# IMPACT OF TECHNOLOGY ON EFFICIENCY OF TRANSPORT COMPONENT IN SUPPLY CHAIN

Hansika Deivendra[1], Kavindu Jayasuriya[2]
[1]*NSBM Green University*, [2]*Logicare Private Limited*
hansika.d@nsbm.ac.lk , kavindu@logicare.lk

**ABSTRACT** - In today's hyper-connected and rapidly evolving business landscape, the efficiency of the transport component within the supply chain plays a pivotal role in driving organizations towards success and competitiveness. The study evaluates the trans-formative impact of technology on the efficiency of the transport component in the supply chain, emphasizing its critical role within organizations. By integrating advanced technologies such as GPS tracking, Transport Management Systems, and real-time analytics, companies have achieved significant improvements in streamlining of transport processes. Through a comprehensive analysis of data collected from Third Party Logistics companies, the research highlights the significant improvements in route optimization, on-time deliveries and transit times at post-technology integration. Analysis of data from 20 3PL companies revealed that 70% of these companies use multiple technologies, leading to a mean reduction of 6.55 km for every 100 trip kms in post-implementation time period. Additionally, on-time deliveries improved by 9.55%, and transit times decreased by 0.4 days on average, both showing statistically significant enhancements ($p < 0.05$). These findings underscore the vital role of technology in driving transport component efficiency and performance within the supply chain landscape.
**Keywords:** Efficiency; Transport; Supply Chain; Technology Integration

## 1. INTRODUCTION

The supply chain denotes the movement of materials, information, and financial resources as they progress through the sequence from supplier to manufacturer, wholesaler, retailer, and ultimately to the customer. As the supply chain consists of functions such as procurement, manufacturing, transportation, warehousing and distribution, the efficiency of each function is very important to increase overall efficiency of the supply chain[1]. The integration of technology has become a cornerstone in enhancing the efficiency of transportation operations, offering unprecedented opportunities for optimization and innovation.

Garcia [2] reviewed technologies, especially information and communication technologies (ICT) are extensively utilized in supply chain operations, primarily due to their dual impact on economic performance and operational efficiency. According to Hussain et al. [3] , adapting to new technologies supports companies to achieve competitive advantage among other competitors. These technologies can be introduced to the components in the supply chain such as transportation, warehousing, procurement (ERP) and distribution etc [3], [4]. Moreover, numerous companies are presently leveraging technologies from industry 4.0 and industry 5.0 to streamline their supply chain processes and enhance their operational performance by attaining process integration [5]. However, according to Andiyappillai [6] , while many companies currently seek technology for penetration into the sector, precision and efficiency while speeding up the processes at the same time, the performance of the supply chain is affected by numerous challenges that can hinder its performance.

Yizhong stated that transport management systems, RFID technology, GPS tracking, drone transportation are some technological innovations in transport component of supply chain. Moreover, autonomous vehicles which belong to industry 5.0 are highlighted in his study as an emerging new technology in transportation [7]. As there are several studies [1], [3], [4], [5], [6], [7] focusing on impact of technology

towards efficiency and performance of supply chain in global context, very fewer studies [8], [9], [10], [11] reviewed in Sri Lankan context, there is a research gap on how technology impacting efficiency of transport component in supply chain in the context of Sri Lanka.

The primary objectives of this research are to assess the impact of advanced technologies on the efficiency of transport operations within Sri Lanka's supply chain sector and to quantify the improvements in key performance metrics, such as route optimization, on-time deliveries, and transit times, resulting from technology integration. This research is essential as it provides empirical evidence on the effectiveness of technology in enhancing transport efficiency, a critical yet under-explored area in Sri Lanka. By quantifying specific improvements, it highlights the potential for significant cost savings and operational enhancements, guiding strategic decisions in supply chain management.

## 2. MATERIALS AND METHODS

### 2.1. Data Collection

This study employed a survey method by circulating a semi-structured questionnaire among transport service providers in Sri Lanka during February 2024. The population size was determined as 212, and a sample size was calculated using a sample size calculator with a Confidence Level of 90%, Margin of Error of 10%, and Population Proportion of 10%. The questionnaire design was guided by input from academics and experts in the 3PL industry, and a pilot survey was conducted to validate the appropriateness and adequacy of the questions. A total of 24 responses were collected, and subsequent quantitative and qualitative analyses were conducted to derive the key findings.

### 2.2. Data description

Data on various technologies employed by organizations, reduction rates of kilometers for identical trips, rates of on-time deliveries, transit times before and after the implementation of technology solutions, and information on transport costs were gathered via a semi-structured questionnaire. Following data cleaning procedures, 20 out of the 24 collected responses were selected as the sample for analysis. The analysis entailed the utilization of t-tests and descriptive data analysis techniques.

