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Original Article

Examining the Role of Adaptive Policy Frameworks and Organisational Sustainability in the Indian Manufacturing Industry under Uncertain Business Conditions

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Abstract: *The Indian manufacturing industry is experiencing a radical change as a result of globalization, digitization, environmental factors, technological disruption, and business uncertainties. Supply chain disruptions, fluctuations in prices of raw materials, geopolitical issues, climate change regulations, and the emergence of Industry 4.0 technology are some of the factors responsible for creating operational and strategic issues for manufacturing firms. The traditional rigid governance strategies are becoming obsolete in managing such uncertain scenarios and, therefore, require new policy strategies that enhance adaptability and sustainability. In this research, an explorative methodology will be used through literature analysis concerning adaptive governance, organizational sustainability, Industry 4.0, and sustainable manufacturing. This study explores the role played by the mechanisms of adaptive governance, which include value chain flexibility, real-time data integration, monitoring mechanisms, and organizational culture with a focus on sustainability, in facilitating organizational resilience, efficient use of resources, innovations, and competitiveness. In addition, the study evaluates the key driving forces and the key hindrances to the uptake of sustainability in India. These factors include institutional pressure, competitive pressure, technical hurdles, financial limitations, and supply-related obstacles. It has been established that manufacturing companies which adopt adaptive governance mechanisms and sustainable practices have better chances of managing uncertainties and enhancing resilience.*

Keywords: *Adaptive Policy Frameworks, Organizational Sustainability, Indian Manufacturing Industry, Industry 4.0, Business Uncertainty, Sustainable Manufacturing, Organizational Resilience, ESG, Dynamic Capabilities, Green Manufacturing.*

1. Introduction

Manufacturing forms the backbone of India's strategy for macroeconomic growth and development. Through proactive state interventions like the 'Make in India' program, Production-Linked Incentives (PLIs) at the national level, and the drive to digitalize the industrial sector, the industry strives to increase its contribution to the national Gross Domestic Product (GDP). But this process faces many challenges from the environmental degradation, frequent geopolitical tensions, volatile prices of raw materials, and fast-changing technologies [1]. The Indian manufacturing industry finds itself working in two distinct domains: on one hand, the companies are required to take advantage of growing demands and digitalization, whereas on the other, they need to comply with international climate goals, including India's commitment to reach Net-Zero carbon emissions by 2070. Working within modern markets, businesses face conditions that can be characterized by business thinkers as turbulent, unpredictable, complex, and ambiguous. Modern global events, such as long-term pandemic restrictions, massive semiconductor shortages, and disorganized marine logistics chains, have led these conditions closer to being defined as BANI: brittle, anxious, non-linear, and incomprehensible. The classical approaches to business planning, which are built on assumptions of stability, multi-year forecasts, and rigid regulation processes, do not possess structural capabilities to absorb such fast and non-linear shocks [2].

The Indian manufacturing industry is currently undergoing huge changes owing to various factors such as digitalization, use of Industry 4.0 technology, sustainable manufacturing processes, Make in India approach, and globalization of the supply chain [3]. However, while these changes present opportunities for growth, they also subject the firm to a higher level of uncertainty and complexity. Under such conditions, the connection between adaptive policy approaches and organizational sustainability becomes crucial. The manufacturing organizations that have adaptive management systems and sustainable practices are better positioned to cope with any disruption, ensure business continuity, and gain a competitive advantage. As a result, manufacturing businesses are highly susceptible to catastrophic disturbances without implementing flexible management practices in their corporate governance [4].

