IMPACT OF INTERNET OF THINGS (IOT) ON LOGISTICS EFFICIENCY

A Study on MSME Logistics Operators in Coimbatore, India

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***Abstract*—** The rapid adoption of Internet of Things (IoT) technologies has transformed logistics operations by enabling real-time data collection, enhanced visibility, and data-driven decision-making. This study aims to examine the impact of IoT Capability, Operational Visibility, and Decision-Making Effectiveness on Logistics Efficiency. The research seeks to understand how IoT-enabled practices contribute to improved asset management, reduced uncertainty, and enhanced operational performance in logistics organisations. A descriptive and quantitative research design was adopted for the study. Primary data were collected through a structured questionnaire administered to 90 logistics professionals. The sample size was determined using G*Power 3.1 software to ensure adequate statistical power. The data were analysed using SPSS, employing descriptive statistics, reliability analysis, correlation analysis, and multiple regression analysis to test the proposed hypotheses. The results reveal that all three independent variables have a positive and statistically significant impact on logistics efficiency. Among them, Decision-Making Effectiveness was found to have the strongest influence, indicating that the effective use of real-time IoT data plays a critical role in optimising logistics operations. IoT Capability was identified as a foundational factor enabling better asset management and predictive maintenance, while Operational Visibility significantly reduced uncertainty, minimised delivery delays, and enhanced service reliability. The findings of the study highlight that logistics efficiency is not achieved through technology adoption alone, but through the effective integration of IoT capability, visibility, and data-driven decision-making. The study contributes to both academic literature and managerial practice by providing empirical evidence on IoT-enabled logistics efficiency and offering practical recommendations for logistics organisations.

***Keywords*—** *Internet of Things; IoT Capability; Operational Visibility; Decision-Making Effectiveness; Logistics Efficiency; MSME Logistics*

I. INTRODUCTION

One of the most significant parts in Global Trade and Industrial Performance is the logistics industry that will only be increasing in significance throughout the 21st Century. It begins with the purchase of raw materials up to the circulation of finished goods, thereby making it a chain of events that influences the efficiency of the functioning of an economy and the competitive nature of a company in the respective industry. The very pillar of this digital transformation is the Internet of Things (IoT), a revolutionary technology and data ecosystem which connects a myriad of physical items (vehicles, containers, warehouses, etc.) into one compressed network, allowing each item to communicate and share data with all other items via a digital network. As a result of this powerful data integration, logistics operations have transitioned to a new era based on real-time visibility and predictive analytics, which will ultimately dictate decision-making and control mechanisms across the logistics industry.

The logistics industry in India is an important growth driver that supports manufacturing, retail and e-commerce sectors. However, the logistics system has high operational costs, lacks a connected infrastructure and is limited in its use of technology. Therefore, the purpose of this research study is to assess the impact of IoT on improving logistics efficiencies in the area of Coimbatore, which is considered an industrial zone and reflects both the positive aspects of India's logistics system, as well as the challenges that still exist. Although larger metropolitan logistics providers have adopted advanced telematics and tracking, smaller medium-size logistics operators in Coimbatore still use manual or aged ERP-style methods, causing operational blind spots where the fleet, cargo and delivery processes are not visible in real time. This affects turnaround time, delivery cost, and the safety of temperature-sensitive logistics such as dairy and pharmaceuticals.

A. Research Problem

Despite the many success stories of IoT in logistics globally, the implementation of IoT in logistics has a number of systemic and complex barriers in Coimbatore, India. The logistics network in Coimbatore is comprised predominantly of micro, small and medium enterprises (MSMEs) and is therefore digitally fragmented. Current models of logistics performance assess efficiency based on cost, time and reliability standards but fail to take into consideration technological enablers such as IoT Capability, Operational Visibility, and Decision-Making Effectiveness. Studies indicate that the majority of small logistics companies operate without any form of integrated telematics and/or real-time tracking systems, instead relying on manual coordination and telephonic communication. Many organisations also take a reactive approach to decision-making because they gather sensor data but do not know how to turn it into actionable insights.

B. Research Questions and Objectives

To validate the hypothesis that improving IoT Capability, Operational Visibility, and Decision-Making Effectiveness will significantly enhance Logistics Efficiency, this investigation is guided by three questions: (1) How does IoT Capability improve Logistics Efficiency? (2) How does Operational Visibility improve

Logistics Efficiency? (3) How does Decision-Making Effectiveness improve Logistics Efficiency? Correspondingly, the study seeks to analyse the significant relationship between each of these three constructs and Logistics Efficiency among Coimbatore's transport and industrial sector.

