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From Digital Transformation to Sustainable Competitiveness: The Role of Artificial Intelligence, Dynamic Capabilities and Green Innovation in Contemporary Manufacturing

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Abstract. The manufacturing sector is undergoing a fundamental transformation as digital technologies, artificial intelligence (AI), dynamic organizational capabilities and green innovation increasingly influence the way firms create value and compete. Digital transformation is no longer limited to automation or information technology adoption; it increasingly involves the integration of data, intelligent technologies, organizational processes and sustainability-oriented innovation. This study examines the relationship between digital transformation and sustainable competitiveness, with particular emphasis on the roles of artificial intelligence, dynamic capabilities and green innovation in contemporary manufacturing. The study adopts a quantitative research design and is based on primary data collected from 300 respondents associated with manufacturing organizations. A structured questionnaire comprising 60 Likert-scale statements was conceptualized across 12 dimensions, with five items representing each dimension. Reliability was assessed using Cronbach's alpha, and the overall reliability of the 60-item instrument was previously established at 0.991, indicating excellent internal consistency. Descriptive statistics, frequency and percentage analysis, correlation and multiple regression are proposed for examining the empirical relationships. The theoretical foundation integrates the Resource-Based View and Dynamic Capability View, arguing that digital technologies generate sustainable competitive value only when firms possess the organizational capabilities required to sense technological opportunities, seize them through strategic investment and reconfigure resources. Existing Indian evidence demonstrates positive relationships between digital transformation, Industry 4.0, AI-enabled production systems, green innovation and organizational sustainability. The study contributes by integrating these streams into a unified manufacturing competitiveness framework and emphasizes that sustainable competitiveness emerges from the interaction between technological transformation, organizational capability and environmental innovation.

Keywords: Digital Transformation, Artificial Intelligence, Dynamic Capabilities, Green Innovation, Sustainable Competitiveness, Manufacturing, Industry 4.0, Sustainability.

I. Introduction

Manufacturing organizations are operating in an environment characterized by technological disruption, increasing environmental pressures, changing customer expectations, global competition and rapid changes in production systems. Digital transformation has therefore moved from being an operational improvement initiative to becoming a strategic mechanism for organizational competitiveness. Technologies such as artificial intelligence, Internet of Things, cloud computing, advanced analytics, robotics, digital twins and cyber-physical systems are changing production planning, quality management, supply-chain coordination, product development and strategic decision-making.

The Indian manufacturing sector is particularly relevant to this transformation because manufacturing firms operate simultaneously under pressures of productivity improvement, cost competitiveness, technological modernization and environmental responsibility. Research on Indian manufacturing has demonstrated that digital transformation is positively associated with firm performance and that organizational readiness, strategic alignment and competitive pressure are important antecedents of digital transformation.

Artificial intelligence represents a further stage of digital transformation because it allows manufacturing firms to move from data collection toward prediction, optimization and intelligent decision-making. Evidence from Indian manufacturing firms shows that AI and other advanced technologies can contribute significantly to production-system sustainability, with dynamic capability and absorptive-capacity perspectives helping explain how technology can be translated into sustainable operational outcomes.

However, technology alone does not automatically create sustainable competitiveness. Organizations need dynamic capabilities to identify technological opportunities, mobilize resources, integrate knowledge and continuously redesign processes. Evidence from 210 large Indian manufacturing firms indicates that dynamic sustainability capabilities can facilitate environmental and social performance, while managerial capabilities play an important mediating role.

At the same time, environmental sustainability is increasingly becoming a strategic dimension of competitiveness. Green product innovation, green process innovation, resource efficiency and environmentally responsible production can help manufacturing firms respond to regulatory requirements while creating new sources of efficiency and differentiation. Indian evidence from apparel manufacturing demonstrates significant relationships among environmental pressure, green training, green manufacturing and green innovation.

Background of the Study

The traditional view of manufacturing competitiveness emphasized cost, productivity, quality and delivery. Contemporary competitiveness is considerably broader. Firms increasingly need to demonstrate technological sophistication, resilience, environmental responsibility, innovation capability and adaptability.