For survival and thrive under such chaotic conditions, organizations need to strike a balance between their immediate profit-driven activities and their long-term ecological and social objectives, commonly referred to as organizational sustainability. This multi-faceted sustainability calls for moving away from rigid compliance strategies to dynamic and responsive regulatory frameworks that keep adapting themselves according to changing realities of operations by taking empirical cues and through comprehensive monitoring systems [5]. Despite much attention that has been paid by researchers to both adaptive regulation and organizational resilience, there remains a marked gap in the traditional literature in terms of the relationship between adaptive corporate policies internally and sustainability externally within an emerging economy such as India. In this respect, this paper seeks to explore whether or not adaptive regulatory mechanisms can help in achieving organizational sustainability in the face of volatile economic environment in the Indian manufacturing industry [6]. Further, this paper will seek to explore how organizational resilience, innovation, efficiency and performance are affected by adaptive techniques, flexible governance and sustainability. Furthermore, it will seek to emphasize the trategic importance of sustainability and adaptation in the Indian manufacturing industry faced with constant uncertainties. Through this research, the study hope to add to the growing body of knowledge regarding adaptable organizational approaches and sustainable business practices in developing economies such as India.

1.1. Objective of the study

- To examine the concept and significance of adaptive policy frameworks in the manufacturing industry.
- To analyse the importance of organisational sustainability under uncertain business conditions.
- To review the challenges faced by the Indian manufacturing industry in dynamic business environments.
- To evaluate the relationship between adaptive policy frameworks and organisational sustainability.
- To identify strategic approaches that enhance resilience and sustainable performance in manufacturing organizations.

2. Conceptual Foundation

Adaptive Policy Frameworks and Agile Governance: An adaptive policy framework constitutes an evolutionary breakthrough from the traditional, command-and-control style of administration. According to academic literature, an adaptive policy is an institutional framework specifically designed to ensure that it continues to be effective and relevant regardless of the future conditions it may face [7]. While a traditional framework follows a one-way linear plan for the future, an adaptive framework considers the policy-making process as one that involves planned modifications, piloting, and continuous M&E. In the business setting, adaptive policies are evident through flexible organizational policies, automatic adjustments of SOPs based on pre-set market benchmarks, and decision-making units that can act swiftly without necessarily seeking approval from the top management of the organization [8]. Organisational Sustainability and the Triple Bottom Line: Organisational sustainability has evolved beyond its previous CSR approach to becoming a fundamental business necessity. Organisational sustainability is based on the Triple Bottom Line (TBL) framework proposed by John Elkington, which mandates that the firm manage all three factors of economic success, ecological preservation, and social development concurrently. For an organization to be sustainable within the manufacturing sector, it must adopt an all-encompassing approach rather than the one-dimensional approach of take-make-waste and embracing the model of the circular economy which emphasizes closed-loop systems in production, minimizing waste, utilizing renewable energy sources, and recycling of resources. Within the developing nations such as India, organizations face the challenge of being efficient and at the same time making significant investments in technology for managing the environment and safe employment for its workers [9]. The Intersection: Sustainable Dynamic Capabilities (SDCs): For a conceptual integration of adaptive policies and sustainability, this paper applies the principles of Dynamic Capabilities Theory, originally developed by David Teece (2018) and further refined by experts in corporate strategy. The term "dynamic capabilities" describes the rare and unique ability of an organization to identify opportunities and threats in its market environment, capitalize on these opportunities by investing in them, and constantly change its physical, human, and technological resources in response to changes in the environment. Applied to corporate green strategies, this leads to the introduction of the concept of "Sustainable Dynamic Capabilities" (SDCs). It denotes the routine activity by which managers turn environmental and adaptive policies into sustainable dynamic capabilities [10].

3. Volatility and Uncertainties in the Indian Manufacturing Landscape

The operational dynamics of manufacturing firms in India are unique in their complexity, characterized by distinct environmental pressures, which make the already difficult aspects of manufacturing even more challenging. These pressures can be generally divided into supply pressures, regulatory pressures, and market pressures [11].

3.1. External Macro-Shocks and Supply Chain Disruptions

Indian producers are highly susceptible to shocks within their global value chains. This is due to the fact that a large number of components, electronic assemblies, and APIs are imported, so any unforeseen event such as maritime disruption, border disputes, or even macroeconomic locking up immediately leads to production stoppage and sharp rises in the prices of inventories. In addition, local risks such as unreliable power supply systems, climate changes impacting raw material sourcing, and logistics constraints within the region undermine value chain flexibility [12].

