FMDB *Transactions on Sustainable Environmental Sciences*

Algorithmic Management and Green Technologies: Dual Enablers of Digital-Green Supply Chain Transformation and Resilience

T. Anand[1,*], P. Paramasivan[2], Paul Kostek[3], Selçuk Bulat[4], G. Arun[5]

[1]Department of Aeronautical Engineering, Sathyabama Institute of Science and Technology, Chennai, Tamil Nadu, India.
[2]Department of Research and Development, Thangavelu Engineering College, Chennai, Tamil Nadu, India.
[3]Department of Systems Engineering, Air Direct Solutions LLC, Seattle, Washington, United States of America.
[4]Department of Nanoscience and Nanoengineering, Institute of Natural Sciences, Sakarya University, Serdivan, Sakarya, Turkey.
[5]Department of Electrical and Electronics Engineering, Dhaanish Ahmed College of Engineering, Chennai, Tamil Nadu, India.
anand.aero@sathyabama.ac.in[1], director@thangavelu.edu.in[2], paul.kostek@incose.net[3], sbulat@tse.org.tr[4], arun.g@dhaanishchennai.in[5]

Abstract: The contemporary industrial environment is under the twin pressure of blistering digitalisation and pressing environment-related requirements. This research paper examines how algorithmic management and green disruptive technologies can serve as significant drivers of transformation and resilience in the green digital supply chain. Drawing on the Stimulus-Organism-Response paradigm and the Resource Orchestration Theory, the paper will explore how digital intelligence can support sustainability transitions. The research uses primary data from 261 cases, focusing on professionals in both the manufacturing and logistics industries. The analysis was carried out using structural equation modelling and high-quality computational tools to map the serially mediating effects of green digital absorptive capacity. It has been determined that algorithmic management is a key driver of the introduction of green technology, thereby enhancing organisations' resilience. The findings highlight that the complementarity between automated decision-making and environmentally friendly innovation is key to overcoming modern market shocks. This study offers a robust model for managers to align their digital strategies with environmental objectives to achieve long-term competitive advantage in a dynamic global economy.

Keywords: Algorithmic Management; Green Disruptive Technology; Supply Chain Resilience; Digital Transformation; Resource Orchestration; Digital Intelligence; Sustainability Transitions.

Received on: 28/02/2025, **Revised on:** 05/05/2025, **Accepted on:** 26/07/2025, **Published on:** 03/03/2026

Journal Homepage: https://www.fmdbpub.com/user/journals/details/FTSESS

DOI: https://doi.org/10.69888/FTSESS.2026.000692

Cite as: T. Anand, P. Paramasivan, P. Kostek, S. Bulat, and G. Arun, "Algorithmic Management and Green Technologies: Dual Enablers of Digital-Green Supply Chain Transformation and Resilience," *FMDB Transactions on Sustainable Environmental Sciences*, vol. 3, no. 1, pp. 33–42, 2026.

1. Introduction

*Corresponding author.

The world economy is now passing through a pivotal period characterised by the convergence of digital innovation and environmental management [11]. Conventionally, supply chain management has been more concerned with cost-cutting and speed, an aspect explored in earlier industrial settings by Yan and Li [16]. But the emergence of the climate change problem and the lack of resources have necessitated a paradigm shift, a phenomenon analysed by Creutzig et al. [1]. Organisations have now realised that efficiency cannot exist in isolation and has become increasingly associated with the principles of sustainability, a fact also highlighted by Hojer and Wangel [12]. This has led to the concept of the green digital supply chain, as conceptualised by Caprotti and Liu [14]. This change is not merely the implementation of new tools, but a fundamental reshaping of the processes of goods production, movement and consumption, as Santarius et al. [2] note. Digital intelligence integration enables a degree of transparency and precision, essentially previously unattainable, which allows firms to track carbon footprints as well as waste of various resources in real-time, as demonstrated by Hojer and Wangel [12]. This developing capacity enhances accountability among stakeholders and introduces quantifiable sustainability standards into operational processes, as further discussed by Milojevic-Dupont and Creutzig [3]. As firms align their environmental metrics with economic targets, the resulting shift can be viewed as a structural shift towards sustainable industrial ecosystems and ecological responsibility, as Argyroudis et al. [8] consistently argue across the literature [13].

Complex data-driven systems are used to oversee, coordinate and optimise workforce and logistics operations as developed by Jiang et al. [4]. When applied to supply chains, these systems become a catalyst for greater change by introducing intelligence into decision-making processes, as described by Liu and Li [5]. Algorithms can detect inefficiencies that human supervision might overlook, making them useful. Such inefficiencies tend to be associated with idle resources, inoptimal routing, and inconsistent scheduling, all of which directly affect environmental performance metrics. To illustrate, route optimisation algorithms are more than time-saving algorithms; they literally reduce fuel consumption and emissions, as Khanna et al. [7] demonstrate. The new technological intervention redefines the operational efficiency by inculcating sustainability into the logic of the operation itself. This technology is the driver of change in an organisation; it is the driving force that moves firms out of legacy systems and into digitally enabled coordination structures, a transition discussed in Wagner et al. [9]. Among them are renewable energy systems, tools to track a circular economy, and carbon-capture logistics, as categorised by Santarius et al. [2]. They do not just improve the current business models, as do incremental improvements, but instead disrupt them in favour of ecological health and long-term sustainability, as analysed by Milojevic-Dupont and Creutzig [3].