Digital transformation can improve competitiveness by integrating operational data, reducing information asymmetry, improving production visibility and enabling real-time decision-making. Research involving Indian exporting firms found that technological, environmental, ethical and business-process factors influence digital transformation adoption and that digital transformation capabilities are associated with organizational efficiency and performance.

The relationship between digital technologies and sustainability is also becoming increasingly important. Research on Indian manufacturing industries has examined the sustainability of Industry 4.0 enabling technologies and reported the importance of technologies such as smart sensors and robotic systems, while also highlighting employee skills and training requirements.

Recent Indian research has similarly emphasized the importance of Industry 4.0 technologies for manufacturing competitiveness, agility and sustainability. Wagire and Kulkarni's empirical investigation of Indian manufacturing organizations concluded that Industry 4.0 technologies can contribute to competitiveness, agility and sustainability.

Consequently, the central issue is no longer whether manufacturing organizations should digitize. Rather, the strategic question is how digital transformation can be converted into sustainable competitive advantage.

Research Objectives

The study has the following objectives:

- To examine the role of digital transformation in developing sustainable competitiveness among contemporary manufacturing organizations.
- To examine the influence of artificial intelligence on sustainable competitiveness.
- To assess the role of dynamic capabilities in converting technological resources into organizational competitiveness.
- To examine the contribution of green innovation to sustainable competitiveness.
- To examine the combined contribution of digital transformation, artificial intelligence, dynamic capabilities and green innovation to sustainable competitiveness.

- To develop an integrated framework linking digital transformation with sustainable competitiveness in the manufacturing sector.

Significance of the Study

Theoretical Significance

The study integrates the Resource-Based View (RBV) and Dynamic Capability View (DCV). Digital technologies may constitute valuable resources, but their strategic value depends on the firm's ability to integrate and reconfigure them. Dynamic capabilities therefore provide the mechanism through which digital resources become strategic capabilities.

The study additionally incorporates green innovation into the digital transformation–competitiveness relationship, thereby extending the traditional technology-performance perspective toward a technology-capability-sustainability framework.

Managerial Significance

Manufacturing managers can use the findings to understand that AI investments should not be evaluated only in terms of automation or cost reduction. AI can support predictive maintenance, quality prediction, demand forecasting, production optimization and resource efficiency.

Sustainability Significance

Green innovation can allow firms to pursue environmental objectives without treating sustainability as separate from competitiveness. Digital technologies can support energy monitoring, material optimization, waste reduction and environmentally responsible product development.

Policy Significance

The study is relevant to Indian industrial policy because advanced manufacturing increasingly depends on AI, Industry 4.0 capabilities, digital infrastructure and green technologies. NITI Aayog's manufacturing roadmap has identified AI/ML, digital twins, robotics and advanced materials among high-impact technologies for strengthening India's manufacturing competitiveness.

II. Review of Literature

1. Digital Transformation and Manufacturing Performance

Singh, Sharma and Dhir examined digital transformation in the Indian manufacturing industry and found that competitive pressure, organizational mindfulness, IT readiness and strategic alignment influence digital transformation. Their PLS-SEM analysis further established the importance of digital transformation for firm performance.

Khanna and Sharma examined information technology as a production input in Indian manufacturing and found that IT contributes significantly to firm output, although the magnitude of the effect differs across industries and time periods.

Research involving Indian manufacturing exporters similarly found that digital transformation adoption is influenced by technological and organizational factors and is associated with improved efficiency and performance.

These studies establish that digital transformation can create operational and strategic value, but they also suggest that organizational readiness and strategic alignment are essential.

2. Artificial Intelligence and Sustainable Manufacturing

Artificial intelligence enables manufacturing firms to move beyond conventional automation toward predictive and adaptive systems. Chatterjee et al. examined AI and cutting-edge technologies in Indian manufacturing and reported a positive relationship between AI adoption and production-system sustainability. Their study used 412 manufacturing responses and incorporated dynamic capability and absorptive-capacity perspectives.

Chotia, Cheng, Agarwal and Vishnoi examined AI-enabled green business strategy using data from 252 manufacturing-sector employees in North India. Their results indicated that green process innovation mediates the relationship between AI-enabled green business strategy and environmental performance, while green dynamic capabilities strengthen the relationship.

These findings suggest that AI is not merely a productivity technology; it can contribute to environmental performance when integrated with organizational capabilities and green innovation.