3.2. Evolving Regulatory Frameworks and Carbon Commitments

There are fast-changing times in terms of the Indian

regulatory framework. Regulations that have been introduced by the Indian government regarding shifting towards the use of EVs, severe regulations about groundwater withdrawal, and strict regulations about MSW disposal force businesses to continuously adapt their business practices. In addition, in light of the fact that India is progressing towards meeting its obligations in terms of carbon emission reductions, penalties on industrial pollutants, emissions, and energy consumption are getting stricter.

3.3. Technological Disruptions: From Industry 4.0 to Industry 5.0

IoT, cloud data warehousing, and robotics—the world is now moving towards Industry 5.0. This industry focuses on a very important shift from automation to a human-centred approach where environmental sustainability is embedded within cyber physical systems. The challenge for Indian organizations is that the integration of these technologies involves considerable investments and flexible human resource management [13][14].

4. Mechanisms of Adaptive Policy Frameworks at the Firm Level

Above flowchart (Fig 1) depicts how adaptive policy frameworks enable manufacturing firms to attain organizational sustainability amidst uncertain business environments. The mechanisms include value chain flexibility, real-time data integration, and organizational culture. Value chain flexibility increases adaptability in procurement, production, and logistics activities in case of disruptions. Real-time data integration ensures that continuous monitoring and feedback take place while decisions are made fast using modern technology such as artificial intelligence and big data analytics. Organizational culture maintains the balance between flexibility and control by fostering employee empowerment, learning, monitoring, and evaluation processes.

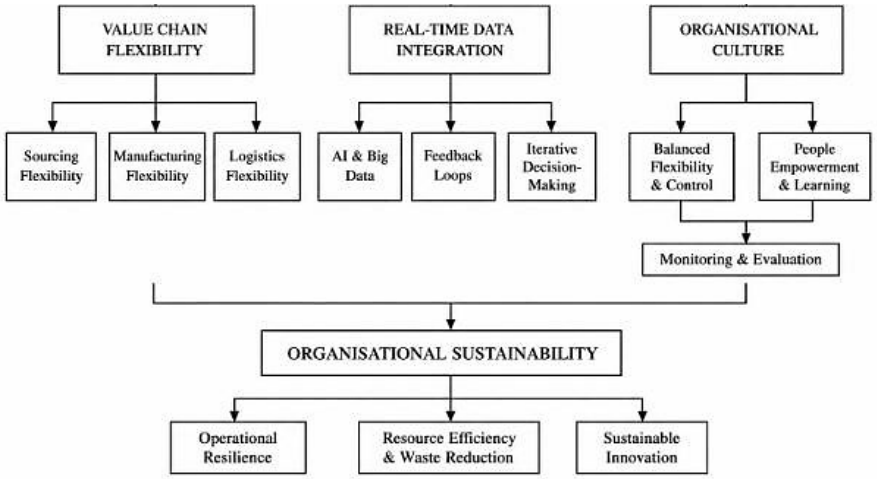

Fig 1: Adaptive Policy Framework

Enhancing Value Chain Flexibility: VCF is the main operational buffer to deal with unexpected external threats. VCF includes sourcing flexibility (which involves switching sources quickly without affecting quality), manufacturing flexibility (which means changing the volume or type of production quickly), and logistics flexibility. In the case of adaptation, companies adopt policies that require multi-sourcing, local sourcing, and modular manufacturing. Flexibility will help the company overcome external threats while reducing negative environmental and social impacts from operational inefficiencies. Iterative Decision-Making and Real-Time Data Integration: Adaptive corporate governance is more concerned with empirical signals in real time than with any assumptions based on past experiences. Through the use of innovative technologies such as Generative Artificial Intelligence (GAI), Big Data [15], and cloud computing, adaptive companies will be able to create feedback mechanisms [16]. With predictive maintenance, real-time emissions, and demand forecasting algorithms, executive boards will be able to quickly revise their production schedules, energy distribution, and raw material usage without wastage. Organisational Culture: Balancing Flexibility and Control: The effective implementation of any adaptive policy will depend primarily on the organization's existing culture. Research shows that embedding sustainability in deep strategic actions needs a multi-faceted culture that is able to align the conflicting values both internally and externally. A highly controlling culture might guarantee compliance with regulations but it tends to undermine the necessary creativity and experimentation for sustainable innovation. At the same time, a flexible culture that lacks governance structures may result in fragmented green actions. Effective adaptation requires creating a culture where people empowerment and constant learning are combined with monitoring and evaluation mechanisms. Monitoring & Evaluation: Monitoring and evaluation in the adaptive policy framework entail the ongoing exercise of observing the operations of the organization, gauging its performance, and determining how effective the achievement of the sustainability objectives is. The exercise of monitoring entails the regular gathering of information concerning the operational performance of the organization in terms of production efficiency, energy usage, waste management, supply chain performance, and environmental impact. The