Their presence in the supply chain is transformational, as they substitute carbon-intensive practices with sustainable practices aligned with global climate objectives, as discussed by Hojer and Wangel [12]. Combined with digital frameworks, these technologies can form intelligent systems with adaptive performance, as demonstrated in Caprotti and Liu [14]. For example, a green technology such as biodegradable packaging will be more widely adopted when used with digital systems that optimise its lifecycle, track degradation, and coordinate supply and demand cycles to work efficiently, as explained by Argyroudis et al. [8]. Such symbiosis between physical resources of sustainability and digital resources of intelligence enhances the power of both spheres. The combination of these technologies with algorithmic systems ensures that sustainability is not an external goal but is incorporated into the core of the work. The present subsection shows how green disruptive technologies can serve as the engine of the green supply chain and provide the physical means to achieve the efficiency and sustainability objectives set by algorithmic decision-making systems, as further elaborated by Yan and Li [16]. The capacity of a supply chain to endure and recuperate following any disruption, irrespective of whether the disruption occurred because of economic shocks, pandemics or environmental crises, as argued by Wagner et al. [9].

In the contemporary world, resilience is increasingly associated with a firm's digital and environmental agility, as Wagner et al. [9] examine. A supply chain based on diversified green energy sources reflects reduced exposure to volatility in fossil fuel markets, as illustrated by Khanna et al. [7]. In the same way, a digitally integrated network would be more responsive, as it would enable real-time data exchange and predictive analytics, enabling firms to dynamically modify operations when disruption occurs, as emphasised by Jiang et al. [4]. The green/digital convergence forms a structural buffer against external shocks by creating dependency on vulnerable resources and increasing adaptive capacity, both of which are examined in Hojer and Wangel [12]. This adaptive ability is further enhanced by organisational learning systems, which help firms acquire, interpret, and effectively utilise new knowledge. Firms internalise technological changes and transform them into strategic benefits, a process known as absorptive capacity Liu and Li [5], by fostering a culture of continuous learning and adaptation. Eventually, the integration of algorithmic management and green technology results in the development of both sustainable and robust supply chain networks that can maintain performance stability in the face of uncertainty and disruption, as Hojer and Mjornell [10] concluded.

2. Review of Literature

The development of supply chain management has shifted toward nonlinear models and interconnected, complex ecosystems, a shift analysed by Argyroudis et al. [8]. Preliminary studies were devoted to the Lean and Agile philosophies, which were oriented at reducing waste and being responsive in accordance with Yan and Li [16]. But these models tended to ignore the environmental externalities of rapid production, a shortcoming noted by Creutzig et al. [1]. As the world becomes more aware of the problem of climate change, researchers have proposed Green Supply Chain Management as the needed change. This shift was accentuated by Santarius et al. [2]. These measures were to minimise the environmental impact throughout the product lifecycle whilst ensuring continuity in its operations. Although successful, these early green strategies were often hampered by a lack of real-time data, which made it difficult for managers to balance environmental goals with profitability. This restraint was explored by Hojer and Wangel [12].

Lacking integrated monitoring systems constrained decision-making accuracy and responsiveness to environmental indicators. Subsequently, sustainability activities remained disjointed and reactive rather than proactive. This drawback necessitated more dynamic systems capable of incorporating environmental concerns into real-time operational systems, which Caprotti and Liu [14] also regard as a secondary concern. Therefore, the transition to green supply chain models is a progressive interpretation of sustainability as a functional requirement rather than an optional addition, as Hojer and Wangel [12] have continually emphasised. As Industry 4.0 emerged, the focus shifted to Digital Supply Chains, which have been widely discussed by Jiang et al. [4]. Those who began researching how the Internet of Things, big data, and artificial intelligence can be used to improve the visibility and coordination of operations, as discussed by Liu and Li [5]. The literature indicates that digitalisation strengthens the supply chain's resilience by enabling instantaneous communication across global networks, as demonstrated by Yin et al. [6]. This led to the introduction of the Twin Transition concept, in which both digital and green objectives are pursued simultaneously, a concept elaborated by Wagner et al. [9].

Research indicates that digital tools are not merely neutral tools but active facilitators that may either hasten or slow the process of sustainability, depending on how they are used, as examined by Wagner et al. [9]. The success of digitalisation in achieving environmental objectives depends on how algorithms are constructed and operated within the functioning systems. This two-dimensional view presents digital transformation as both a challenge and an opportunity in meeting sustainability goals. With firms becoming increasingly dependent on digital tools, alignment between technological capabilities and environmental goals comes to the forefront in delivering integrated supply chain performance, as further highlighted by Hojer and Mjornell [10]. The concept of algorithmic management has recently come to the forefront of organisational research, especially in the context of data-intensive features, as described by Jiang et al. [4]. It was first studied within the gig economy framework, but today it is a crucial element of industrial supply chains, as Liu and Li [5] describe. According to scholars, algorithms can handle complexity that humans cannot, enabling real-time, cross-node, multi-process processing. Yin et al. [6] highlight these capabilities and their significance in managing complexity. Numerous studies in the literature have shown that algorithmic management is associated with greater efficiency and lower operational costs, as Khanna et al. [7] demonstrated.