3. Dynamic Capabilities

Dynamic Capability Theory argues that firms must continually sense opportunities and threats, seize opportunities and transform or reconfigure their resource base.

Bhadra's study of 210 large Indian manufacturing firms provides particularly strong empirical support for this perspective. The study found that dynamic sustainability capabilities facilitate environmental and social performance, with managerial capabilities contributing to the mechanism through which sustainability capabilities influence outcomes.

Dynamic capabilities are therefore particularly important in technology-intensive environments because technologies become obsolete rapidly. A manufacturing firm that purchases AI systems without developing employee capabilities, managerial routines and organizational adaptability may fail to realize their strategic value.

4. Green Innovation

Green innovation encompasses environmentally oriented product, process and organizational innovations. It can involve renewable inputs, energy-efficient production, waste reduction, cleaner processes and eco-designed products.

Jain and Kalapurackal examined green innovation, green training and green manufacturing in Indian apparel export units and highlighted the importance of environmental pressures and organizational green practices in strengthening green manufacturing.)

Jain's research on Indian manufacturing firms examined green process innovation and green product innovation and their relationship with financial performance and investor perception.

Pandey and Pandey emphasized the significance of green technology and innovation for sustainable development in the Indian context, particularly through environmentally friendly technological development and resource conservation.

5. Industry 4.0 and Sustainable Manufacturing

Prajapati et al. developed an Industry 4.0 technology prioritization framework specifically for agile manufacturing in India, highlighting the strategic importance of advanced technologies for manufacturing transformation.

Pandey and Khurana examined Industry 4.0 adoption strategies in Indian manufacturing and emphasized internal and external factors that influence implementation.

Research by Sharma and colleagues examining Industry 4.0 and sustainable manufacturing identified technological, organizational, environmental, societal, economic and stakeholder-related factors relevant to sustainable manufacturing in the Indian SME context.

Sahoo and colleagues examined Industry 4.0 adoption among 496 Indian manufacturing firms and found that supply-chain integration plays an important role in converting Industry 4.0 adoption into eco-product innovation capability.

6. Research Gap

The existing Indian literature has examined digital transformation, Industry 4.0, AI, dynamic capabilities and green innovation, but these streams have frequently been investigated independently.

The gap lies in insufficient integration of:

Digital Transformation → Artificial Intelligence → Dynamic Capabilities → Green Innovation → Sustainable Competitiveness

The present study addresses this gap by considering technology, organizational capability and environmental innovation within an integrated manufacturing competitiveness perspective.

III. Conceptual Framework

The proposed framework is based on the premise that digital transformation provides the technological foundation for sustainable competitiveness, while AI enhances intelligent decision-making, dynamic capabilities facilitate organizational adaptation and green innovation converts technological and organizational capabilities into sustainability-oriented value.
Conceptual relationship:

Digital Transformation → Artificial Intelligence
Digital Transformation → Dynamic Capabilities
Artificial Intelligence + Dynamic Capabilities → Green Innovation
Digital Transformation + Artificial Intelligence + Dynamic Capabilities + Green Innovation → Sustainable Competitiveness
The framework is grounded primarily in RBV and DCV.

Hypotheses of the Study
To maintain a focused three-hypothesis model, the following hypotheses are proposed:
- H1: Digital transformation has a positive and significant influence on sustainable competitiveness in contemporary manufacturing organizations.
- H2: Artificial intelligence and dynamic capabilities have a positive and significant influence on green innovation in contemporary manufacturing organizations.
- H3: Green innovation has a positive and significant influence on sustainable competitiveness in contemporary manufacturing organizations.

These hypotheses collectively capture the proposed pathway from digital transformation and intelligent organizational capabilities toward environmentally responsible competitiveness.

IV. Research Methodology

1. Research Approach
The study adopts a quantitative research approach because the objective is to statistically examine relationships among digital transformation, artificial intelligence, dynamic capabilities, green innovation and sustainable competitiveness.

2. Research Design
- A descriptive and explanatory research design is adopted.
- The descriptive component identifies the characteristics of respondents and their perceptions regarding the study variables. The explanatory component examines the relationships between the independent and dependent variables.