exercise of evaluation entails the analysis of such information to determine the strengths, weaknesses, threats, and opportunities [17]. In the flowchart, monitoring and evaluation are used as a control process that provides a balance between adaptability and responsibility within an organization. This ensures that the adaptation process remains in line with the business objectives and sustainability goals. Organisational Sustainability: Sustainability of an organisation is concerned with the capacity of the manufacturing company to achieve sustained growth, stability, and competitiveness while fulfilling economic, social, and environmental obligations. The sustainability of the organization is viewed as the main goal in the flowchart that can be realized through the use of adaptive policies such as flexible value chain, instant data integration, and organizational culture. Operational Resilience: This refers to the ability of an organization to continue operating in conditions of disruption, uncertainty, or market change. Efficiency of Resource Management and Waste Management: Effective resource management and efficient reduction of waste production. Sustainable Innovation: This refers to the innovation of new products/technologies for sustainable development of businesses.

However, this approach will have to rely largely on how successful the implementation process will be. It is due to the fact that it is the combination of value chain agility, relevant information provision, and cultural issues that make this approach valuable. Multi-sourcing, modular production, and predictive analysis allow firms to respond to any external disturbance instantly, thus avoiding the waste of scarce resources. However, implementation of this framework is quite complicated, as it requires sophisticated technology and high-quality talent as well as proper governance mechanisms, which can be difficult for small firms to achieve. Cultural consideration in the framework is especially sensitive – too much control will stifle creativity, but too much flexibility may lead to inconsistent actions. Additionally, there is always a risk of inaccuracy and biases because of the use of artificial intelligence and data-based signals when the quality of data is poor. Evaluation and monitoring offer accountability, but measuring social and environmental performance is not easy.

5. Correlation Between Organisational Sustainability and Adaptive Policy Frameworks

Adaptive policy frameworks and organisational sustainability have a very strong correlation because adaptive governance systems allow organisations to adapt and respond to uncertainty and constant changes within business environments while ensuring sustainable performance. Adaptive policy frameworks involve being flexible and responsive, making continuous improvements, and adopting an ability to make decisions dynamically. By means of these adaptive policy models, it is possible for organizations to be prepared for all kinds of economic fluctuations, technical disturbances, environmental threats, and market uncertainty. It can be accomplished through ensuring that organizations become adaptable in their business models, allocate their resources more effectively, enhance their risk management practices, and implement technology according to the changing dynamics of the business environment. Organizational sustainability can be defined as making sure that there is economic viability, environmental responsibility, socio-economic benefit, and sustainability. The connection between these two becomes clear since adaptive policy models act as a basis for achieving sustainability. In India's manufacturing sector, where businesses are faced with globalization, policy uncertainty, technological change, and environmental factors, adaptive policies enable organisations to sustain themselves through a combination of flexibility and control. As such, adaptive governance is an important facilitator of organisational sustainability due to its contribution towards resilience, innovation, sustainable manufacturing, and long-term survival.

