JARTE
Journal of Applied Research in Technology & Engineering

5(2): 69-74, 2024
https://doi.org/10.4995/jarte.2024.21122
Received: February 01, 2024; Accepted: March 12, 2024; Published: July 31, 2024

IMPACT OF ICT ON THE PERFORMANCE OF SUSTAINABLE LOGISTICS

Muhammad Ahmed Kalwar

Shafi Private Limited, Lahore, Pakistan.

ahmedkalwar22@gmail.com

Abstract:

The environment of the planet Earth has been the concern of governments, academia, and researchers so the impacts of various factors on it have become the prime focus so that the things that damage it can be investigated and the environmental damage can be minimized accordingly. Logistics and transport are the sectors that are responsible for the greatest percentage of greenhouse gases and carbon emissions. The transport sector has been initiated towards the sustainable side because, in many countries, public transport is operated on electricity, and manufacturers have also introduced electric vehicles for citizens to drive and travel in. Freight transport is still a problem because of its carbon footprint; technological advancement has made it easier to minimize the carbon emissions generated from freight transport and logistics with the advent of information communication technology (ICT) devices. With the help of the Internet of Things (IoT), geographical positioning systems, and sensors, it has become easier to monitor the routes of vehicles, their fuel consumption, and the optimization of routes as well. The various innovations can potentially help the logistics sector increase its overall efficiency. Minimizing the carbon footprint in the logistics sector makes it green logistics. In the present research paper, the authors have conducted a literature review in which they intend to highlight the impacts of ICT on green logistics. It was indicated by the results that ICT positively influences the performance of green logistics, but at the same time, it was concluded that poor quality of logistics' infrastructure, service quality of logistics, and cargo transportation timeliness consume a greater quantity of fossil fuels and therefore cause increased carbon emissions, which negatively impact human health and the environment of the planet.

Keywords: information and communication technology; green logistics; sustainability; performance; greenhouse emission.

Cite as: Kalwar, M.A. (2024). Impact of ICT on the performance of sustainable logistics. *J Appl Res Eng Technol & Engineering, 5*(2), 69-74. https://doi.org/10.4995/jarte.2024.21122

1. Introduction

Green logistics is the main part of green supply chain management as it connects every member of the supply chain (Liu et al., 2018). Logistics is the process by which the movement, materials` storage, inventory, and associated flows of information are managed strategically in such a way that order fulfilment is carried out cost-effectively in an organization (Drews & Sagawe, 2014). Logistics is considered the main element of economic growth across the globe (Yingfei et al., 2022). With the rapid growth of the economy, logistic operations are required to be efficient when there is the question of accommodating growth. The advent of information technology (IT) has transformed the roles of supply chains in logistics companies. This is because information and communication technology (ICT) is considered the critical factor that influences the process of modern logistics firms and increases their efficiency in service provision (Kechil et al., 2022). The corporate sector`s operation has been permanently changed by the advent of modern technological developments, and the logistics service sector is a special case in this scenario (Nour, 2022). It is an essential function of freight transport that provides access to materials and goods by using major import and export distribution channels (Chatti, 2021a). Logistic activity plays a major role in polluting the environment specifically in the sector of road transport and its effects will be catastrophic for the quality of the environment if the average temperature of this planet increases by 2°C (Chatti, 2021a; Santos, 2017). Any attempt that is made to the minimization of environmental impact caused by logistic activity is referred to as green logistics (Baxter, 2022). Green logistics is also called eco-logistics, it stresses ecological efficiency and sustainability (Baxter, 2022).