## 3. RESULTS AND DISCUSSION

### 3.1. Technology Usage

The Figure 1 illustrates the number of companies employing various technologies in their transport related operations. Cooling sensors are utilized by a one company to monitor and control temperatures, ensuring optimal conditions for pharmaceuticals. Telematics, employed by 5 companies out of 20, integrates telecommunications and informatics for effective fleet management. Transportation Management Systems (TMS) are adopted to streamline logistics and supply chain processes by 6 companies which accounts for 33% of the Sample. RFID technology, used by some companies, enhances inventory tracking and management through radio-frequency identification. Real-time analytics, essential for data-driven decision-making, are implemented to provide immediate insights into operational efficiencies. GPS tracking, the most widely adopted technology, enables precise location monitoring of assets and vehicles. Lastly, AI-

based dashboards, used by a smaller number of companies, leverage artificial intelligence to offer advanced data visualization and predictive analytics for strategic planning.

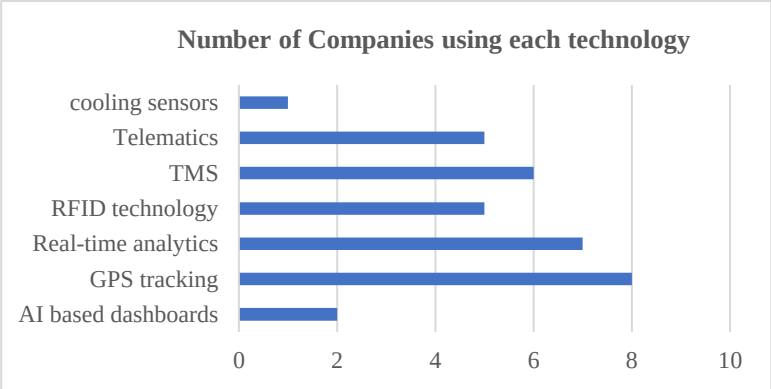


Figure 1. Number of Companies using each technology

### 3.2. Impact of Technology on kms for identical trips

As an efficiency measure, reduction rate of kms for every 100 kms were analyzed by using hypothesis testing as shown in **Table 1**.

**Table 1**. t-test for reduction rate of kms

| Kms for identical trips | |
|---|---|
| $H_0$ : | The Mean reduction rate of kilometers after implementing technology solutions is equal to zero.($\mu = 0$) |
| $H_1$ : | The Mean reduction rate of kilometers after implementing technology solutions is not equal to zero.($\mu \neq 0$) |
| $\mu$ = | 6.55 |
| df = | 19 |
| t = | 50 |
| p = | 0.00 |

As p value is less than 0.05, the null hypothesis is rejected. Therefore, it can be concluded that there is a statistically significant difference in mean reduction rate of kms after implementing technology solutions.

### 3.3. Impact of Technology on transit time and on-time deliveries

**Table 2**. t-test for transit times and on-time deliveries

| | **On-time deliveries** | **Transit Time** |
|---|---|---|
| $H_0$ : | The mean on-time deliveries before technology integration is greater than mean on-time deliveries after technology integration ($\mu_{before} \geq \mu_{after}$) | The mean transit time before technology integration is lower than mean transit time after technology integration ($\mu_{after} \geq \mu_{before}$) |

| $H_1$ : | The mean on-time deliveries before technology integration is lower that mean on-time deliveries after technology integration.($\mu_{before} < \mu_{after}$) | | | The mean transit time before technology integration is greater than mean transit time after technology integration.($\mu_{after} < \mu_{before}$) | | |
|---|---|---|---|---|---|---|
| | **Before Technology Integration** | **After Technology Integration** | **Difference** | **Before Technology Integration** | **After Technology Integration** | **Difference** |
| μ = | 61.6500 | 71.2000 | 9.5500 | 2.2150 | 1.8150 | 0.4000 |
| sd = | 15.2946 | 11.7813 | 3.5132 | 0.6133 | 0.5480 | 0.0653 |
| t = | 12.1566 | | | 27.4087 | | |
| p = | 0.0000 | | | 0.0000 | | |

According to the analysis, as p value of both hypothesis testings conducted on transit times and on-time deliveries are less than 0.05, null hypotheses are rejected. Therefore, it can be concluded with 95% of significance level, the mean value of on-time deliveries before technology integration is lower that mean on-time deliveries after technology integration. In other words, technology integration has increased on-time deliveries of these companies. Not only that but also the mean transit time before technology integration is greater than mean transit time after technology integration. In other words, technology integration has decreased transit time of transportation operations of companies.

The results of this research offer significant perspectives for scholars and professionals working in the supply chain and logistics sector. With the use of the empirical data provided, scholars are able to understand how technology affects transportation efficiency, which might influence future research and curriculum. Through careful selection of technology investments and process enhancements, practitioners can use these insights to optimize their operations. In addition to providing a path for businesses looking to improve service quality, cut expenses, and gain a competitive edge in the market, the shown improvements in route optimization, on-time deliveries, and transit times highlight the real benefits of technology integration.