The concept of dynamic governance responsiveness is the capacity of an organization to modify its policies, strategies, and governance systems based on changes in the external environment. The adaptive policy framework enables an organization to make decisions that ensure quick adjustments of its policies and governance system so as to cope with economic instability, technological disruption, and market uncertainty. This enhances the sustainability of the organization through its ability to sustain operations and be adaptable. Framework helps sustain organizations due to intelligent mechanisms of resource optimization, which involve effective use of energy, material, labour, and technology resources. Monitoring, prediction, and control of operations using data assist organizations in cutting down wastes, increasing efficiency, and maintaining sustainable practices of production. Such mechanisms not only ensure reduced cost but also contribute to environmental sustainability by reducing resource exploitation and pollution from industries [18]. Continuous innovation and transformation are key aspects of adaptive governance that contribute to sustainable industrial development. The flexibility of policy frameworks helps manufacturing organisations to integrate innovative technologies, transform production processes, and embrace sustainable business practices [19]. Innovation-based transformation helps companies to enhance the quality of their products, boost efficiency, practice green manufacturing, and gain competitive advantage in dynamic environments. Employees, suppliers, consumers, investors, regulators, and community members are all considered internal and external stakeholders in adaptive policy designs. These designs encourage all parties involved to be open, involved, accountable, and work towards a shared objective of sustainability. In order to improve trust, corporate image, compliance with rules, and social responsibility, it is essential for a business to be in alignment with its stakeholders. This makes these types of businesses better able to maintain growth even when faced with strong market competition and the backing of key stakeholders.

6. Literature Review

Tiyasa Mishra & Bhagirath Behera (2024), the study has been done using secondary data collected from the KLEMS database of Reserve Bank of India for the period 1980-81 to 2019-20 through the use of descriptive statistics and econometric methods for achieving the aim of the study. It has

been seen that the decreasing trend has been witnessed in case of energy intensity, vertical integration, capital intensity, and growth in total factor productivity in the decades, however, an increasing trend has been seen in labour productivity in most of the sectors. However, in case of material intensity, there is inconsistency in trends. Moreover, regression analysis shows that there have been significant effects of exogenous shocks on resource utilization and factor productivity [20].

Gunjan Yadav et al. (2020) seeks to suggest a model which could be utilized to encourage the adoption of sustainability in the manufacturing firms of developing countries using the technologies associated with Industry 4.0. First and foremost, the elements or variables that have an important bearing on the adoption of sustainability are identified via the technique of literature review. Thereafter, the factors that will be included in the model as the enablers of Industry 4.0 technologies are determined via the technique of conducting a survey on a large scale. Subsequently, an empirical model is formulated and tested in a manufacturing firm based in India. Finally, the Robust Best Worst Method (RBWM) is utilized to gauge the extent of influence of each variable incorporated in the model. The findings from this research suggest that the managerial, economic and environmental enablers significantly influence the adoption of sustainability [21].

Minhaj Ahemad et.al (2016) study includes A practical assessment and set of rules for gauging the effect of green manufacturing (GM) strategies on the efficiency and effectiveness of Indian businesses. Deriving key GM practices from empirical data, assessing these elements' beneficial effect on organizational performance, and constructing a model to correlate these vital aspects with performance metrics are all goals of the study process. The data for this study was gathered using a survey approach. To gather information from Indian manufacturing enterprises that engage in or undergo GM, a diagnostic research survey method was developed and put into use. In addition to building a model, the authors optimize it, undertake sensitivity analyses to check its robustness, and use artificial neural network (ANN) simulation to see how well it can predict patterns and trends. As an additional piece of evidence for the model's efficacy in lowering environmental effects, data from a case firm has been used to validate it. Factors that impact different manufacturing techniques and have a substantial impact on organizational performance were identified, prioritized, then modelled and validated in this study [22].

Danny Weyns et al. (2023), Many aspects of modern society rely on computing systems, including healthcare, industry, traffic control, and financial institutions. Systems in which software is integral to the planning, construction, and operation are known as software-intensive systems. Automating tasks that would normally need human operators or handling unexpected scenarios are both made possible by self-adaptation, a feedback loop for software-intensive systems. Several real-world applications have made use of these feedback loops; two common ones are elastic clouds, which allow for the dynamic modification of computer resources, and automated server management, which allows businesses to react quickly to changes in demand. They performed a large-scale survey to learn more about the following: the reasons for employing self-adaptation in practice, the problems that self-adaptation solves and how it solves them, and the risks and difficulties that industry faces when it adopts self-adaptation. Practitioners from 21 different countries contributed 184 valid responses. They provide an empirically-grounded summary of the current state-of-practice in self-adaptation implementation based on the analysis of the survey data. It provides useful information for both researchers and practitioners to evaluate the relevance of their current work to industry needs and the efficacy of self-adaptation strategies. These findings lay the groundwork for future research into self-adaptation and its possible practical applications [23].