Nevertheless, in recent debates, it has been the focus of its role in Green Digital Absorptive Capacity, as explored by Wagner et al. [9]. This means a firm's capability to identify, value, and put into practice new green knowledge digitally, and to incorporate sustainability into the basic processes of running a firm. The literature proposes that firms with strong absorptive capacity are better positioned to incorporate disruptive technologies into their operations. These companies use digital devices to analyse environmental data, streamline resource use, and conduct large-scale sustainable activities. The interplay between algorithmic systems and absorptive capacity enables organisations to continually adapt to changing environmental standards and technological advancements. This integration embeds sustainability as a strategic capability within organisational processes, as further explained by Caprotti and Liu [14]. Consequently, algorithmic management emerges as a key facilitator of sustainable change by connecting data intelligence and environmental innovation, thereby confirming its relevance in contemporary supply chain systems, as emphasised by Hojer and Wangel [12]. Lastly, the so-called resilience has been redefined in terms of sustainability, which is also the subject of analysis of Wanger et al. [9]. The main mechanisms of coping with disruption presented in Wagner et al. [9] align with the traditional resilience literature, which emphasises redundancy and safety stocks as key mechanisms for controlling disruptions.

These methods focused on buffer capacity and risk mitigation, without considering the long-term environmental implications of these practices. According to modern outlooks, sustainability is a fundamental element of resilience, as demonstrated by Creutzig et al. [1] by incorporating ecological concerns into risk management systems. An environmentally responsible supply chain tends to be more socially stable and legally compliant, and less prone to soft disruptions such as consumer boycotts or regulatory penalties, as explained by Santarius et al. [2]. This broadening of the concept of resilience integrates the social, environmental, and economic aspects. The literature synthesis leads to the identification of a theoretical model according to which algorithmic management can catalyse change toward data-driven decision-making processes, as the authors put it. Green technologies are processes that operationalise sustainability goals through concrete interventions, as discussed by Hojer and Wangel [12]. This leads to resilience as the outcome of a successful digital-green transformation, and Hojer and Mjornell [10] conclude that resilience should be considered a result of such a transformation. Such a combination of perspectives redefines resilience as a dynamic, multidimensional ability, grounded in the synergy between digital intelligence and environmental responsibility, to establish a comprehensive framework for sustainable supply chain management in the new era.

3. Methodology

The research design will be used to empirically confirm the connections between the digital management practices and sustainable resilience outcomes. The research design for this study is quantitative, cross-sectional, and will use a structured survey instrument to collect primary data from industry professionals. The target population includes middle- and upper-level management, supply chain analysts, and technology officers working in the manufacturing, logistics, and technology sectors. The survey was developed using validated scales from the existing literature on digital transformation and environmental management to ensure the reliability and validity of the findings. 261 valid responses were collected, which represent a representative sample of a wide variety of organisation sizes and geographic areas [15].