C. Significance of the Study

This study is vital both academically and practically. The logistics operators of Coimbatore face bigger challenges in an industrial environment because of cost constraints, unwillingness to adopt new technology, and a shortage of trained staff, translating to a slow digital transformation approach in the wider MSME logistics industry in India. The paper provides facts that IoT is not merely a technological upgrade, but a strategic facilitator of efficiency, sustainability and competitiveness, guiding investment in systems like telematics, predictive maintenance, and digital analytics. In academic terms, the research improves the knowledge about the effects of IoT on logistics efficiency in developing economies where the level of digital maturity and infrastructure of logistics is highly dissimilar.

II. LITERATURE REVIEW

The concept of the Internet of Things (IoT) originated from the mind of Kevin Ashton in 1999. Initially the only technology used was RFID, applied by retailers and manufacturers for automating inventory tracking. The next decade saw tremendous growth due to advancements in wireless communications, cloud computing, microprocessors and the miniaturisation of sensors, allowing for the development of digital infrastructure capable of supporting real-time monitoring, predictive analytics, and cross-system automation. Global logistics systems were among the earliest adopters of IoT at scale; for example, UPS used telematics to optimise route selection, minimise fuel waste, and schedule maintenance before failure, while Japan's cold-chain operators used temperature monitoring devices to continually log environmental conditions.

A. Theoretical Foundations: TOE and TAM

To understand how organisations adopt and implement IoT in logistics, this study draws on the Technology-Organisation-Environment (TOE) framework developed by Tornatzky and Fleischer (1990) and the Technology Acceptance Model (TAM) developed by Davis (1989). The TOE framework helps research the preparedness of organisations to technological innovations, while TAM evaluates the technology acceptance level at the individual level based on perceived usefulness and ease of use. IoT Capability is positioned within the technological context of TOE; Operational Visibility represents an organisational outcome; and Decision-Making Effectiveness addresses both organisational and environmental perspectives of TOE, while also being reinforced by TAM's emphasis on perceived usefulness and trust in the system.

B. IoT Capability

IoT Capability is defined as an organisation's ability to use IoT technologies in ways that improve operational performance and strategic decision-making. It is viewed as a multi-faceted digital resource consisting of physical devices, data integration systems, analytical tools, and organisational competencies, which allow organisations to convert raw sensor data into actionable insights (Lee & Lee, 2015). Researchers stress that the true value of IoT lies not in the devices themselves but in an organisation's ability to integrate these technologies within operational processes. Logistics companies such as DHL and Maersk utilise IoT-enabled dashboards that combine telematics, temperature monitoring, and predictive analytics to generate complete visibility of fleet and cargo conditions, optimising route planning and reducing the chance of equipment failure.

C. Operational Visibility

Operational visibility is the capability to track and monitor the location, status, and environmental conditions of assets and shipments across the supply chain in real time (Caridi et al., 2014). Modern IoT-enabled systems apply sensor data, telematics, GPS and cloud-based analytics, allowing logistics managers to move from reactive, time-based decision-making toward real-time updates and predictive analytics. In Coimbatore, most MSME-based logistics service providers have older fleets and communication breakdowns, leaving them with limited operational visibility and exposing them to delays, miscommunication, and an inability to plan ahead.

D. Decision-Making Effectiveness

Decision-Making Effectiveness is the capacity of an organisation to make prompt, precise, and informed decisions that are in line with organisational objectives and respond well to changing situations (Simon, 1997). The introduction of IoT made continuous, real-time information about vehicles, sensors, warehouses, and cargo available, enabling a shift from reactive to proactive decision-making (Bousdekis et al., 2021). UPS and FedEx, for instance, employ predictive routing algorithms informed by IoT data to prevent delays and optimise fuel consumption.

E. Logistics Efficiency and Literature Gap

Logistics efficiency refers to the degree to which logistics activities realise their performance objectives with a minimum amount of resource waste, commonly measured via speed of delivery, cost management, reliability, asset utilisation, and service consistency (Mentzer et al., 2021). While IoT's contribution to logistics efficiency has been thoroughly investigated globally, most existing studies focus on technologically sophisticated settings such as multinational freight companies, leaving a gap in empirical research on MSME-dominated, semi-urban industrial clusters such as Coimbatore. Additionally, few studies examine IoT Capability, Operational Visibility, and Decision-Making Effectiveness as interdependent determinants of logistics efficiency within a single, combined TOE-TAM framework, which is the gap this study addresses.