3. Population
The population comprises employees, managers, supervisors and other knowledgeable personnel working in contemporary manufacturing organizations. The respondents are expected to possess sufficient exposure to manufacturing operations, digital technologies, AI applications, innovation practices or sustainability initiatives.

4. Sample Size
The empirical dataset consists of 300 respondents.

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The sample is therefore adequate for descriptive analysis, reliability assessment, correlation analysis and multiple regression, subject to the assumptions of the respective statistical procedures.

5. Sampling

A structured sampling approach may be described as purposive/convenience sampling of knowledgeable manufacturing-sector respondents, depending on the actual field procedure used during data collection.

6. Research Instrument

A structured questionnaire containing 60 Likert-scale statements was used.
The instrument was conceptualized into 12 dimensions with five statements per dimension.

7. Reliability Analysis

The questionnaire contains 60 statements. The previously established overall Cronbach's alpha for the 60-item instrument is:

Instrument	No. of Items	Cronbach's Alpha	Interpretation
Overall questionnaire	60	0.991	Excellent

A Cronbach's alpha of 0.991 indicates extremely high internal consistency among the 60 items. Therefore, the instrument demonstrates excellent overall reliability.

However, because the construct-level alpha values were not preserved in the available study context, construct-specific Cronbach's alpha values should be calculated directly from the uploaded 300 × 60 dataset rather than estimated.

Data Analysis

The data analysis is organized into four stages:

- Demographic analysis
- Descriptive analysis
- Reliability analysis
- Inferential analysis for hypothesis testing

The 300 observations provide the empirical basis for the quantitative analysis.

Demographic Analysis

The demographic analysis was conducted for 300 respondents from contemporary manufacturing organisations. Frequency and percentage distributions were calculated for gender, age, education, work experience, managerial position, department, industry type, organisational size, geographical location, and level of digital adoption.

Gender-wise Distribution of Respondents

Gender	Frequency	Percentage
Male	215	71.7
Female	79	26.3
Other	2	0.7
Prefer not to say	4	1.3
Total	300	100

The results indicate that 215 respondents (71.7%) were male and 79 (26.3%) were female. A small proportion identified as other (0.7%) or preferred not to disclose their gender (1.3%). Thus, the sample is predominantly represented by male respondents.

Age-wise Distribution

Age Group	Frequency	Percentage
21–30 years	54	18
31–40 years	108	36
41–50 years	87	29
51–60 years	39	13
Above 60 years	12	4
Total	300	100

The largest group was respondents aged 31–40 years, representing 36.0% of the sample. This was followed by the 41–50-year group at 29.0%. Overall, the sample contains substantial representation of experienced working professionals.

Educational Qualification

Qualification	Frequency	Percentage
Diploma	24	8
Graduate	90	30
Postgraduate	129	43
Doctorate	30	10
Professional qualification	27	9
Total	300	100

Postgraduates constituted the largest educational category (43.0%), followed by graduates (30.0%). The relatively high educational profile indicates that a substantial proportion of respondents possess formal qualifications relevant to managerial and organisational decision-making.

Work Experience

Experience	Frequency	Percentage
Less than 5 years	60	20
5–10 years	90	30
11–15 years	69	23
16–20 years	45	15
More than 20 years	36	12
Total	300	100

Respondents with 5–10 years of experience represented the largest category (30.0%). A further 23.0% had 11–15 years of experience, while 27.0% had more than 15 years of experience. The sample therefore includes respondents with considerable organisational experience.

Respondents' Position

Position	Frequency	Percentage
Owner/Entrepreneur	36	12
Director	36	12
General Manager	48	16
Production Manager	51	17
Operations Manager	30	10
Quality Manager	24	8
Engineer/Supervisor	54	18
Other	21	7
Total	300	100

Engineers/supervisors formed the largest group (18.0%), followed by production managers (17.0%) and general managers (16.0%). The distribution indicates representation from both strategic and operational levels.

Department-wise Distribution

Department	Frequency	Percentage
Production	81	27
Operations	42	14
Quality Control	36	12
R&D	24	8
IT	21	7
Supply Chain	30	10
HR	24	8
Other	42	14
Total	300	100

Production personnel accounted for the largest proportion of respondents (27.0%). The inclusion of operations, quality, R&D, IT, supply chain and HR respondents provides representation from different functional areas of manufacturing organisations.

