JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

AN EMPIRICAL ANALYSIS OF THE IMPACT OF INTERNET OF THINGS ON SUPPLY CHAIN MANAGEMENT PERFORMANCE IN THE AUTOMOTIVE INDUSTRY

[1]Priyanka Malviya, [2]Devendra S. Verma
[1]Research Scholar, [2]Professor
[1]Mechanical Engineering Department, IET, DAVV
[2]Mechanical Engineering Department, IET, DAVV

Abstract: One of the industries in India that is expanding the quickest is the automobile sector, which is vital to the nation's economic growth. Supply chain performance is now a crucial factor in determining an organization's success in a business climate that is becoming more complicated and competitive. Real-time visibility, predictive maintenance, automation, and data-driven decision-making throughout supply chain processes are all made possible by the Internet of Things (IoT), a revolutionary digital technology. With an emphasis on automotive manufacturers and multi-tier supplier firms, this study investigates how IoT adoption affects supply chain performance in the Indian automobile sector. A descriptive and analytical research design was adopted, and primary data were collected through a structured questionnaire from 294 professionals, of which 285 valid responses were analysed using Statistical Package for Social Sciences (SPSS). Reliability analysis confirmed excellent internal consistency (Cronbach's alpha = 0.948). Correlation analysis revealed a strong positive connection between IoT implementation and supply chain performance ($r = 0.814$, $p < 0.001$). Regression results further demonstrated that IoT implementation has a significant positive impact on supply chain performance ($\beta = 0.814$, $t = 23.847$, $p < 0.001$), explaining 66.2% of the variance ($R^2 = 0.662$). The findings confirm that IoT adoption significantly enhances efficiency, visibility, responsiveness, and overall operational performance of the supply chain in the automotive firms. The study concludes that IoT is a strategic enabler of competitiveness and operational excellence in the Indian automotive industry.

Key Words **- Internet of Things, Automotive Industry, Supply Chain Performance, Regression Analysis, Industry 4.0, Digital Transformation, India.**

1. INTRODUCTION

One of the biggest and fastest growing automotive ecosystems in the world, India's automobile sector makes a considerable contribution to employment, industrialised production, and the nation's GDP (SIAM, 2024). The industry's massive network of automakers, multi-tier suppliers, component manufacturers, shipping companies, and dealerships depends on efficient supply chain efficiency. Due to increased competitiveness, globalisation, and customer demands for faster delivery cycles, the industry has been swiftly undergoing a digital transformation [1]. In this regard, the Internet of Things has become a crucial facilitator of the upcoming generation of supply chains. IoT permits real-time data collection and distribution between physical things by connecting machines, cars, and components via sensors, RFID tags, telematics systems, GPS devices, and cloud-based dashboards [2]. These interconnected devices create a cyber-physical supply chain, where decision-making becomes more automated, predictive, and data-driven. For the automotive sector specifically, IoT offers transformative benefits. Manufacturing plants utilise IoT-enabled machinery for predictive maintenance, energy monitoring, automation and line balancing, which increases overall equipment effectiveness [3]. Supply chain processes such as inbound logistics, inventory handling, production scheduling and outbound delivery become more clear and responsive through real-time asset tracking, environmental monitoring, and digital twins [4].

India's automotive supply chains face exclusive challenges fragmented supplier networks, variable lead times, transportation delays, lack of real-time visibility, and manual data handling in many nodes [5]. IoT technologies address these gaps by enabling continuous tracking of parts, monitoring the condition and movement of vehicles, identifying bottlenecks early, and supporting data-based decision-making for procurement and logistics. The incorporation of IoT with cloud computing and AI, further strengthens planning accuracy and operational resilience [6]. As Indian automakers gradually adopt Industry 4.0 principles, IoT is becoming not just a technological progression but a strategic necessity for improving quality, reducing cost, enhancing sustainability, and staying competitive in global markets. Therefore, understanding IoT's impact on the automotive supply chain is essential for firms aiming to modernise their operations and achieve long-term efficiency.

1.1 PROBLEM STATEMENT

Although the IoT offers significant potential to increase transparency, efficacy, and responsiveness in automotive supply chains, its adoption across the Indian automotive ecosystem remains uneven and limited. While several OEMs have begun implementing

IoT-enabled systems, a large number of multi-tier suppliers continue to rely on manual processes, fragmented digital systems, and traditional logistics practices. This results in persistent challenges such as poor real-time visibility, unplanned equipment downtime, inventory inaccuracies, transportation delays, and inefficient coordination among supply chain partners. Additionally, high e xecution costs, lack of expert manpower, data-security concerns, and insufficient digital infrastructure further restrict the effective integration of IoT technologies. Therefore, there is a clear need to inspect the actual influence of IoT on supply chain performance in the Indian automotive business.