Ankur Aggarwal et al (2022) Smart and sustainable manufacturing techniques have been favoured by manufacturing industries due to the fast-paced technology progress and unpredictable global client demand. Now businesses are moving towards Industry 4.0 to meet the demands of mass customisation and create value in a sustainable way. The Indian industrial sector is vital to the country's economic growth and is well recognized as a global leader in producing automotive components. However, owing to a number of technical and financial limitations, smart manufacturing processes have not yet reached a widespread level of acceptance in India. In emerging nations like India, the industrial sector is struggling to implement smart and sustainable production methods. Therefore, our research aims to connect the dots between smart manufacturing and sustainable practices in developing nations. This study employed a hypothesis modelling approach to look at how smart manufacturing and sustainable practices relate to manufacturing competitiveness and the dedication of upper management. The manufacturing industries in India were the subjects of a research that used a questionnaire to collect data. Therefore, the scanning electron microscopy technique was used for this inquiry. The findings of this study suggest that manufacturing companies in emerging markets, such as India, may embrace smart and sustainable manufacturing practices [24].

Moreover, below Table I will explain the comparison.

Table 1: Comparison of Literature Review

Authors & Year	Research Focus	Methodology Used	Major Findings
Tiyasa Mishra & Bhagirath Behera (2024)	Examined the impact of external shocks on resource use patterns and productivity in Indian manufacturing industries.	Secondary data from RBI KLEMS database (1980–81 to 2019–20); descriptive statistics and econometric analysis.	Found declining trends in energy intensity, capital intensity, and productivity growth, while labour productivity increased. External shocks significantly influenced resource usage and productivity across industries.
Gunjan Yadav et al. (2020)	Proposed a framework to promote sustainability adoption in manufacturing organizations using Industry 4.0 technologies.	Literature review, large-scale survey, empirical model testing, and Robust Best Worst Method (RBWM).	Identified managerial, economic, and environmental enablers as key drivers of sustainability adoption through Industry 4.0 technologies.
Minhaj Ahemad et al. (2016)	Evaluated the impact of green manufacturing (GM) practices on organisational performance in India.	Survey methodology, empirical modeling, sensitivity analysis, Artificial Neural Network (ANN) simulation, and case validation.	Identified and prioritized critical green manufacturing factors influencing organizational performance and environmental impact reduction.
Danny Weyns et al. (2023)	Investigated the implementation of self-adaptation in software-intensive systems across industries.	Large-scale international survey with 184 valid responses from practitioners in 21 countries.	Found that self-adaptation improves operational responsiveness, automation, and management of unpredictable situations through feedback-loop systems.
Ankur Aggarwal et al. (2022)	Studied the relationship between smart manufacturing, sustainability, and manufacturing competitiveness in Indian industries.	Questionnaire-based survey and Structural Equation Modeling (SEM).	Concluded that top management commitment and manufacturing competitiveness positively influence the adoption of smart and sustainable manufacturing practices.

Research Gap: Previous studies have examined adaptive governance, organisational resilience, green manufacturing, and sustainability practises separately, but few have examined how adaptive policy frameworks affect organisational sustainability in the Indian manufacturing industry under uncertain business conditions. Most studies evaluate technological adoption, Industry 4.0 deployment, or environmental sustainability without combining adaptive governance mechanisms with long-term sustainability. Insufficient empirical research shows how adaptive policies like flexible governance, real-time decision-making, value chain flexibility, and monitoring systems affect operational resilience, innovation capability, and sustainable performance in Indian manufacturing firms. MSMEs' adaptable and sustainable practices under unpredictable economic and environmental settings are similarly understudied. Thus, this study examines adaptable policy frameworks and organizational sustainability in India's dynamic industrial environment to close this gap.