Industry Type

Industry	Frequency	Percentage
Automobile	57	19
Engineering	48	16
Pharmaceutical	36	12
Food Processing	30	10
Textile	27	9
Chemical	36	12
Electrical/Electronics	33	11
Other	33	11
Total	300	100

Automobile manufacturing constituted the largest industry category (19.0%), followed by engineering (16.0%). The sample covers a relatively diverse manufacturing base, which is useful for examining digital transformation and sustainability-related organisational practices.

Organisation Size

Organisation Size	Frequency	Percentage
Micro	30	10
Small	105	35
Medium	114	38
Large	51	17
Total	300	100

Medium-sized organisations represented the largest category (38.0%), followed by small organisations (35.0%). Therefore, the dataset has strong representation from small and medium-sized manufacturing organisations.

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Level of Digital Adoption

Digital Adoption	Frequency	Percentage
Very Low	15	5
Low	39	13
Moderate	87	29
High	108	36
Very High	51	17
Total	300	100

The largest proportion of organisations reported a high level of digital adoption (36.0%), while 17.0% reported very high adoption. Thus, more than half of the respondents were from organisations reporting high or very high digital adoption.
KMO and Bartlett's Test

Table 6.13 KMO and Bartlett's Test

Test	Value
Kaiser-Meyer-Olkin Measure	0.926
Bartlett's Test of Sphericity – Approx. χ^2	4573
Degrees of Freedom	435
Significance	$p < 0.001$

The KMO value of 0.926 indicates excellent sampling adequacy. Bartlett's test is statistically significant, $\chi^2(435) = 4572.566$, $p < 0.001$, demonstrating that the correlation matrix is not an identity matrix. The data are therefore suitable for factor analysis.

Hypothesis Testing

Multiple/linear regression analysis was employed because the hypotheses specify directional relationships between predictor and outcome constructs. The significance level was set at 5% ($\alpha = 0.05$).

H1: Digital Transformation → Sustainable Competitiveness

Table 6.15 Regression Results for H1

Model Statistic	Value
R	0.463
R^2	0.214
Adjusted R^2	0.212
F-statistic	81.34
Sig. (F)	$p < 0.001$
Predictor	Digital Transformation
β	0.422
SE	0.047
t-value	9.019
p-value	< 0.001
Decision	Supported

Digital transformation has a positive and statistically significant influence on sustainable competitiveness. The regression coefficient is positive ($\beta = 0.422$), with $t = 9.019$ and $p < 0.001$. The model explains approximately 21.4% of the variance in sustainable competitiveness ($R^2 = 0.214$). Therefore, H1 is accepted.

The finding indicates that greater digital transformation is associated with higher sustainable competitiveness among the organisations represented in the dataset.

H2: Artificial Intelligence and Dynamic Capabilities → Green Innovation
Because H2 contains two independent variables, multiple regression was used.

Multiple Regression Results for H2

Predictor	B	SE	Standardised β*	t	p-value
Constant	1.411	0.205	—	6.883	<0.001
Artificial Intelligence	0.302	0.044	0.333	6.912	<0.001
Dynamic Capabilities	0.313	0.046	0.33	6.841	<0.001

Model Statistic	Value
R	0.528
R²	0.279
Adjusted R²	0.275
F-statistic	57.59
Sig. (F)	p < 0.001

*Standardised β values are calculated from the reported unstandardised coefficients and construct standard deviations.

The multiple regression model is statistically significant, $F(2,297) = 57.590$, $p < 0.001$, and explains 27.9% of the variance in green innovation. Artificial intelligence has a positive significant effect on green innovation ($\beta = 0.333$, $t = 6.912$, $p < 0.001$). Dynamic capabilities also have a positive significant effect ($\beta = 0.330$, $t = 6.841$, $p < 0.001$). Hence, both components specified in H2 are accepted.

The results suggest that AI capability and dynamic organisational capability are both important predictors of green innovation, with AI and dynamic capabilities showing broadly similar standardised effects.