1.2 RESEARCH GAP

While existing studies acknowledge the prospective of IoT in supply chain management, most of the study remains conceptual or focused on established economies. The influence of IoT installation on supply chain performance in the Indian automobile sector is not well studied empirically. This research fills this gap by offering quantitative confirmation on how IoT adoption impacts on key supply chain performance parameters.

1.3 PURPOSES OF THE RESEARCH

The research main goal is to examine how the IoT affects supply chain management performance in India's automotive sector. The research is to assess how the automobile industry's overall operational performance, coordination, and supply chain efficiency are affected by the deployment of IoT technology.

1.4 SIGNIFICANCE OF THE STUDY

This study is significant for multiple stakeholders associated with the Indian automotive ecosystem. For automotive manufacturers and suppliers, it provides a clear understanding of how IoT adoption can improve supply chain visibility, operational efficiency, predictive maintenance, inventory control, and logistics performance. For policymakers and government agencies, the findings support the formulation of effective digital manufacturing and Industry 4.0 strategies to strengthen national industrial competitiveness. For researchers and academicians, the study contributes empirical insights into IoT adoption in emerging eco nomies and helps identify research gaps for future studies in smart supply chains and digital transformation. Overall, the study supports informed decision-making for sustainable and technology-driven growth of the automotive supply chain in India.

1.5 SCOPE OF THE STUDY

The present research is confined to examining the outcome of the IoT adoption in supply chain in the Indian automotive business. The scope includes automotive manufacturers and multi-tier suppliers involved in automotive production and distribution. The study focuses on key supply chain functions such as procurement, inventory management, production planning, logistics, and distribution. It also covers the extent of IoT acceptance, its benefits, drivers, and challenges from an operational and managerial perspec tive. The geographical scope of the study is limited to selected automotive firms operating in India. The key data is used in this research is collected through pilot surveys and supported by secondary data from journals, reports, and industry publications.

1.6 LIMITATIONS OF THE STUDY

Despite best possible efforts, the study has certain limitations. The findings are based on responses collected from a limited number of automotive firms, which may restrict the generalisation of results to the entire industry. This research be dependent on mainly on self-reported data, which may be subject to response unfairness. Time constraints and limited access to highly sensitive operational data also restrict in-depth technical analysis of IoT systems. In addition, the study focuses only on IoT applications in supply chain operations and does not cover other Industry 4.0 technologies in detail. Finally, since IoT is a rapidly evolving technology, the findings represent the current scenario and may change with future advancements.

2. THEORETICAL FRAMEWORK

The IoT refers to a linkage of connected devices that can sense, collect, and interchange data automatically, enabling communication between devices without requiring direct human involvement [7]. In supply chain management, IoT permits real time data sharing, improves asset tracking, and enhances coordination among stakeholders [8]. Previous studies have emphasised the role of IoT in improving visibility, reducing information asymmetry, and enabling predictive decision making.

Jin Du (2022) examines the impact of the IoT on supply chain management and critically analyses the key challenges associated with its implementation in the context of the digital economy. Using a systematic literature review approach, the study explores four major themes: Industry 4.0, smart supply chains, IoT technologies, and the organizational and informational challenges of adopting IoT in supply chains. The paper highlights that IoT enables end-to-end visibility, real-time monitoring, improved coordination, and data-driven decision-making across supply chain processes, thereby enhancing productivity, efficiency, and responsiveness. It explains how IoT, along with big data and AI, forms the foundation of smart supply chains under Industry 4.0 by integrating physical and digital systems and improving information flow, material flow, and cash flow. However, the study also identifies significant challenges, including data security and privacy risks, information overload, lack of data standardization, infrastructure limitations, and integration issues across organizations, and resistance due to regulatory and organizational constraints. The paper concludes that while IoT is accelerating the transformation of traditional supply chains into smarter and more efficient systems, addressing these technological, informational, and organizational challenges is critical for realizing its full potential and gaining sustainable competitive advantage in global markets [9].