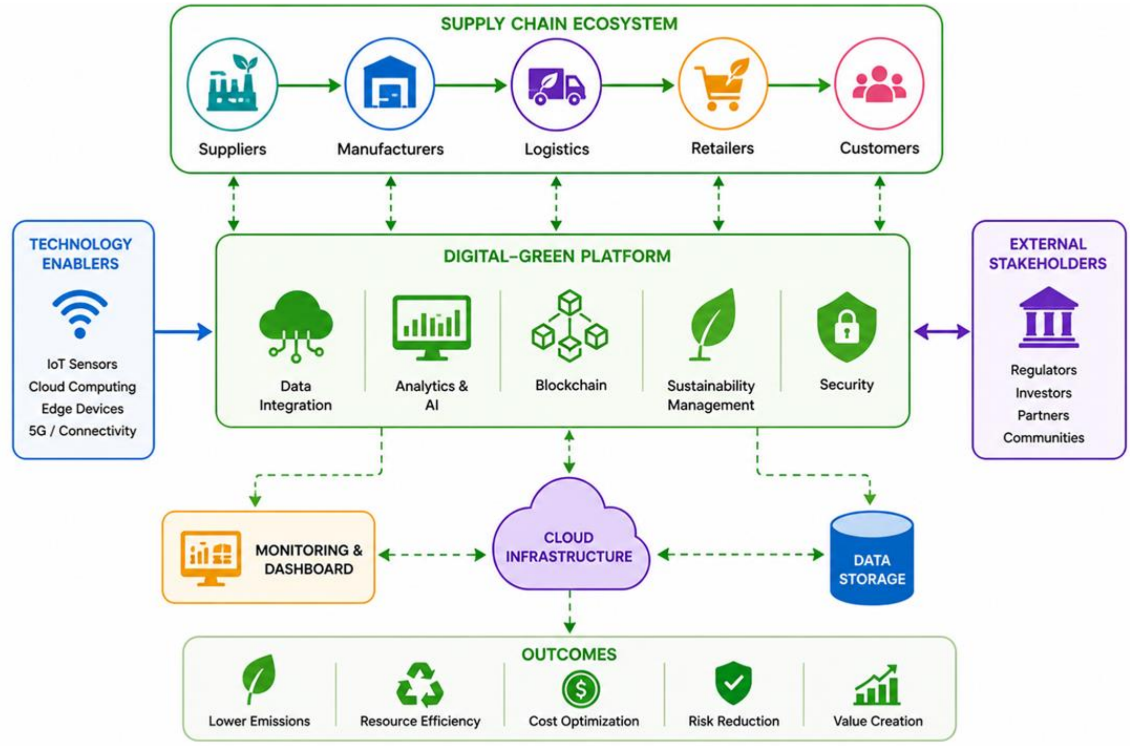

Figure 1: Design of digital-green supply chain transformation

The sampling method adopted was purposive, focusing on people with first-hand experience in implementing digital or green initiatives in their respective organisations. A multi-stage approach was used to analyse the data. First, descriptive statistics were computed to characterise the firms involved and to assess the extent of digital-green integration at present. The research subsequently used Structural Equation Modelling to test the conceptual framework. This method was selected because it can simultaneously analyse both direct and indirect paths, specifically the mediating role of green digital absorptive capacity. Construct reliability, convergent and discriminant validity were measured. After confirming the measurement model, the structural model was tested to test the research hypotheses. Bootstrapping of the mediation analysis was performed using advanced computational software, thereby ensuring robust results. The rigorous approach enables one to develop a comprehensive understanding of how algorithmic management is used as a stimulus that, through technological adoption and knowledge absorption, culminates in improved supply chain resilience. The Architecture of Digital-Green Supply Chain Transformation is presented in Figure 1 as a systematic deployment structure that integrates sustainability with the latest digital technologies to maximise overall supply chain performance. The architecture starts with the Supply Chain Ecosystem layer that consists of suppliers, manufacturers, logistics, retailers, and customers, which is the physical and operational backbone of the flow of products and value creation.

These are related to the Digital-Green Platform, the primary intelligence layer that enables coordination of efforts and decision-making based on real-time data. The key functional modules in this platform include data integration, analytics and artificial intelligence, blockchain, sustainability management, and security, all of which support transparency, efficiency, and environmental accountability. The Technology Enablers layer supports this platform by providing connectivity via IoT sensors, cloud computing, edge devices, and high-speed communication networks, enabling continuous data collection and monitoring across all stages of the supply chain. External Stakeholders, such as regulators, investors, partners, and communities, engage with the system to guarantee compliance, governance, and alignment with the sustainability goals. The Cloud Infrastructure component provides scalable processing and storage capacity, while the Data Storage module supports structured and unstructured datasets for analytics, traceability, and reporting. With the Monitoring and Dashboard interface, one gets a real-time view of operations, performance metrics, and environmental indicators, enabling easy proactive decision-making. Finally, the effect of the transformation, such as decreased emissions, high resource efficiency, economical cost, reduced risk, and increased value creation, is reflected in the Outcomes layer. In totality, the architecture will integrate digital intelligence, environmental sustainability, and operational coordination, with a clean, scalable architecture that will support sustainable, environmentally friendly supply chain transformation.

3.1. Data Description

The dataset comprises 261 unique cases collected from a broad survey of industrial professionals. Every case is a personal perspective on a single company's digital and green maturity levels. The data include measures of the degree of implementation of green disruptive technologies, the adoption rate of green disruptive technologies, and the perceived level of supply chain resilience. To obtain the correct data, the data were cleaned to eliminate outliers and incomplete responses. The sample consists of companies from different industries: 40% are from the manufacturing sector, 30% from the logistics sector, 20% from the technology sector, and 10% from the energy sector. Firms range from small- to medium-sized businesses to large multinational companies. This variation will make the results generalizable in various industrial settings. The dataset serves as the basis for the statistical models in the results section.

4. Results

The analysis began with an overview of the direct effects of algorithmic management on supply chain operations. The results suggest that the introduction of automated decision-making systems is strongly positively associated with the pace of the digital transformation. Firms that used algorithms to manage operations, predict demand, and plan logistics reported that operational transparency increased significantly compared with those that used manual methods. Moreover, these algorithms were also discovered to be the main catalysts of Green Digital Supply Chain Transformation. Algorithms can detect points at which energy consumption can be minimised, e.g., in maritime shipping by optimising vessel speed or in warehouses by reducing idle time. This implies that digital intelligence is not merely a means of efficiency but a basic need of contemporary sustainability endeavours. The multi-objective function for green digital supply chain optimisation is given as:

$$\min Z = \sum_{i\in I} \sum_{j\in J} C_{ij}\, X_{ij} + \psi \sum_{i\in I} \sum_{j\in J} E_{ij}\, X_{ij} \tag{1}$$

Table 1: Relationship analysis of study variables

Variable	ALGM	G-DTC	G-DAC	G-DSCT	G-DSCR
ALGM	1.00	0.65	0.58	0.72	0.61
G-DTC	0.65	1.00	0.62	0.68	0.75
G-DAC	0.58	0.62	1.00	0.55	0.69
G-DSCT	0.72	0.68	0.55	1.00	0.70
G-DSCR	0.61	0.75	0.69	0.70	1.00