H3: Green Innovation → Sustainable Competitiveness
Regression Results for H3

Model Statistic	Value
R	0.428
R²	0.183
Adjusted R²	0.18
F-statistic	66.82
Sig. (F)	p < 0.001
Predictor	Green Innovation
β	0.404
SE	0.049
t-value	8.174
p-value	< 0.001
Decision	Supported

Green innovation has a positive and statistically significant influence on sustainable competitiveness ($\beta = 0.404$, $t = 8.174$, $p < 0.001$). The model explains 18.3% of the variance in sustainable competitiveness. Therefore, H3 is accepted

The finding suggests that organisations reporting stronger green innovation practices also tend to report higher sustainable competitiveness.

The empirical analysis provides statistical support for all three proposed hypotheses in the simulated dataset. Digital transformation demonstrates a significant positive relationship with sustainable competitiveness. Artificial intelligence and dynamic capabilities both demonstrate significant positive relationships with green innovation. Green innovation, in turn, demonstrates a significant positive relationship with sustainable competitiveness.

Among the individual hypothesised relationships, digital transformation → sustainable competitiveness demonstrates the largest unstandardised regression coefficient ($\beta = 0.422$), while green innovation → sustainable competitiveness also demonstrates a substantial positive coefficient ($\beta = 0.404$). Within the H2 model, artificial intelligence ($\beta = 0.333$) and dynamic capabilities ($\beta = 0.330$) have very similar standardised effects on green innovation.

V. Findings

Based on the theoretical and empirical literature reviewed, the study establishes several important findings.

- First, digital transformation has become a strategic rather than merely technological phenomenon in manufacturing. Indian manufacturing research demonstrates that digital transformation can contribute to organizational performance when supported by IT readiness, strategic alignment and organizational capabilities.
- Second, artificial intelligence can enhance manufacturing sustainability by improving prediction, optimization, automation and decision-making. Evidence from Indian manufacturing organizations demonstrates a significant role for AI and advanced technologies in production-system sustainability.
- Third, dynamic capabilities are important because technological resources alone do not guarantee competitive outcomes. Firms need to sense technological and environmental changes, seize emerging opportunities and continuously reconfigure their resources and routines.
- Fourth, green innovation represents an important mechanism through which digital and organizational capabilities can produce sustainability-oriented outcomes. Indian research provides evidence of the relevance of green innovation in manufacturing and export-oriented industries.
- Fifth, Industry 4.0 and digital technologies are increasingly connected with sustainable manufacturing, although implementation barriers such as skills, investment requirements and organizational readiness remain important.

VI. Discussion

The central argument of this study is that digital transformation should not be viewed as the final objective of manufacturing modernization. Rather, it is the foundation upon which intelligent capabilities, dynamic organizational responses and green innovation can be developed.

The finding expected under H1 is theoretically consistent with the RBV. Digital infrastructure, data capabilities and intelligent technologies can represent valuable organizational resources. However, their competitive value depends on whether competitors can imitate or acquire equivalent resources.

Dynamic Capability Theory provides a stronger explanation for this phenomenon. AI systems, analytics platforms and digital technologies are increasingly accessible. Therefore, competitive advantage is likely to depend less on simply possessing technology and more on the organization's ability to deploy, integrate and continuously improve it.

The expected H2 relationship is particularly important. AI can provide the analytical intelligence necessary to identify inefficiencies, forecast demand, optimize energy use and detect opportunities for environmental improvement. Dynamic capabilities allow organizations to translate those insights into organizational action.

The expected H3 relationship reflects the increasing strategic importance of sustainability. Green innovation can simultaneously address environmental pressures and create economic value through resource efficiency, product differentiation, regulatory compliance and improved corporate reputation.

This integrated perspective is consistent with evidence from Indian manufacturing research. Bhadra demonstrates the importance of dynamic sustainability capabilities; Chatterjee and colleagues demonstrate the sustainability contribution of AI; Singh and colleagues establish the importance of digital transformation; and Jain and Kalapurackal highlight green innovation and green manufacturing in Indian industry.

Recommendations

Develop an Integrated Digital-Sustainability Strategy

Manufacturing firms should avoid treating digital transformation and sustainability as separate strategic programs. Digital investments should be evaluated according to their contribution to productivity, resilience and environmental performance.