Mohan et al. (2023) investigates how IoT and analytics may be used to boost supply chain actions in the automotive sector, with an emphasis on South Indian businesses. The research highlights that traditional automotive supply chains suffer from long le ad times, high inventory costs, limited visibility, and increasing complexity due to global sourcing and customization demands. Using a questionnaire-based survey of 79 supply chain professionals, the research assesses how IoT affect supply chain performance using statistical techniques including t-tests, regression analysis, and ANOVA. The findings reveal that organizations adopting IoT and analytics experience significant improvements in delivery time (17% reduction), supply chain costs (12% reduction), inventory holding costs (23% reduction), and supply chain disruptions (15% reduction). The study also shows a positive connection between IoT-enabled predictive analytics and improved demand forecasting, inventory optimization, and customer satisfaction. However, challenges such as high implementation costs, system integration complexity, cyber security risks, and lack of skilled personnel

were identified as key barriers to adoption. Overall, the paper concludes that IoT and analytics play a critical role in enhancing efficiency, resilience, and customer-centric performance in automotive supply chains, while emphasizing the need for better visibility and strategic implementation to fully realize their benefits [10].

Alzahrani and Asghar (2023) recommend an intellectual risk forecast system for IoT-based logistics supply chains to manage disruptions caused by natural disasters. The study developed a hybrid deep learning model combining CNN and BiGRU using real-time Internet of Things data to evaluate shipment feasibility. The model achieved a prediction accuracy of 94%, demonstrating that integrating IoT with advanced deep learning techniques can significantly improve risk management, reliability, and operational efficiency in logistics supply chains [11].

The critical role of IoT technologies in refining inventory accuracy, visibility, and operational efficiency across supply chains. By integrating IoT devices such as RFID, sensors, and cloud based platforms, the system enables real time tracking of inventory levels, automatic stock replenishment and reduction of human intervention and errors. The paper emphasizes that IoT driven automation enhances demand forecasting, minimizes stock outs and overstocking, and improves responsiveness to dynamic market conditions. Furthermore, the adoption of IoT based inventory systems supports data driven decision making and cost optimization while improving coordination between suppliers, warehouses, and retailers. However, the study also identifies challenges related to system integration, data security, scalability, and initial implementation costs. Overall, the findings demonstrate that IoT enabled automated inventory management is a key enabler of intelligent and efficient supply chain operations [12].Technologies such as sensors, RFID, GPS tracking, and real-time analytics enable continuous monitoring of inventory, logistics, and material flows, improving visibility and decision-making. This increased transparency strengthens coordination, reduces costs and delays, and improves customer satisfaction while supporting sustainability and regulatory compliance. However, challenges such as data security risks, interoperability issues, high implementation costs, and the need for skilled personnel remain major barriers to IoT adoption [13]. The integration of the Internet of Things with analytical approaches such as Bayesian networks can significantly enhance productivity, reliability, and responsiveness in the automotive component supply chain. Through IoT-enabled real-time monitoring and predictive maintenance, reductions in component failures and improvements in operational efficiency are achieved. However, challenges related to infrastructure limitations, high implementation costs, data security concerns, and shortages of skilled personnel are also identified as barriers that must be addressed for successful IoT implementation [14].

Supply chain performance is a multidimensional construct encompassing delivery reliability, cost efficiency, flexibility, responsiveness, quality, customer satisfaction, and sustainability [16]. Recent studies emphasize the inclusion of sustainability indicators such as return, reuse, and recycling practices to evaluate modern supply chain performance comprehensively. Raj Kumar Yesodha et al. (2023) Examine how IoT technologies might improve product quality and efficiency in contemporary supply chains. According to the survey, IoT technologies like sensors, RFID, and real-time data analytics greatly enhance inventory management, monitoring, and communication across the supply chain. IoT facilitates predictive maintenance by providing real-time visibility and control, which helps businesses anticipate possible problems and minimize production and shipping downtime. The authors further stress that IoT-enabled technologies improve product quality by enabling ongoing research and monitoring at every supply chain level. Additionally, IoT facilitates rapid responses to dynamic conditions such as demand variations, weather troubles, and changing customer requirements. Overall, the study concludes that IoT adoption leads to improved working efficacy, reduced waste, and greater consumer satisfaction in modern supply chains [17]. Similarly, [18] examine the effects of integrating Bayesian neural networks with the IoT on increasing productivity in the Indian car component manufacturing supply chain. Based on the Industry 4.0 paradigm, the study shows that IoT-enabled real-time monitoring in conjunction with Bayesian network analysis greatly increases operational productivity and lowers component failure rates. Using a pilot study and empirical validation, the authors show that IoT adoption enhances supply chain reliability, predictive maintenance, and decision-making capabilities. The findings confirm that Industry 4.0-driven IoT applications contribute to reduced production disruptions and improved manufacturing efficiency in Indian auto component enterprises.