Table 1 presents an organised correlation Table quantifying the relationships among five critical constructs: Algorithmic Management, Green Disruptive Technologies, Green Digital Absorptive Capacity, Green Digital Supply Chain Transformation, and Green Digital Supply Chain Resilience. The values in the matrix indicate the extent of the relationship between each pair of variables, providing information about the system's structural relationships. Interestingly, a strong positive correlation is observed between Algorithmic Management and Green Digital Supply Chain Transformation, suggesting that the introduction of algorithm-based decision-making is central to systemic change. This correlation stems from automation, data-based optimisation, and intelligent control systems, which directly lead to the reconfiguration of supply chain operations. Moreover, there is a strong correlation between Green Disruptive Technologies and Green Digital Supply Chain Resilience, indicating that these strategies directly improve adaptability, sustainability, and robustness. The interconnection between absorptive capacity and both transformation and resilience is also moderate to strong, as indicated in the matrix. The consistency of positive correlations across all constructs indicates a unified framework in which one component supports the others. The fact that the constructs do not have negative or weak associations means they work in harmony rather than in opposition. In general, Table 1 provides a statistical background to explain how technological, managerial, and cognitive aspects combine to create resilient and sustainable digital supply chain systems. The dynamic resource orchestration index under resource orchestration theory is:

$$\mathcal{R}_{orchestration} = \int_{t_0}^{t_f} [\mathcal{S}(t) \cdot \mathcal{B}(t) \cdot \mathcal{L}(t)]\, dt \tag{2}$$

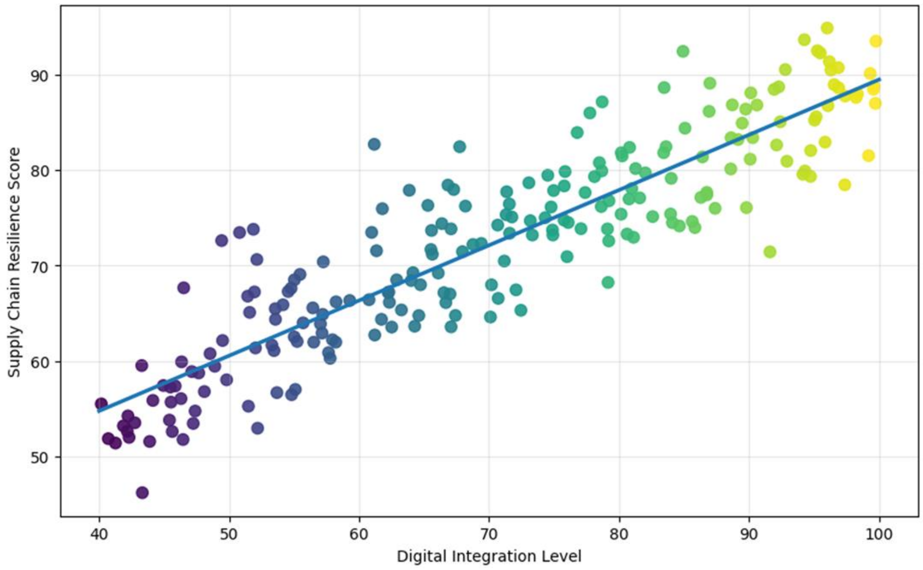

Figure 2: The increasing tendency between the use of technology and organisational stability

Figure 2 is an empirical visualisation of the relationship between digital integration and organisational resilience in supply chain systems. The scatter plot distribution shows a strong concentration of data points in the upper-right quadrant, reflecting firms with a strong concentration in the upper-left quadrant. Spheres such as technology and logistics are where this clustering trend is most evident in working processes. The trend line plotted from the data supports the idea that this relationship has been consistent, with resilience steadily rising as digital adoption increases. The lack of curvature or flattening in the trend suggests that the gains in resilience are proportional to the technological investment over the range considered. This linearity demonstrates that organisations that use automation, predictive analytics, and real-time monitoring systems are more responsive to disruptions, including supply chain and operational disruptions. Moreover, the range of data points around the trend is relatively small, suggesting low variance and high reliability in the relationship between the two variables across observations. The graphical evidence confirms that firms with higher levels of digital maturity consistently perform better than others in maintaining continuity, absorbing disruptions, and adapting to dynamic environmental factors. Structural equation modelling for green digital absorptive capacity can be expressed as:

$$\eta = \Gamma\xi + \mathrm{B}\eta + \zeta \tag{3}$$

Table 2: Sector-wise digital-green maturity levels

Sector	Digital Score	Green Score	Capacity	Transf.	Resilience
Manufacturing	78	82	75	80	79
Logistics	85	70	82	77	81
Technology	92	75	88	85	84
Energy	70	90	72	79	82
Retail	65	60	68	62	65

Table 2 provides a comparative analysis of average performance scores across many industries, with key indicators including digital capability, green adoption, absorptive capacity and resilience. The technology sector is the best performing in terms of digital integration and absorptive capacity, and, as such, it has an inherent orientation towards innovation, data utilisation, and advanced system implementation. The Energy sector, however, has the highest scores in the adoption of green technology, indicating that it has paid close attention to sustainability and environmentally driven transformation initiatives. However, the Logistics sector scores almost the same level of resilience as the Energy sector, despite having a relatively lower green score than the Energy sector. This points out the compensatory impact of digital capabilities in preserving resilience despite moderate levels of green adoption. Retail, however, performs worst across all measured dimensions and is thus less digitalised, less inclined to adopt sustainable technologies, and less absorptive. This positioning indicates a structural gap in adapting to changing technology and environmental needs. The differences in sector performance highlight the impact of industry-specific features on the adoption and integration of digital and green practices. Table 2 captures these differences and shows how various sectors are leveraging their strengths to build resilience, while indicating the different levels of transformation across the broader economic environment. Algorithmic efficiency in green logistics distribution is:

$$\text{Efficiency}(A) = \frac{\sum_{k=1}^{n}(O_k \cdot \text{CO}_{2e\_saved})}{\sum_{m=1}^{p}(R_m \cdot T_m)} \quad (4)$$