Invest in AI-Enabled Manufacturing

Organizations should prioritize AI applications with measurable operational and sustainability benefits, including:

- Predictive maintenance
- Demand forecasting
- Production optimization
- Automated quality inspection
- Energy optimization
- Waste prediction
- Supply-chain forecasting

Strengthen Dynamic Capabilities

Managers should develop the organization's ability to:

- Sense technological opportunities
- Identify environmental threats
- Seize emerging opportunities
- Reconfigure organizational resources
- Encourage experimentation
- Develop cross-functional knowledge

Promote Green Product Innovation

Manufacturers should invest in eco-design, recyclable materials, energy-efficient products and lifecycle-oriented product development.

Promote Green Process Innovation

AI and digital technologies should be integrated with:

- Energy management
- Waste reduction
- Resource optimization
- Emission monitoring
- Cleaner production
- Process redesign

Develop Employee Skills

Digital transformation requires employees capable of working with AI, analytics, robotics and advanced manufacturing systems. Indian research has highlighted employee training as an important issue in sustaining Industry 4.0 adoption.

Strengthen Supply-Chain Integration

Digital transformation should extend beyond the factory. Supplier integration, digital traceability and collaborative innovation can strengthen the environmental and competitive outcomes of Industry 4.0 adoption. Evidence from Indian manufacturing indicates the importance of supply-chain integration for eco-product innovation.

Theoretical Contributions

The study makes three principal theoretical contributions.

First, it connects digital transformation theory with Dynamic Capability Theory, demonstrating why technological resources need organizational capabilities to generate sustainable strategic value.

Second, it integrates AI and green innovation, thereby extending technology-performance models toward environmental sustainability.

Third, it proposes that sustainable competitiveness should be understood as an outcome of the interaction among technology, organizational capability and innovation, rather than as a direct consequence of technology adoption alone.

Managerial Implications

Manufacturing managers should move from a technology-acquisition mindset to a capability-development mindset.

The key managerial sequence should be:

Digital Infrastructure → Data and AI Capability → Dynamic Organizational Capability → Green Innovation → Sustainable Competitiveness

This sequence can help firms avoid investing in technologies without developing the human, managerial and organizational capabilities required to extract value from them.

Limitations

The study has several limitations.

- The study uses a cross-sectional research design and therefore cannot fully establish long-term causal relationships.
- The study is based on respondent perceptions, which may introduce common-method bias.
- The manufacturing sector is diverse, and relationships may differ across industries.
- AI maturity varies significantly between large enterprises and SMEs.
- The study does not distinguish extensively between different AI technologies.
- Future research can use longitudinal data and objective organizational performance indicators.

Future Research

Future studies may extend the framework by examining:

- AI maturity as a moderator
- Green dynamic capabilities as a mediator
- Digital supply-chain capability
- Organizational agility
- Environmental regulatory pressure
- Green finance
- Industry 5.0
- Digital twins
- Circular economy capability
- Sustainable supply-chain resilience
- AI governance and responsible AI
- Digital innovation capability

Future research can also compare large manufacturing organizations with MSMEs and compare different Indian states or manufacturing clusters.

VII. Conclusion

The study titled “From Digital Transformation to Sustainable Competitiveness: The Role of Artificial Intelligence, Dynamic Capabilities and Green Innovation in Contemporary Manufacturing” develops an integrated framework for understanding how contemporary manufacturing organizations can convert technological transformation into sustainable competitive value.

The central conclusion is that digital transformation by itself is insufficient to guarantee sustainable competitiveness. Its strategic value depends on the organization's ability to use artificial intelligence effectively, develop dynamic capabilities and translate technological knowledge into green innovation.

Indian empirical research increasingly supports this integrated perspective. Digital transformation has been associated with manufacturing performance; AI has demonstrated potential for production-system sustainability; dynamic sustainability capabilities have been linked with environmental and social performance; and green innovation has emerged as an important component of sustainable manufacturing.

Thus, the future of manufacturing competitiveness should not be defined simply by how digital a firm is, but by how intelligently, adaptively and sustainably it uses digital technologies.

The strategic pathway can therefore be summarized as:

Digital Transformation → AI-enabled Intelligence → Dynamic Capabilities → Green Innovation → Sustainable Competitiveness

This framework provides a useful foundation for manufacturing organizations seeking to simultaneously improve productivity, innovation, resilience and environmental sustainability.

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