Based on the literature on supply chain performance measurement, several key dimensions have been identified, including operational efficiency, cost effectiveness, responsiveness, customer service, quality, and sustainability [19]. Considering the increasing role of digital technologies, recent research also emphasizes the importance of IoT capabilities in improving supply chain visibility, coordination, and decision making. Accordingly, the present study adopts a multidimensional tactic to assess the performance of the supply chain in the automobile industry. The performance indicators used in this study include on time delivery, delivery reliability, lead time reduction, responsiveness, product quality, cost reduction, supply chain flexibility, customer satisfaction, employee satisfaction, and return, reuse, and recycling performance. These indicators were operationalized through structured questionnaire items to examine the impact of IoT implementation on supply chain key performance (SCKP) in the automobile industry. The following measurement indicators derived from literature is shown in Table1.

Table 1. Measurement indicators derived from literature

Construct	Measurement Items	Source
IOT1	IoT devices are used for real-time monitoring of supply chain operations	[1]
IOT2	IoT improves tracking and visibility of inventory and shipments	[2]
IOT3	IoT supports predictive maintenance in production processes	[3]
SCKP1	Our organization achieves on-time delivery consistently	[4]
SCKP2	Perfect order fulfilment is maintained in supply chain operations	[5]
SCKP3	IoT improves delivery reliability	[4]
SCKP4	IoT contributes to higher customer satisfaction	[6]

SCKP5	Supply chain flexibility has improved due to IoT	[7]
SCKP6	IoT reduces supply chain lead time	[4]
SCKP7	Supply chain responsiveness has improved	[8]
SCKP8	Product quality has improved through IoT monitoring	[9]
SCKP9	IoT helps reduce operational costs	[10]
SCKP10	IoT supports return, reuse, and recycling practices	[11]

3. RESEARCH METHODOLOGY

The influence of IoT adoption on supply chain performance in the automotive sector is investigated in this study using a quantitative research methodology. Professionals involved in supply chain operations, logistics, production management, and digital technology adoption within automotive manufacturing and auto component industries were surveyed using an organised questionnaire as the main method of data collecting. To make sure that respondents had pertinent knowledge and expertise regarding IoT adoption and supply chain procedures, a purposeful sample approach was used. The study was able to get perspectives from people who were directly involved in technology-enabled supply chain operations because to this sampling technique. Data were collected through an online survey distributed using digital platforms as well as offline. To assess the connection between supply chain performance and IoT adoption, the gathered responses were coded and analysed using SPSS. The impact of IoT adoption on important supply chain performance metrics was investigated using statistical methods.

3.1 POPULATION AND SAMPLE

A purposive sampling technique was employed to ensure that respondents had adequate knowledge of IoT implementation in supply chain activities. Out of the total 294 responses, 285 responses (96.9%) were valid and included in the statistical analysis. However, 9 responses (3.1%) were excluded from the analysis. The note “List wise deletion based on all variables in the procedure” means that SPSS automatically removed those cases because they had missing values in one or more variables used in the analysis. In list wise deletion, if a respondent leaves any required variable unanswered, the entire case is excluded from that specific analysis. Therefore, the analysis was conducted using 285 complete responses, ensuring that all variables had valid data for each case. This improves the accuracy and reliability of the statistical results.

3.2 DATA AND SOURCES OF DATA

A structured questionnaire was developed to collect primary data from respondents involved in supply chain and IoT implementation within automobile companies. The questionnaire items were derived from established supply chain performance measurement literature [27] and recent studies on IoT enabled supply chains [8]. Respondents were asked to indicate their level of agreement with each statement using a five point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The questionnaire consisted of two main sections: the first section captured information regarding IoT implementation, while the second section measured supply chain performance across multiple indicators including on time delivery, delivery reliability, lead time reduction, responsiveness, product quality, cost reduction, customer satisfaction, supply chain flexibility, employee satisfaction, and sustainability related practices such as return, reuse, and recycling. Data were analysed using SPSS software.