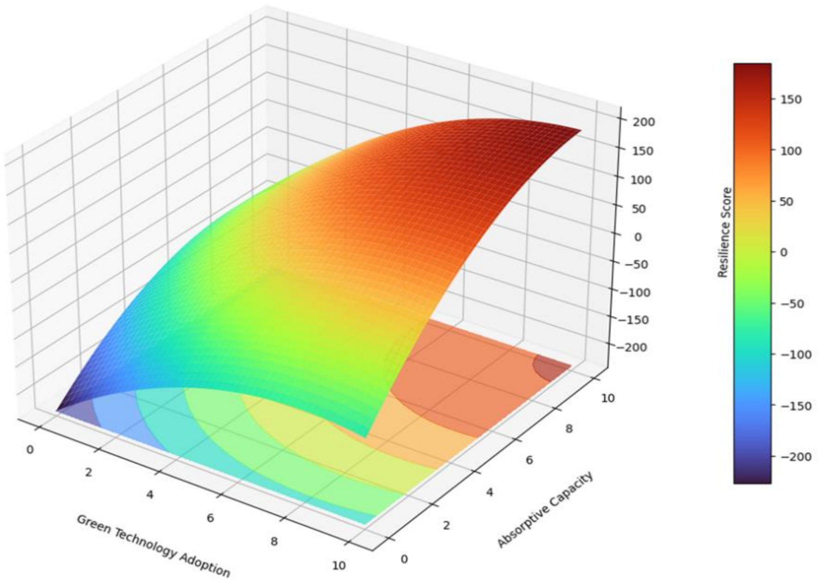

Figure 3: Feedback between technology and the knowledge of a person

Figure 3 provides a detailed three-dimensional view of the interplay between the adoption of green technology and absorptive capacity, and the overall impact on the supply chain's resilience. The mesh surface illustrates a non-linear relationship in which resilience levels are maximised only when both variables are high. Peaks on the surface are sharp at the intersection of high levels of technological adoption and strong absorptive capacity, indicating that optimal performance is achieved through integration between the use of advanced tools and the ability to interpret, assimilate, and apply knowledge effectively. This structural pattern shows that technological investments, by themselves, will not necessarily translate into better resilience unless organisational learning capabilities and knowledge integration mechanisms support them. On the same note, large absorptive capacity, in the absence of proper technological infrastructure, restricts the extent of resilience improvement. The sensitivity of resilience to changes in both dimensions is also evident in the surface gradient, with steeper slopes towards the peak region. This diagram illustrates the interrelationship of both the physical and intellectual resources in an organisation. The three-dimensional plot enables a holistic understanding of the co-evolution of these variables within the organisational system. Non-linear stimulus-organism-response resilience function is:

$$R(s) = \frac{L}{1+e^{-k(s-s_0)}} \quad (5)$$

This paper has also examined the role of green disruptive technology in enhancing supply chain resilience. Statistics show that companies that have already incorporated renewable energy sources and a system for tracking circular materials are much better prepared to withstand external shocks. These technologies offer a certain degree of self-sufficiency that traditional carbon-dependent systems do not. For example, companies that used local microgrids or on-site solar power did not have a significant impact on the region-wide spike in energy prices. The findings indicate that the green technologies will stabilise the network. These decentralised and efficient systems enable the firm to continue its core operations even as other firms face resource scarcity due to environmental or economic crises. This affirms that the green part of the change is crucial for long-term survival. One of the critical findings of this research is that Green Digital Absorptive Capacity can be used as a mediator. The statistics indicate that it is not merely a matter of embracing technology; a firm must have the internal strength to comprehend and utilise it. A significant correlation between algorithmic management and resilience was found to be much stronger in companies with high scores in knowledge acquisition and assimilation.

These companies are not simply using algorithms; they are training on the information generated by them. This in-house operation enables them to keep on improving their green policies. In the absence of such ability, investments in digital and green tools cannot deliver the desired resilience. The last part of the analysis focused on the serial mediation path, beginning with Algorithmic Management, then Green Disruptive Technologies and Absorptive Capacity, and ending with resilience. These findings corroborate this complicated series of impacts. The data push towards the use of green technologies is driven by algorithmic management. These technologies, in turn, create a new learning environment that increases the firm's absorptive capacity. Lastly, this increases the capacity, resulting in high supply chain resilience. Organisations that took this integrated path recorded the highest scores for adaptability and environmental performance. This implies that resilience emerges within a well-known digital-green ecosystem. The results highlight that managers should adopt a holistic perspective, with every step of the technological and organisational process supported.