7. Driversa and Barriers to Organizational Sustainability in India

Institutional and Market Drivers: The external force is currently one of the key factors that are motivating Indian manufacturing companies to go green. In the current world where the global economy has taken shape, Indian manufacturing companies are not working only in their local markets but are also embedded in international supply chains and export channels. Garments, automotive parts, chemicals, pharmaceuticals, electronics, among others, are some of the industries that supply products to multinationals and global brands operating in Europe, North America, and other advanced economies [25]. The multinational partners and global brands require the suppliers to adhere to ESG standards, sustainable supply chains, carbon emissions reductions, and ethical production systems. Consequently, there is pressure on Indian companies to embrace environmentally friendly operations. In addition, global consumer protection watchdogs, environmental activists, and sustainability agencies have also added to the external pressure through constant surveillance of business practices concerning the environment. Firms that do not meet the sustainability criteria could be subjected to negative reputation, loss of investor confidence, trade sanctions, and even exclusion from international supply chains [26]. Moreover, institutional investors and financial institutions have become interested in investing in those firms that have high ESG performance, good governance systems, and sustainable operations. An example of an initiative is the

Perform, Achieve and Trade (PAT) Scheme implemented by the Bureau of Energy Efficiency within the Ministry of Power. The Perform, Achieve and Trade Scheme is a market-based energy efficiency tool that establishes energy consumption targets for energy-intensive industries like cement, steel, thermal power, fertilizer production, and aluminium smelting. Companies that are able to meet or surpass the set energy efficiency targets earn Energy Saving Certificates (ESCerts) that can be traded on the market, whereas those that fall short pay fines. This approach provides incentives as well as the pressure for industrial organizations to use cleaner technologies, optimize energy use, increase production efficiency, and decrease their carbon footprint [27]. As a result, many manufacturing companies in India have started making investments in renewable energy systems, waste management technology, automation, process optimization, and sustainable production techniques. In other words, market pressure, international pressure, investor pressure, and government pressure together become very effective drivers of sustainable transformation for Indian manufacturing companies.

Key Operational and Structural Barriers**:** Although there is greater consciousness regarding environmental protection and sustainable practices among businesses, the implementation of sustainability programs on a large scale by Indian industries still faces many important issues and barriers. There are many manufacturing companies aware of the importance of sustainability for competitiveness and regulatory purposes; however, there are quite a few challenges faced while implementing such sustainable initiatives. The lack of commitment from suppliers toward sustainability is among the biggest challenges. Sustainable success in the Indian manufacturing supply chain, in industries like textiles, chemicals, automotive components, and consumer goods, cannot be realized just through the focus firm but requires involvement from suppliers and logistics firms [28][29]. The suppliers, especially small suppliers, do not have sufficient funds or technology to adopt sustainable inputs and sustainable procurement processes. Another key challenge related to sustainability lies in the knowledge gap regarding sustainable manufacturing practices. In many cases, people involved in manufacturing such as managers, workers, suppliers, etc., have insufficient knowledge of concepts such as environment management systems, energy efficiency, waste minimization, carbon accounting, circular economies, etc. This problem exists mainly in the case of low tier suppliers and conventional manufacturing industry as sustainability is viewed as a burden rather than being a method of gaining a competitive edge. Inadequate knowledge and technological expertise hinder the adoption of sustainability in manufacturing processes. Another major hindrance to sustainability is financial constraints, especially in the case of SMMES. The technology used in sustainable production systems, including renewable energy systems, waste recycling plants, smart manufacturing equipment, energy-efficient machines, and emission control technologies, involves substantial capital expenditure. Many firms do not have engineers, sustainability officers, environmental officers, and IT experts who can implement initiatives aimed at green transformation. These deficiencies affect firms' capacity to incorporate sustainable technologies and adapt their operations in order to ensure monitoring of their performance levels. Hence, while more attention has been drawn towards organizational sustainability in India, implementation of sustainable measures is hindered by such factors as issues from suppliers, lack of information, funding constraints, low returns on investment, and technical inadequacy. These difficulties are especially prevalent in MSMEs, thereby necessitating institutional backing in such areas as sustainable finance and technology.