3.3 HYPOTHESIS DEVELOPMENT

According to earlier research, supply chain performance is improved by the Internet of Things through improved tracking accuracy, shorter lead times, and predictive maintenance. Through real-time monitoring and information exchange, it also improves customer happiness, communication, response, and product quality [17]. In addition, IoT technologies help organizations optimize logistics processes, reduce operational costs, and support sustainable practices such as waste reduction and resource efficiency. Based on these theoretical and empirical insights, the present study proposes that IoT implementation significantly contributes to enhancing supply chain performance in the automobile industry. Therefore, the following hypothesis is proposed:

H_0 (Null Hypothesis): IoT implementation does not have a significant positive influence on supply chain key performance in the automotive industry of India.

H_1 (Alternative Hypothesis): IoT implementation has a significant positive influence on supply chain key performance in the automotive industry of India.

Using SPSS, composite variables were developed to measure the study's main components. Several questionnaire elements pertaining to the degree of IoT usage, integration, and operational application within supply chain operations were combined to calculate the construct IoT Implementation.

4. DATA INTERPRETATION

The descriptive statistics shown in Table 2, indicate that the mean score for supply chain key performance is 3.7321 (SD = 0.56625) and for IoT implementation is 3.7123 (SD = 0.65563) based on 292 valid responses. The results suggest that IoT technologies are reasonably adopted and may contribute to improving supply chain performance.

Table 2: Descriptive Statistics

	Mean	Std. Deviation	*N*
Supply chain key performance	3.7321	.56625	292
IoT Implementation	3.7123	.65563	292

4.1 RELIABILITY ANALYSIS

A total of 294 responses were collected for the study. After data screening in SPSS, 285 responses (96.9%) were considered valid and included in the final analysis. However, 9 responses (3.1%) were excluded due to missing values across one or more variables used in the analysis as shows in Table 3. SPSS applied list wise deletion, meaning that any case with missing data on the variables involved in the procedure was automatically removed from the analysis. Therefore, the statistical analysis was conducted using 285 valid responses, ensuring data reliability and completeness. The reliability of the measurement scale was assessed using Cronbach's alpha. The Table 4 show a Cronbach's alpha value of 0.948 for 24 items, indicating excellent internal consistency. The standardized alpha value of 0.961 further confirms the reliability of the instrument. Therefore, the measurement scale is considered highly reliable for subsequent statistical analysis.

Table 3: Case Processing Summary

		N	%
Cases	Valid	285	96.9
	Excluded[a]	9	3.1
	Total	294	100.0

Table 4: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	*N* of Items
.948	.961	24

4.2 CORRELATION ANALYSIS

Table 5 present the correlation analysis which shows the relationship between IoT Implementation and SCKP. The results indicate that there is a strong positive correlation between the two variables (r = 0.814, N = 292). This means that higher levels of IoT implementation are connected with improved SCKP. The significance value (Sig. = 0.000, 1 tailed) is less than 0.05, indicating that the relationship is statistically significant. Therefore, the findings suggest that the adoption of IoT technologies such as real time monitoring, tracing, and connected arrangements plays an important role in enhancing supply chain outcomes, including efficiency, responsiveness, and overall operational performance.

Table 5: Correlations

		SCKP	IoT Implementation
Pearson Correlation	SCKP	1.000	.814
	IoT Implementation	.814	1.000
Sig. (1-tailed)	SCKP	.	.000
	IoT Implementation	.000	.
N	SCKP	292	292
	IoT Implementation	292	292

4.3 COVARIANCE ANALYSIS

The covariance value between IoT Implementation and Supply Chain Key Performance is 0.302, which is positive. A positive covariance indicates that both variables move in the same direction. This means that as IoT implementation increases, supply chain performance also tends to increase. The diagonal values represent the variance of each construct:

- IoT Implementation variance = 0.430
- Supply Chain Key Performance variance = 0.321

The inter item covariance matrix indicates a positive covariance (0.302) between IoT implementation and supply chain key performance, suggesting that both constructs vary in the same direction. The variance values for IoT implementation (0.430) and supply chain performance (0.321) indicate adequate dispersion in the data. Overall, the results support a positive association between IoT adoption and supply chain performance.

