraged as competitive advantages within the RBV framework, with digital transformation becoming a crucial aspect of contemporary corporate strategy. The results indicate that the synergy between sustainability and technology could lead to substantial increases in corporate value. As such, future research should explore the impact of these factors on organisational effectiveness across different contexts.

This study has important practical implications for corporate leaders and executives, as well as theoretical contributions. ESG performance and smart manufacturing, key drivers of corporate value, highlight the importance of technology and sustainability. To optimise corporate value, this study recommends prioritising ESG performance and advanced manufacturing technologies. Sustainability initiatives focusing on ESG aspects can improve a company's reputation, reduce risks, and attract investors. Smart manufacturing, in turn, enhances operational efficiency, cost-effectiveness, and product quality. Therefore, businesses should view ESG and smart manufacturing as complementary strategies that can collectively drive value creation.

5.2. Limitations and Future Directions

This study explores the impact of ESG performance, smart manufacturing, digital maturity, and AI/Big Data adoption on corporate value but has several limitations. Its cross-sectional design restricts causal inferences and temporal analysis. Future research could benefit from a longitudinal approach to assess the long-term effects of ESG initiatives and smart manufacturing. The study's focus on Chinese manufacturers limits generalizability to other regions and industries; future

work could explore comparative studies in different cultural and legal contexts, such as Europe, North America, or emerging markets. The use of self-reported data also introduces the potential for response bias, and future research should consider objective measures like financial data or sustainability reports. Additionally, integrating qualitative methods, such as case studies or interviews, would provide deeper insights into how these factors influence corporate value.

6. Conclusion

This study reveals that AI/Big Data and digital maturity significantly alter the relationship between corporate value, ESG performance, and smart manufacturing. The data highlights that both technological and environmental initiatives contribute to enhancing corporate value. Research indicates that smart manufacturing and ESG performance are key drivers of corporate value, demonstrating how sustainability and technology can improve long-term performance and financial outcomes. ESG principles and advanced manufacturing technologies can drive improvements in financial performance, operational efficiency, and competitiveness. The study further underscores the influence of digital maturity on corporate value and ESG performance. Firms with greater digital maturity are better positioned to optimise their ESG initiatives by leveraging innovative technologies that enhance sustainability and value creation. AI and Big Data also play a critical role in strengthening the connection between ESG performance, smart manufacturing, and corporate value. These technologies accelerate processes, enhance decision-making, and enable firms to meet their sustainability objectives more effectively. The research highlights the importance of digital transformation, particularly in integrating smart manufacturing, ESG, and sustainability efforts alongside digital technologies. This study contributes to the expanding field of business technology and sustainability, demonstrating how AI/Big Data and digital maturity can support modern organisations in thriving within the digital economy. These findings offer valuable insights for business leaders and regulators, advising them to integrate sustainability with digital technologies to drive long-term growth and success.

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