The literature associated with logistics, operations, environmental considerations, and sustainability are the points of interest for researchers and academicians; in this regard, firms have increased their focus to make efforts so that they can minimize the risk and sustain a firm`s competitive position (Pazirandeh & Jafari, 2013). Companies that use ICTs in logistics and transportation services take green initiatives in their external collaborations, internal management, collaboration with customers, distribution strategies, packaging management, warehousing, execution of transportation, reverse logistics, and green building (Chan et al., 1997). The logistics sector has seen a lot of technological advancement in the previous ten years in terms of global positioning system (GPS) (Macaulay et al., 2020; Shaikh, 2023), general packet radio service (GPRS) (Goh & Fraser, 2011), and radio frequency identification (RFID) (Goh & Fraser, 2011; Macaulay et al., 2020; Nour, 2022; Perego et al., 2011; Shee et al., 2021; Wang et al., 2015), cloud computing

*Corresponding author: M.A. Kalwar, ahmedkalwar22@gmail.com

(Trappey et al., 2017), wireless sensor network (WSN) (Trappey et al., 2017) are used for the enhancement of decision supports and traceability in logistics process; at the same time flexibility, accuracy and real-time speed also increases (Trappey et al., 2017). Companies are operating very efficiently by using ICTs (Goh & Fraser, 2011). Moreover, Jovanovi and Olovi (2017) reported the use of electronic data interchange (EDI), logistics information system (LIS), internet of Things (IoT), and big data in the logistics sector for its performance improvement (Jovanovi & Olovi, 2017). GPS technology enables logistics companies to develop mobile solutions to monitor and control their manpower and fleet vehicles (Shaikh, 2023). GPRS is fundamentally a packet-switching technology by which the data is transferred through mobile networks in a convenient way (BasuMallick, 2022). RFID facilitates managers in tracking and managing assets and products throughout the supply chain; RFID tags and scanning machines have the potential to improve material handling (receiving, issuance, and dispatch) in the company (Maplesden, 2022).

According to Dey et al. (2011), little research has been conducted to highlight the logistics` role and importance as a step of the organization toward sustainability. The logistics function is needed to play a notable role when a firm takes a step towards the implementation of a sustainability strategy in the operations of the supply chain because the whole scenario of sustainability, carbon footprint is the main point and it is closely associated with logistics operation (Dey et al., 2011). It was reported that ICT has a positive impact on the environment. Wang et al. (2015) showed the problem of CO_2 emission is efficiently mitigated by the use of ICTs in logistics operations i.e. freight transport. According to case studies based on three grocery retailers from the United Kingdom, it was indicated that ICTs minimize CO_2 emissions by minimizing the consumption of energy; thus it was highlighted that ICTs contribute to environmental protection (Wang et al., 2015). In this way, logistics operations can be optimized in transport companies through the adoption of ICTs, environmental damage can be reduced by freight transport companies because the freight transport sector contributes 6% of atmospheric pollution (Chatti, 2021a). According to Champion (2021), green logistics has three benefits if implemented; it reduces the emission of harmful gases, it reduces the plastic waste used in packaging, increases the awareness of customers, and it makes the brand reputation stronger (Champion, 2021).

As the population on this planet increases, the probability of environmental damage inclines, and in that situation strategies to sustain the environment are necessary to be implemented. In this regard, the present review was conducted to highlight the impact of ICT services on the logistics performance of companies. The motivation for the present review was the environmental concern and at the same time, the contribution of ICT applications in helping companies to save the environment. The present review provides a detailed review of how ICT services can increase logistics performance with less environmental damage.

2. Purpose of Research

With the advent of effective applications of ICT, things have become easy to manage and monitor., CO_2 emissions have been an issue of concern for the corporate and academic world and the logistics sector greatly contributes to CO_2 emissions. Therefore, the present research aims to highlight the role of information and communication technology in increasing the performance of sustainable logistics. This research also includes a review based on the optimization of vehicle usage and how ICT helps in the minimization of CO_2 emissions in the context of the logistics sector.

3. Research Methodology

When it is to provide insightful information on a scholarly topic, a literature review effectively helps researchers analyze the available research on the topic (Jahan et al., 2016). The present research paper is based on the narrative review. The author of the present research mainly discussed the findings of the research papers published in peer-reviewed journals. The present review focused on the published research papers regardless of their publication year. Therefore, no range of time was followed to select the research papers.