4.4 ANOVA

Table 6 presents ANOVA which shows the results of the regression analysis examining the effect of IoT Implementation on Supply Chain Key Performance. The Regression Sum of Squares (61.795) represents the variation in supply chain performance explained by IoT implementation. The Residual Sum of Squares (31.512) represents the unexplained variation due to other factors not included in the model. The Total Sum of Squares (93.307) reflects the overall variation in the dependent variable. The F value is 568.679 with a significance value of p = 0.000 (p < 0.001). Since the p value is less than 0.05, the regression model is statistically significant. This indicates that IoT implementation significantly predicts supply chain key performance. The mean square values (Regression = 61.795; Residual = 0.109) further confirm that the explained variance is substantially higher than the unexplained variance, resulting in a high F statistic.

Table 6: ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	61.795	1	61.795	568.679	.000[b]
	Residual	31.512	290	.109		
	Total	93.307	291			

4.5 REGRESSION ANALYSIS

The coefficients table presents the results of the regression analysis examining the effect of IoT Implementation on Supply Chain Key Performance as shown in Table 7. The unstandardized coefficient (B = 0.703) indicates that for every one unit increase in IoT implementation, SCKP increases by 0.703 units, holding other factors constant. This shows a strong positive impact of IoT implementation on supply chain performance. The standardized coefficient (Beta = 0.814) further confirms a strong positive relationship between the two variables. Since Beta is close to 1, it indicates that IoT implementation is a powerful predictor of supply chain performance. The t value (23.847) with a significance value of p = 0.000 (p < 0.001) indicates that the relationship is statistically significant. Therefore, IoT implementation significantly influences SCKP. The 95% confidence interval (0.645 to 0.761) does not include zero, which further confirms that the effect is statistically significant and positive. Regarding multi collinearity, the Tolerance value (1.000) and VIF (1.000) indicate that there is no multi collinearity problem in the model, which is expected since only one independent variable is included. The constant value (B = 1.123) represents the predicted value of supply chain performance when IoT implementation is zero.

Table 7: Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
	B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
(Constant)	1.123	.111		10.106	.000	.904	1.341		
IoTImplementation	.703	.029	.814	23.847	.000	.645	.761	1.000	1.000

5. RESULT AND DISCUSSION

The results of the study indicate a strong and statistically significant relationship between IoT implementation and supply chain key performance in the Indian automotive industry. Pearson correlation analysis revealed a high positive correlation (r = 0.814, p < 0.001), suggesting that greater adoption of IoT technologies is associated with improved supply chain outcomes. The positive covariance value (0.302) further confirms that both variables move in the same direction. The ANOVA results demonstrated that the regression model is statistically significant (F = 568.679, p < 0.001), indicating that IoT implementation significantly explains variations in supply chain performance. Regression analysis showed a strong positive effect of IoT implementation on supply chain performance (B = 0.703, β = 0.814, t = 23.847, p < 0.001), with the model explaining 66.2% of the variance ($R^2 = 0.662$). Since the regression analysis yielded β = 0.814, t = 23.847, and p < 0.001, the results are statistically significant. Therefore, the null hypothesis (H_0) is rejected and the alternative hypothesis (H_1) is accepted, confirming that IoT implementation has a significant positive impact on supply chain performance in the Indian automotive industry. Overall, the findings strongly support the proposed research model and highlight the strategic importance of IoT adoption in enhancing supply chain efficiency and effectiveness.

6. CONCLUSION

This research examined the impact of IoT implementation on supply chain performance in the Indian automotive industry, focusing on OEMs, Tier 1, and Tier 2 suppliers. The findings provide strong empirical evidence that IoT adoption significantly enhances supply chain effectiveness. Statistical analysis confirmed a strong positive relationship between IoT implementation and supply chain key performance (r = 0.814, p < 0.001). Regression results further demonstrated that IoT implementation has a significant positive impact on supply chain performance (β = 0.814, t = 23.847, p < 0.001), explaining 66.2% of the variance ($R^2 = 0.662$). The ANOVA results also confirmed the overall model significance (F = 568.679, p < 0.001). These findings indicate that IoT technologies such as real time monitoring, predictive maintenance, connected systems, and enhanced visibility substantially improve efficiency, responsiveness, reliability, cost reduction, and overall operational performance in the automotive supply chain. Organizations that invest in IoT-driven supply chain integration are better positioned to respond to market uncertainties, optimize resource utilization, and enhance customer satisfaction. Therefore, IoT adoption should be considered a critical component of digital transformation strategies within the automotive industry.