8. Conclusion

The Indian manufacturing sector presently functions within a business environment that is highly uncertain and dynamic, due to economic instability, technology disruption, environmental issues, geopolitical tensions, supply chain volatility, and regulatory changes. Rigid policies and traditional forms of long-term planning have become inadequate in tackling such volatile and non-linear business environments. In situations like these, the concept of adaptive policies has become an extremely significant strategic tool to cope with uncertainty, through flexibility, quick decisions, learning, and adaptive governance structure. This research concludes that the implementation of adaptive policies is vital for achieving organisational sustainability in that they increase the capacity of organisations to deal with uncertainty through resilience, flexible value chain, effective utilization of resources, and innovativeness. The fusion of adaptive governance and sustainability makes it possible for manufacturing businesses to sustain themselves while meeting their environmental, economic, and social obligations. Adaptive policies that include data integration, artificial intelligence, analytics, flexible supply chain and monitoring tools help organisations become proactive in addressing disruption issues and inefficiencies in operations. Another key finding from the review includes the influence of institutional and market pressure on the Indian manufacturing industry. Some of these pressures that can be cited as examples are ESG, international sustainability standards, investor demands, and environmental regulations such as the PAT scheme and Make in India. These pressures compel firms to adopt an adaptive approach and engage in sustainable production techniques. There have been several challenges in adopting sustainability initiatives, particularly by MSMEs, and some of these challenges are lack of supplier commitment, lack of sustainability awareness, financial limitations, lack of technology, limited ROI, and lack of technical expertise. To conclude, there exists a high correlation between adaptive policies and organisational sustainability. Organisations that are adaptive and innovative, have responsive policies and engage in sustainability practices will be able to overcome disruptions and compete sustainably in the industrial environment. The Indian manufacturing sector's sustainable transition should be accelerated, and adaptive governance structures should be strengthened. The practical use of adaptive policy frameworks in several industrial sectors, including automotive, pharmaceuticals, textiles, electronics, and heavy engineering, needs further empirical research. A fuller knowledge of the efficacy of adaptive governance

systems in various industrial contexts may be obtained through sector-specific comparative research. Future studies should also concentrate on how cutting-edge technologies like blockchain, cloud computing, digital twins, IoT, AI, and predictive analytics may enhance organizational resilience and sustainability. Future research should look at how Indian firms may successfully handle the shift from Industry 4.0 to Industry 5.0, which offers substantial prospects for fusing human-cantered innovation with environmental sustainability. More attention is also required for the MSMEs due to the challenges faced by the MSMEs in their efforts toward achieving sustainability due to high technological barriers and capital constraints. There is a need to explore innovative approaches related to financial mechanisms, green investments models, sustainability training programs, and industrial ecosystems, which can help the sustainability journey of MSMEs in the coming years. Researchers could further explore the role of standard measures of sustainability performance metrics as well as ESG frameworks, which could be helpful in making the sustainability assessment process much easier for organizations. Other possible avenues for future research could include the impact of carbon neutrality commitments, use of renewable energy sources, circular economies, and climatic risks on the sustainability of the industrial sector in countries like India. The Production-Linked Incentives (PLIs), energy-efficient schemes like the Perform, Achieve and Trade (PAT) Scheme, and incentives towards adopting renewable energy sources must replace inflexible approaches to enhance flexibility and sustainability. Real-time monitoring and predictive analyses depend on digitalization. The government should encourage skill development initiatives that can help workers get acquainted with Industry 4.0 and 5.0 technology. Green finance measures can involve providing tax benefits and low interest rate loans to firms using environmentally friendly technologies and adopting sustainable practices. Lastly, an effective national-level evaluation process must be developed to monitor and assess the sustainability performance of industries, ensuring transparency and accountability as well as the adoption of Net-Zero carbon emissions targets. Thus, this approach will enable India to become a pioneer in sustainable manufacturing across the globe.

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