4. Minimizing Fuel Consumption and CO_2 Emission

The operations of logistics on a global scale have developed a significant threat to the beauty of the environment in terms of climate change, air quality, emissions of carbon and greenhouse gases (Yu et al., 2018; Khan et al., 2020). The strategy of the corporate sector has been towards cost reduction and maximization of sales but the increasing concerns on certain problems like global warming, limitation of resources, and greenhouse gases (GHGs) have increased the focus of firms to consider sustainability into their strategic planning (Dey et al., 2011). Shee et al. indicated that the use of ICTs and the capability of IT are positively associated with smart logistics. The smart logistics that are technology-enabled are positively associated with the environment, by which economic and social performance is affected in turn (Shee et al., 2021). Yu, Abdul, and Khan (2018) reported a negative association of green logistics with carbon emissions and in this way, green logistics promote economic and environmental sustainability (Yu et al., 2018). Mohsin et al. (2022) also found a significant association among the factors i.e. environment, green logistics, and economic growth; they concluded that the poor quality of logistics` infrastructure, service quality of logistics and cargo transportation timeliness consume a greater quantity of fossil fuels and therefore cause an increased carbon emissions which negatively impacts human health and the environment of the planet (Mohsin et al., 2022).

CO_2 emissions are estimated to increase by 60% in 2050 from transportation activities and it will be 160% only from freight transport on the planet if no further actions are taken to protect the environment (Liu et al., 2018). The general use of ICTs (mobile phone networks, telephone

usage, and internet usage) was reported to be associated positively with CO_2 emissions (Alataş, 2021; Asongu et al., 2019; Avom et al., 2020; Su et al., 2021). The use of ICTs contributes to 2% of global CO_2 emissions (Mingay, 2007). At the same time, if ICTs are used after their integration with transportation entities, they have the potential to minimize CO_2 emissions. Air pollution and road congestion are the major problems in big cities (Bates, Friday, Allen, Cherrett, et al., 2018). It has been estimated that one truck leaves as much carbon footprint in the environment as 14 people do in one year; which is equal to 223 tons of CO_2; moreover, the transportation sector contributes 26% of the carbon footprint (Sporrer, 2021). However, more efficient vehicles and alternative fuels were used to a greater extent at the beginning of the 21st century so that carbon emissions caused by road transport could be minimized (Isaksson, 2012, p.3). Liu et al. (2019) developed an Internet of Things-enabled status-sensing model for logistics vehicles. The model works on the strategy of dynamic optimization that is driven by real-time information collected by the IoT. Liu indicated that the model contributed to the minimization of fuel consumption and logistics costs, and it also helped in improving the utilization rate of vehicles and achieving high efficiency in the provision of logistics services (Liu et al., 2019). According to the perception of companies, cost saving is a main challenge and they work very hard to minimize costs by minimizing fuel consumption (Isaksson, 2012). The literature review indicates that there is an association between cloud operating systems (CLS), environmental protection, and sustainable development; moreover, it also indicates that cloud technology reduces fuel consumption and so carbon emissions while travelling around (Chen et al., 2019; Mahmood & Mann, 2015). Kechil et al. (2022) researched how the implementation of IT influences the logistics firms` performance in terms of customer service, safety and security, tracking, and integration of information at Shah Alam Selangor. In their research, they found that fuel management was on the fourth highest service rank among the benefits of ICT services used by logistics firms (Kechil et al., 2022). Bates et al. (2018) explained a three-tier ICT platform as given in Figure 1 which provided a vision by which spatial modelling and optimization, data sciences, data visualization and communication, information systems, and software engineering can enable sustainable and smart last mile logistics. This collaboration is fundamental when it is about developing a platform which can significantly reduce carbon emissions caused by logistics and transport.

Cano, Gomez, and Cotes (2021) indicated that the application of ICT i.e. transportation management system (TMS) influences the CO_2 reduction in the distribution networks by bringing the improvement in driving behaviour, optimization of routes, the load level of vehicles (Cano et al., 2021). Chatti (2021) indicated that ICTs and local freight transportation have a negative impact on CO_2 emissions; she further indicated that environmental damage can be minimized by 2.36 per cent if the interaction between mobile phone subscription and inland freight transport is improved by 10 per cent. Moreover, if the interaction between internet users and inland freight transport is improved by 10%, the pollution would decrease by 1.27%. Chatti further revealed that by increasing telephone landlines by 10%, the CO_2 emission can be reduced by 3.02% (Chatti, 2021b). Kwakwa, Adjei-Mantey, and Adusah-Poku (2022) researched to support the argument that the use of ICT in the transportation sector influences CO_2 emissions. They analyzed the