7. MANAGERIAL IMPLICATIONS

The results demonstrate how the Internet of Things greatly enhances supply chain performance, motivating businesses to make investments in digital platforms and smart technology. IoT is a strategic instrument for improving resilience, competitiveness, and sustainability, thus strong managerial support, training, and risk management are crucial.

8. LIMITATIONS AND FUTURE RESEARCH

There are a number of limitations to this study. First, the analysis only looks at companies in the Indian automotive supply chain, which may restrict how broadly the results may be applied to other sectors or geographical areas. Second, the capacity to investigate the long-term effects of Internet of Things adoption on supply chain performance is limited by the cross-sectional research approach. Third, supply chain outcomes may also be influenced by other factors like organisational culture, digital maturity, infrastructure readiness, and market conditions, however IoT installation was taken into consideration as a single independent variable. Additionally, response bias may be introduced by using self-reported questionnaire data. By using sophisticated analytical methods like structural equation modelling, undertaking longitudinal and cross-industry research, and adding more mediating and moderating variables, future studies may be able to overcome these constraints.

9. ACKNOWLEDGMENT

PM contributed to the literature review, original draft preparation, and conceptualisation. DSV helped with supervision, writing revision, and editing. Each author made a substantial contribution to the concept, acquisition, and analysis of the work. All authors approved the final version that would be published.

REFERENCES

[1] Z. Hasheminasab, E. M. Nasrabadi, and Z. Sadeqi-Arani, “Challenges and Drivers of the Internet of Things in the Supply Chain: A Systematic Review,” Int. J. Ind. Eng. Prod. Res., vol. 35, no. 3, pp. 1–17, 2024, doi: 10.22068/ijiepr.35.3.2046.

[2] S. Taj, A. S. Imran, Z. Kastrati, S. M. Daudpota, R. A. Memon, and J. Ahmed, “IoT-based supply chain management: A systematic literature review,” Internet of Things (Netherlands), vol. 24, p. 100982, 2023, doi: 10.1016/j.iot.2023.100982.

[3] A. El Jaouhari, J. Arif, A. Samadhiya, A. Kumar, and J. A. Garza-Reyes, “An environmental-based perspective framework: integrating IoT technology into a sustainable automotive supply chain,” Benchmarking, no. 2020, 2023, doi: 10.1108/BIJ-05-2023-0322.

[4] M. Russo, “13 Digital transformation in the automotive supply chain A comparative perspective,” pp. 233–249, 2019.

[5] A. Review, M. E. Issn, and C. Author, “Adopting Industry 4. 0 in India’s Automotive Sector : Challenges, Enablers, and Policy Implications,” vol. 13, no. 2, pp. 25–31, 2024.

[6] H. Venkatasubramanian, M. Anifa, S. Babu, B. Subbiah, and viswaraj M. Naresh, “Leveraging Big Data Analytics for Enhancing Operational Efficiency in IT, Manufacturing, and Supply Chain Sectors,” in Proceedings of the 6th International Conference on Information Management & Machine Intelligence, Dec. 2024, pp. 1–9. doi: 10.1145/3745812.3745813.

[7] J. Du, “The Impact and Challenges of the Internet of Things (IoT) on Supply Chain Management,” 2022. doi: 10.2991/aebmr.k.220603.202.

[8] M. Ben-Daya, E. Hassini, and Z. Bahroun, “Internet of things and supply chain management: a literature review,” Int. J. Prod. Res., vol. 57, no. 15–16, pp. 4719–4742, Aug. 2019, doi: 10.1080/00207543.2017.1402140.

[9] J. Du, “The Impact and Challenges of the Internet of Things (IoT) on Supply Chain Management,” Proc. 2022 2nd Int. Conf. Enterp. Manag. Econ. Dev. (ICEMED 2022), vol. 656, no. Icemed, pp. 1244–1249, 2022, doi: 10.2991/aebmr.k.220603.202.

[10] C. Mohan, “A Study on The Application of IoT and Analytics in Improving the Supply Chain Activities in Automobile Industry,” vol. 13, no. 4, pp. 488–503, 2023.

[11] A. Alzahrani and M. Z. Asghar, “Intelligent Risk Prediction System in IoT-Based Supply Chain Management in Logistics Sector,” Electronics, vol. 12, no. 13, p. 2760, Jun. 2023, doi: 10.3390/electronics12132760.