4.1. Discussions

The findings of this paper provide strong arguments that the future of a resilient supply chain in the modern era lies in both digital and green innovations. The correlation matrix concludes that algorithmic management is the main driver of change. If data-driven algorithms drive management decisions, the shift towards a green supply chain becomes more systematic and quantifiable. This aligns with the theory that the value lies not merely in the possession of resources such as technology but in how they are managed and deployed. The correlation between algorithmic management and change is very high, suggesting that digital tools may provide the control needed to successfully implement complex environmental strategies. The sector-wise analysis provides fascinating insights into the priorities of different industries across these two pillars. Such a large capacity to learn and integrate digitally makes the technology sector a pioneer in overall transformation. Nonetheless, the energy sector's strong performance on green measures indicates that the bottom-up approach to resilience can be applied as well. The Resilience scores for Manufacturing, Logistics, and Energy are astonishingly close despite their varying strengths. This is in line with the fact that there are various routes leading to achieving a reliable supply chain, but all these routes must, in the end, include both the digital and the green in the supply chain to be considered competitive.

The images used emphasise a management point: technology alone is not an investment worth spending on. Only after high technology adoption is balanced by high absorptive capacity is resilience achieved at its highest level. Many organisations cannot succeed in their digital-green transformation due to a lack of focus on how to train their workforce with the skills needed to interpret the resulting data. Absorptive capacity is the organism in our model which processes the digital stimulus. This can be important in the eyes of the managers, as investments in human capital, namely in digital literacy and environmental awareness, are as significant as the investments in the technologies themselves. The facts substantiate the claim that the Twin Transition is not only an ideal theory but also a practical reality with quantifiable benefits. The evident increasing trend is that the more companies are digitally integrated, the more resilient they become. This is in opposition to the argument that digital complexity makes systems more fragile. Quite the opposite: used properly, digital tools will provide the visibility needed to predict problems before they become crises. In sum, the synergies between algorithmic management and green technology create a virtuous cycle of efficiency, learning, and adaptability that is key to the future success of global trade.

5. Conclusion

This study provides profound insight into the potential of algorithmic management and green disruptive technologies to work together to lay the foundation for resilient supply chain ecosystems. The results of an empirical test of 261 industrial cases show that digital intelligence is a catalytic force that accelerates environmentally friendly transformation and simultaneously makes operations more robust. A combination of algorithm-based decision-making and a green innovation framework will help organisations move beyond traditional supply chain patterns and adopt new, resource-efficient, and dynamically adaptive systems. One of the main contributions of this study is that green digital absorptive capacity is a key decisive facilitator in this transformation process. Organisations with a high capacity to acquire, understand and utilise technological knowledge achieve much higher resilience outcomes than those that rely solely on infrastructure investments. The discussion shows that resilience does not arise from adopting isolated technological solutions but from the coordinated orchestration of digital tools and sustainability-driven strategies. This mutual support between environmental accountability and technological development is called the Twin Transition. In addition, the results indicate that organisations with high resilience levels are always able to integrate predictive analytics, automation, and green operations into a unified operational system. This synergy increases responsiveness to disruption, reduces the ecological footprint, and helps meet long-term sustainability objectives. The study has ultimately provided a systematic roadmap for industries keen to improve their adaptability in unpredictable environments. By making digital transformation and environmental responsibility intersect, organisations are assured that their supply chain is more than efficient and responsive; it can also withstand performance under conditions of uncertainty and global disruption.

5.1. Limitations

Although the current study offers valuable insights into the relationships among digitalisation, sustainability, and resilience, it has certain limitations that may affect the generalizability and depth of its results. The cross-sectional nature of the data used limits the analysis to a single temporal snapshot, preventing the dynamic, evolving nature of digital green transformation processes from being captured. Since organisational adaptation occurs over long periods, the lack of long-term monitoring diminishes the ability to monitor causal processes and to track changes in resilience patterns over time. Also, since self-reported data are used, there is a risk of subjective bias, as respondents might over- or underestimate their firm's technological maturity and sustainability performance. This variability, based on perception, may affect the accuracy of the measured constructs. Although the sample composition is diverse across industrial categories, it remains concentrated within certain sectors, which limits the implications of the findings for broader contexts, such as service-oriented industries or non-profit organisations. The other limitation is the failure to account for regulatory and institutional differences across regions. Differences in environmental policies, provision of digital infrastructure support and compliance requirements have tremendous impacts on the adoption rate and performance of both algorithmic management and green technologies. These contextual variables are not included, making it impossible to explain the results in a global comparative context. All these limitations serve to specify the boundaries within which the study's findings are interpreted, while maintaining the internal consistency and analytical validity of the observed relationships.

5.2. Future Scope

Future research can be further extended to the temporal, contextual and technological aspects that have not been explored in the present research paper. Longitudinal studies offer the opportunity to examine the gradual evolution of digital green transformation and its long-term effects on supply chain resilience. These studies allow us to observe the cycles of adaptation, the impact of learning, and the structural changes that occur when advanced technologies and sustainability practices are implemented in the organisation. The inclusion of small and medium-sized enterprises and service-oriented sectors in the research framework enhances the analysis's comprehensive nature, as it encompasses a range of operational environments and resource constraints. The other crucial direction, particularly regarding the implications for the workforce, data management, and transparency in decision-making processes in environment-driven systems, is the exploration of the ethical dimensions of the situation, which is connected to algorithmic management. The effects of governmental policies and institutional frameworks, through further research of the subject matter, can offer valuable insights into the role of external factors in the interaction between digitalisation and sustainability. The relevance of policy incentives, regulatory requirements, and supportive infrastructure mechanisms may also affect the pace and effectiveness of the transformation initiatives.