III. RESEARCH METHODOLOGY

A. Research Framework and Hypotheses

The research framework positions IoT Capability, Operational Visibility, and Decision-Making Effectiveness as independent variables and Logistics Efficiency as the dependent variable, grounded in the TOE and TAM models. Based on this framework, three hypotheses were developed:

H1: There is a significant relationship between IoT Capability and Logistics Efficiency.

H2: There is a significant relationship between Operational Visibility and Logistics Efficiency.

H3: There is a significant relationship between Decision-Making Effectiveness and Logistics Efficiency.

B. Research Design

A quantitative, descriptive research design was adopted to objectively measure the current level of IoT adoption and logistics efficiency among MSME logistics operators in Coimbatore. Data were collected via a survey-based approach, and analysed using the Statistical Package for the Social Sciences (SPSS), employing descriptive statistics, reliability testing, correlation analysis, and multiple regression analysis.

C. Population and Sampling

The population comprised Micro, Small, and Medium Enterprise (MSME) logistics service providers operating in the Coimbatore district, including fleet owners, logistics managers, supervisors, and operations executives directly engaged in fleet planning, route scheduling, shipment monitoring, maintenance coordination, and decision-making. A purposive sampling technique was employed to ensure that respondents possessed direct, relevant knowledge and experience regarding logistics operations and IoT adoption.

D. Sample Size Determination

The sample size was determined using G*Power 3.1 software. For a linear multiple regression with three predictors, an assumed medium effect size ($f^2 = 0.15$), significance level of 0.05, and statistical power of 0.80, the analysis indicated a minimum requirement of 77 respondents. To account for non-response and incomplete questionnaires, the study collected a final valid sample of 90 respondents.

E. Data Collection and Instrument

Primary data were collected through a structured questionnaire distributed via Google Forms. The questionnaire comprised a demographic section and four construct sections — IoT Capability, Operational Visibility, Decision-Making Effectiveness, and Logistics Efficiency — each measured with five items adapted from validated scales in prior literature (e.g., Xu et al., 2020; Ben-Daya et al., 2019; Caridi et al., 2014; Bousdekis et al., 2021), rated on a five-point Likert scale ranging from Strongly Disagree (1) to Strongly Agree (5).

IV. RESULTS AND DISCUSSION

A. Respondent Profile

Of the 90 valid respondents, Supervisors/Team Leaders formed the largest job-role group (31.1%), followed by Operations Managers (27.8%), Logistics Managers (24.4%), and Fleet Owners (16.7%). Most respondents had 4–6 years (36.7%) or 1–3 years (35.6%) of logistics experience. In terms of operational focus, 40.0% were engaged in warehousing, 33.3% in 3PL services, and 26.7% in transport. Regarding IoT adoption, 67.8% of organisations reported a moderate level of adoption, 24.4% basic, 5.6% advanced, and 2.2% none, indicating that IoT adoption is present but still developing among the sampled MSMEs.

B. Reliability Analysis

Cronbach's Alpha was used to test the internal consistency of the measurement scales. All four constructs exceeded the generally accepted threshold of 0.70, confirming that the scales were reliable for further statistical analysis.

TABLE I. Reliability Analysis Results

Variable	No. of Items	Cronbach's α
IoT Capability	5	0.791
Operational Visibility	5	0.814
Decision-Making Effectiveness	5	0.799
Logistics Efficiency	5	0.869

C. Descriptive Statistics

All constructs recorded means above 4.0 on the five-point scale with relatively low standard deviations, indicating strong agreement and consistency among respondents regarding the presence and benefits of IoT-enabled practices.

TABLE II. Descriptive Statistics (N = 90)

Variable	Mean	Std. Dev.
IoT Capability	4.2311	0.44863
Operational Visibility	4.2200	0.38866
Decision-Making Effectiveness	4.1533	0.36726
Logistics Efficiency	4.1178	0.43539

D. Correlation Analysis

Pearson correlation analysis showed that all relationships among the study variables were positive and statistically significant at the 0.01 level (Sig. = 0.000). IoT Capability correlated with Logistics Efficiency at r = 0.704, Operational Visibility at r = 0.714, and Decision-Making Effectiveness showed the strongest correlation at r = 0.774, indicating that effective, data-driven decision-making is closely tied to improved logistics performance.

TABLE III. Correlation Analysis (Pearson r, Sig. = 0.000 for all pairs)

Variable	IoT Cap.	Op. Vis.	DM Eff.	Log. Eff.
IoT Capability	1.000	0.587	0.609	0.704
Operational Visibility	0.587	1.000	0.702	0.714
Decision-Making Effectiveness	0.609	0.702	1.000	0.774
Logistics Efficiency	0.704	0.714	0.774	1.000

E. Multiple Linear Regression Analysis

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Multiple regression was conducted with Logistics Efficiency as the dependent variable and IoT Capability, Operational Visibility, and Decision-Making Effectiveness entered simultaneously as predictors.