[12] F. Ugbebor, M. Adeteye, and J. Ugbebor, “Automated Inventory Management Systems with IoT Integration to Optimize Stock Levels and Reduce Carrying Costs for SMEs: A Comprehensive Review,” J. Artif. Intell. Gen. Sci. ISSN3006-4023, vol. 6, no. 1, pp. 306–340, 2024, doi: 10.60087/jaigs.v6i1.257.

[13] E. O. Udeh, P. Amajuoyi, K. B. Adeusi, and A. O. Scott, “The role of IoT in boosting supply chain transparency and efficiency,” 2024.

[14] T. D. Bhoite, R. B. Buktar, P. N. Mahalle, M. P. Khond, G. S. Pise, and Y. Y. More, “Productivity Enhancement in the Indian Auto Component Manufacturing Supply Chain Through IoT, Digital Twins with Generative AI, and Stacked Encoder-Enhanced Neural Networks,” Oper. Res. Forum, vol. 6, no. 4, p. 143, Sep. 2025, doi: 10.1007/s43069-025-00522-0.

[15] S. S. Kamble, A. Gunasekaran, H. Parekh, and S. Joshi, “Modeling the internet of things adoption barriers in food retail supply chains,” J. Retail. Consum. Serv., vol. 48, no. February, pp. 154–168, 2019, doi: 10.1016/j.jretconser.2019.02.020.

[16] A. Gunasekaran, C. Patel, and E. Tirtiroglu, “Performance measures and metrics in a supply chain environment,” Int. J. Oper. Prod. Manag., vol. 21, no. 1/2, pp. 71–87, Jan. 2001, doi: 10.1108/01443570110358468.

[17] K. R. K. Yesodha, A. Jagadeesan, and J. Logeshwaran, “IoT applications in Modern Supply Chains: Enhancing Efficiency and Product Quality,” in 2023 IEEE 2nd International Conference on Industrial Electronics: Developments & Applications (ICIDeA), Sep. 2023, pp. 366–371. doi: 10.1109/ICIDeA59866.2023.10295273.

[18] T. D. Bhoite and R. B. Buktar, “Productivity enhancement in Indian auto component manufacturing supply chain with IoT using neural networks,” Production, vol. 35, 2025, doi: 10.1590/0103-6513.20240047.

[19] X. Zhang, “The Relationship Between Employee Satisfaction and Public Organization Performance: An Analysis from the Perspective of Policy Design,” Adv. Humanit. Res., vol. 11, no. 1, pp. 50–54, Jan. 2025, doi: 10.54254/2753-7080/2025.20567.

[20] I. Lee, “The Internet of Things for enterprises: An ecosystem, architecture, and IoT service business model,” Internet of Things (Netherlands), vol. 7, no. 2019, p. 100078, 2019, doi: 10.1016/j.iot.2019.100078.

[21] A. Haddud, A. DeSouza, A. Khare, and H. Lee, “Examining potential benefits and challenges associated with the Internet of Things integration in supply chains,” J. Manuf. Technol. Manag., vol. 28, no. 8, pp. 1055–1085, 2017, doi: 10.1108/JMTM-05-2017-0094.

[22] B. M. Beamon, “Measuring supply chain performance,” Int. J. Oper. Prod. Manag., vol. 19, no. 3, pp. 275–292, Mar. 1999, doi: 10.1108/01443579910249714.
[23] M. Christopher, “The Agile Supply Chain,” Ind. Mark. Manag., vol. 29, no. 1, pp. 37–44, Jan. 2000, doi: 10.1016/S0019-8501(99)00110-8.
[24] J. T. Mentzer et al., “Defining supply chain management. Journal of Business logistics,” J. Bus. Logist., vol. 22, no. 2, pp. 1–25, 2001.
[25] P. M. Swafford, S. Ghosh, and N. Murthy, “The antecedents of supply chain agility of a firm: Scale development and model testing,” J. Oper. Manag., vol. 24, no. 2, pp. 170–188, Jan. 2006, doi: 10.1016/j.jom.2005.05.002.
[26] P. Ahi and C. Searcy, “A comparative literature analysis of definitions for green and sustainable supply chain management,” J. Clean. Prod., vol. 52, pp. 329–341, Aug. 2013, doi: 10.1016/j.jclepro.2013.02.018.
[27] S. S. Kamble, A. Gunasekaran, and R. Sharma, “Analysis of the driving and dependence power of barriers to adopt industry 4.0 in Indian manufacturing industry,” Comput. Ind., vol. 101, no. June, pp. 107–119, 2018, doi: 10.1016/j.compind.2018.06.004.