## 4. CONCLUSION

The study has conducted a thorough analysis of how new technologies affect the effectiveness of transportation in Sri Lanka's supply chain industry. The study has shown notable gains in key performance measures, such as route optimization, on-time deliveries, and transit times, through the integration of technology like GPS tracking, Transport Management Systems (TMS), and real-time analytics. Data gathered from 20 third-party logistics businesses showed statistically significant reductions in transit times (0.4 days), on-time delivery (9.55%), and mean reductions of 6.55 km for every 100 trip kms.

Each objective of the study was substantiated with empirical evidence demonstrating the positive impact of technology. The investigation into prevalent technologies within the transport component revealed a widespread adoption of GPS tracking and Transport Management Systems (TMS). The analysis of technology's influence on efficiency yielded quantifiable improvements, corroborating the hypothesis that technological integration enhances operational performance. These results highlight the crucial role of technological advancements in optimizing transport processes and enhancing efficiency within the supply chain.

A small sample size and a restricted geographic focus within Sri Lanka were among the study's limitations, notwithstanding the strong results. In order to confirm and generalize the findings, future studies should enlarge the sample size and investigate a range of geographic locations. The accuracy of the results could also be increased by using longer-term research and more sophisticated statistical techniques. More investigation into innovative technologies and their uses will lead to more wealthy knowledge and encourage the creation of supply networks that are sturdier and more efficient.

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## REFERENCES

[1] R. Bhandari, "Impact of Technology on Logistics and Supply Chain Management." [Online]. Available: www.iosrjournals.org

[2] J. L. García-Alcaraz, A. A. Maldonado-Macías, G. Alor-Hernández, and C. Sánchez-Ramírez, "The impact of information and communication technologies (ICT) on agility, operating, and economical performance of supply chain," *Advances in Production Engineering And Management*, vol. 12, no. 1, pp. 29–40, Mar. 2017, doi: 10.14743/apem2017.1.237.

[3] M. M. H. Shahadat, A. H. M. Y. Chowdhury, R. J. Nathan, and M. Fekete-Farkas, "Digital Technologies for Firms' Competitive Advantage and Improved Supply Chain Performance," *Journal of Risk and Financial Management*, vol. 16, no. 2, Feb. 2023, doi: 10.3390/jrfm16020094.

[4] A. Gunasekaran, N. Subramanian, and T. Papadopoulos, "Information technology for competitive advantage within logistics and supply chains: A review," *Transp Res E Logist Transp Rev*, vol. 99, pp. 14–33, Mar. 2017, doi: 10.1016/j.tre.2016.12.008.

[5] H. Fatorachian and H. Kazemi, "Impact of Industry 4.0 on supply chain performance," *Production Planning and Control*, vol. 32, no. 1, pp. 63–81, 2021, doi: 10.1080/09537287.2020.1712487.

[6] N. Andiyappillai, "An Analysis of the Impact of Automation on Supply Chain Performance in Logistics Companies," *IOP Conf Ser Mater Sci Eng*, vol. 1055, no. 1, p. 012055, Feb. 2021, doi: 10.1088/1757-899x/1055/1/012055.

[7] Y. Z. Wang, O. K. W. Ho, G. Q. Huang, and D. Li, "Journal of Manufacturing Systems, International Journal of Machine Tools and Manufacture and Measurement Science and Technology. He has published over 100 papers in journals such as Journal of Robotics and Computer Integrated Manufacture," 2008.

[8] S. L. W. Gunawardana and D. H. Wedage, "Supply Chain Management practices: Competitive Advantage and Organizational Performance in Sri Lankan Construction Industry," Online.

[9] M. T. D. Malsinghe, M. H. A. Gunathilaka, I. P. C. Dinesh Bandara, A. I. Wijerathne, N. Nagendrakumar, and W. D. N. Madhavika, "Sustainable Supply Chains of Sri Lankan Manufacturing Organizations: A Study on Operational Excellence Models During the COVID-19 Pandemic Chains of Sri Lankan Manufacturing Organizations: A Study on Operational Excellence Models Operations and Supply Chain Management 15(2) pp," *OPERATIONS AND SUPPLY CHAIN MANAGEMENT*, vol. 15, no. 2, pp. 228–239, 2022.

[10] Doluweera LK, "Industry 5.0 Technologies for Supply Chain Management through Triple Bottom Line Approach in Companies of Sri Lanka for Economic Growth and Socio-Environmental Protection." [Online]. Available: https://www.epa.gov/ghgemissions/overview-

[11] "talkingeconomics - How Technology is Shaping Apparel Sector Supply Chains in Sri Lanka: Shifting to Nearshoring and Reshoring." Accessed: Jul. 09, 2024. [Online]. Available: https://www.ips.lk/talkingeconomics/2020/01/27/how-technology-is-shaping-apparel-sector-supply-chains-in-sri-lanka-shifting-to-nearshoring-and-reshoring/