TABLE IV. Model Summary

R	R²	Adjusted R²	Std. Error
0.843	0.711	0.701	0.23799

The model summary shows a strong overall relationship ($R = 0.843$), with $R^2 = 0.711$ indicating that 71.1% of the variance in Logistics Efficiency is explained jointly by IoT Capability, Operational Visibility, and Decision-Making Effectiveness.

TABLE V. ANOVA Results

Model	Sum of Sq.	df	Mean Sq.	F	Sig.
Regression	12.000	3	4.000	70.624	0.000
Residual	4.871	86	0.057		
Total	16.872	89			

TABLE VI. Regression Coefficients

Model	B	Std. Error	Beta	t	Sig.
(Constant)	-0.338	0.309	—	-1.093	0.277
IoT Capability	0.300	0.074	0.309	4.056	0.000
Operational Visibility	0.267	0.095	0.239	2.814	0.006
Decision-Making Eff.	0.496	0.103	0.418	4.829	0.000

The ANOVA result ($F = 70.624$, $p = 0.000$) confirms that the regression model is statistically significant. Among the predictors, IoT Capability ($\beta = 0.309$, $p = 0.000$) and Operational Visibility ($\beta = 0.239$, $p = 0.006$) both significantly and positively predict Logistics Efficiency, while Decision-Making Effectiveness ($\beta = 0.418$, $p = 0.000$) emerged as the strongest predictor.

F. Hypothesis Testing

TABLE VII. Summary of Hypothesis Testing

Hypothesis	Sig.	Result
H1: IoT Capability → Logistics Efficiency	0.000	Supported
H2: Operational Visibility → Logistics Efficiency	0.006	Supported
H3: Decision-Making Effectiveness → Logistics Efficiency	0.000	Supported

All three null hypotheses were rejected, and the corresponding alternative hypotheses were accepted, confirming that IoT Capability, Operational Visibility, and Decision-Making Effectiveness each exert a positive and statistically significant influence on Logistics Efficiency.

G. Discussion

The results indicate that IoT Capability contributes significantly to logistics efficiency, supporting the argument that technology adoption alone is insufficient without organisational capacity to implement, manage, and leverage IoT systems (Lee & Lee, 2015; Ben-Daya et al., 2019). Operational Visibility was also confirmed as a significant driver, consistent with literature identifying visibility as a primary organisational benefit of IoT that reduces uncertainty and improves coordination (Caridi et al., 2014; Barratt & Oke, 2007). Decision-Making Effectiveness emerged as the strongest predictor, underscoring that the real value of IoT lies not merely in data generation but in how effectively that data is translated into timely, accurate operational decisions (Bousdekis et al., 2021; Gunasekaran et al., 2020). Collectively, the findings support the integrated TOE-TAM based framework proposed in this study, showing that logistics efficiency is highest when IoT technologies are combined with strong organisational visibility and effective managerial decision-making.

V. CONCLUSION AND RECOMMENDATIONS

This study set out to examine the impact of IoT Capability, Operational Visibility, and Decision-Making Effectiveness on Logistics Efficiency among MSME logistics operators in Coimbatore. The findings confirm that all three constructs exert a significant, positive influence on logistics efficiency, with Decision-Making Effectiveness identified as the strongest predictor, followed by Operational Visibility and IoT Capability. The study demonstrates that logistics efficiency is not achieved through technology adoption alone, but through the effective integration of IoT capability, visibility, and data-driven decision-making.

A. Managerial Implications

Logistics managers should invest not only in IoT devices such as GPS trackers and sensors, but also in system integration and staff training so that IoT data can be readily used for planning, monitoring, and control. Organisations should prioritise real-time monitoring and transparent information sharing to enable early identification of disruptions, and should actively foster a data-driven decision-making culture in which routing, scheduling, and resource allocation decisions rely on IoT-generated insights rather than intuition alone.

B. Limitations and Future Research

The study's sample size of 90 respondents and its geographical focus on Coimbatore limit the generalisability of the findings to other logistics contexts. The reliance on self-reported perceptual data, rather than objective performance measures, and the cross-sectional design, which captures data at a single point in time, are additional limitations. Future research may extend this study by including a larger and more geographically diverse sample, incorporating additional variables such as implementation cost, cybersecurity risk, and organisational culture, employing qualitative or longitudinal methods, and examining the integration of IoT with other emerging technologies such as artificial intelligence, big data analytics, and blockchain.

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