Acknowledgement: The authors would like to express their sincere gratitude to Sathyabama Institute of Science and Technology, Thangavelu Engineering College, Air Direct Solutions LLC, Sakarya University, and Dhaanish Ahmed College of Engineering for their valuable support, guidance, and resources throughout this research.

Data Availability Statement: Data is available upon request from the corresponding author.

Funding Statement: This research received no financial support.

Conflicts of Interest Statement: No conflicts of interest were declared; all references were appropriately cited.

Ethics and Consent Statement: The research adhered to ethical guidelines, with informed consent and confidentiality ensured.

References

1. F. Creutzig, D. Acemoglu, X. Bai, P. N. Edwards, M. J. Hintz, L. H. Kaack, S. Kilkis, S. Kunkel, A. Luers, N. Milojevic-Dupont, D. Rejeski, J. Renn, D. Rolnick, C. Rosol, D. Russ, T. Turnbull, E. Verdolini, F. Wagner, C. Wilson, A. Zekar, and M. Zumwald, "Digitalization and the anthropocene," *Annual Review of Environment and Resources*, vol. 47, no. 10, pp. 479–509, 2022.
2. T. Santarius, J. C. T. Bieser, V. Frick, M. Hojer, M. Gossen, L. M. Hilty, E. Kern, J. Pohl, F. Rohde, and S. Lange, "Digital sufficiency: Conceptual considerations for ICTs on a finite planet," *Annals of Telecommunications*, vol. 78, no. 5, pp. 277–295, 2023.
3. N. Milojevic-Dupont and F. Creutzig, "Machine learning for geographically differentiated climate change mitigation in urban areas," *Sustainable Cities and Society*, vol. 64, no. 1, p. 102526, 2021.
4. H. Jiang, Z. Sun, H. Guo, Q. Weng, W. Du, Q. Xing, and G. Cai, "An assessment of urbanization sustainability in China between 1990 and 2015 using land use efficiency indicators," *npj Urban Sustainability*, vol. 1, no. 7, p. 34, 2021.
5. T. Liu and Y. Li, "Green development of China's Pan-Pearl River Delta mega-urban agglomeration," *Scientific Reports*, vol. 11, no. 8, p. 15717, 2021.
6. Z. Yin, X. Jiang, S. Lin, and J. Liu, "The impact of online education on carbon emissions in the context of the COVID-19 pandemic—Taking Chinese universities as examples," *Applied Energy*, vol. 314, no. 5, p. 118875, 2022.
7. T. M. Khanna, G. Baiocchi, M. Callaghan, F. Creutzig, H. Guias, N. R. Haddaway, L. Hirth, A. Javaid, N. Koch, S. Laukemper, A. Löschel, M. del Mar Zamora Dominguez, and J. C. Minx, "A multi-country meta-analysis on the role

of behavioural change in reducing energy consumption and CO2 emissions in residential buildings," *Nature Energy*, vol. 6, no. 9, pp. 925–932, 2021.
8. S. A. Argyroudis, S. A. Mitoulis, E. Chatzi, J. W. Baker, I. Brilakis, K. Gkoumas, M. Vousdoukas, W. Hynes, S. Carluccio, O. Keou, D. M. Frangopol, and I. Linkov, "Digital technologies can enhance climate resilience of critical infrastructure," *Climate Risk Management*, vol. 35, no. 1, p. 100387, 2022.
9. F. Wagner, N. Milojevic-Dupont, L. Franken, A. Zekar, B. Thies, N. Koch, and F. Creutzig, "Using explainable machine learning to understand how urban form shapes sustainable mobility," *Transportation Research Part D: Transport and Environment*, vol. 111, no. 10, p. 103442, 2022.
10. M. Hojer and K. Mjornell, "Measures and steps for more efficient use of buildings," *Sustainability*, vol. 10, no. 6, p. 1949, 2018.
11. S. Parida and M. Acharya, "Effects of green technology investment and trade-credit facility in a two-warehouse fuzzy inventory model under partially backlogged shortages," *AVE Trends in Intelligent Applied Sciences*, vol. 1, no. 1, pp. 37–47, 2025.
12. M. Hojer and J. Wangel, "Smart sustainable cities: Definition and challenges," in ICT Innovations for Sustainability, *Springer*, Cham, Switzerland, 2015.
13. C. R. Mohapatra, S. Subhadarshini, and D. K. Mishra, "Leveraging technology for sustainability: The role of HRIS and green software in enhancing Green HRM practices," *AVE Trends in Intelligent Technoprise Letters*, vol. 2, no. 3, pp. 170–179, 2025.
14. F. Caprotti and D. Liu, "Platform urbanism and the Chinese smart city: The co-production and territorialisation of Hangzhou City Brain," *GeoJournal*, vol. 87, no. 3, pp. 1559–1573, 2022.
15. S. O. Manjare, "Rooted resilience: Sustainable agriculture as a catalyst for rural development in India," *AVE Trends in Intelligent Social Letters*, vol. 2, no. 1, pp. 38–51, 2025.
16. X. Yan and T. Li, "Construction and application of urban digital infrastructure—Practice of 'Urban Brain' in facing COVID-19 in Hangzhou, China," *Engineering, Construction and Architectural Management*, vol. 30, no. 8, pp. 3123–3141, 2023.