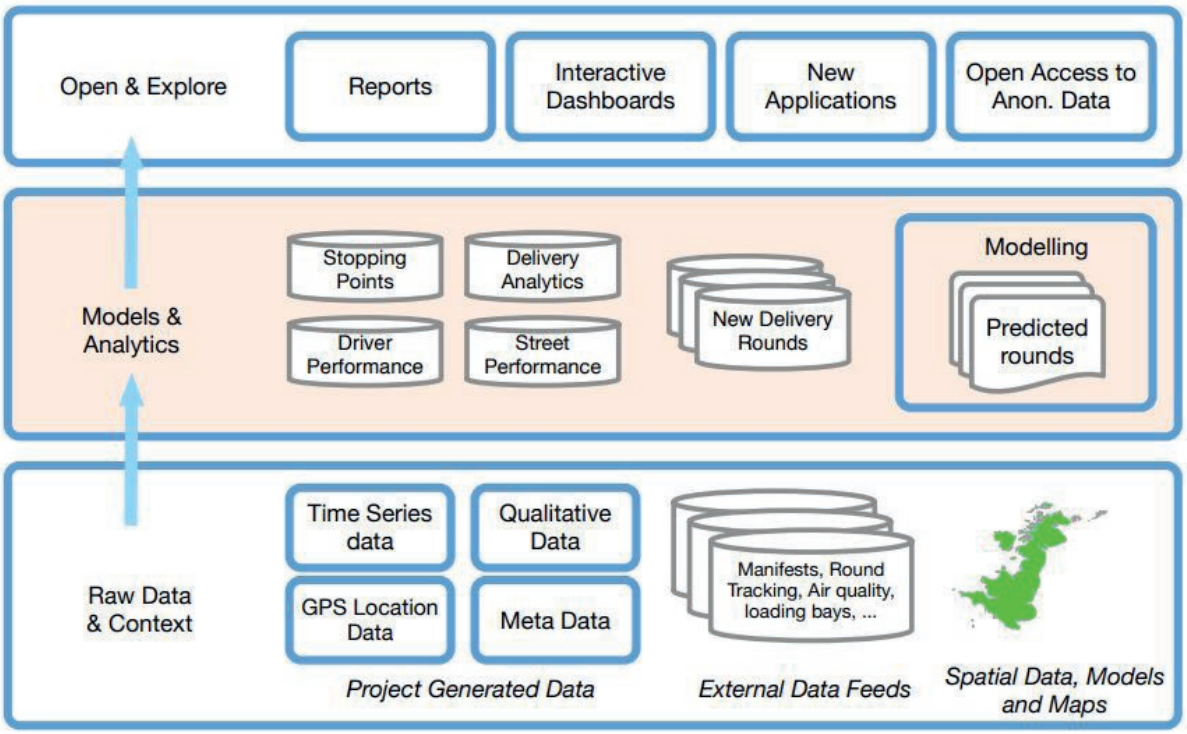

Figure 1: An overview of the platform that brought data sources together and enabled decision support at last-mile logistics (Source: (Bates, Friday, Allen, Mcleod, et al., 2018)).

impact of the transportation sector on CO_2 emissions in South Africa. They conducted regression analysis on the data from 1989 to 2018 and the results indicated the positive association of mobile adoption, telephone, and internet usage with CO_2. On the other hand, transportation services helped to reduce it. Moreover, results also revealed a direct association between CO_2 emissions and the use of ICT in the transportation sector (Kwakwa et al., 2022). The direct positive association between ICT solutions and reduction in CO_2 emissions was also confirmed by Wang et al. (2015); they indicated that there are further opportunities to reduce CO_2 emissions but they are perceived to lie beyond the reach of the network of retailers` distribution. The opportunities are under-utilized because of the complex collaborative ICT services and the reluctance of retailers to share the information in the market (Wang et al., 2015). Karaduman et al. (2020) also reported a positive and significant association between the performance of logistics and CO_2 emissions in Balkan countries (Karaduman et al., 2020).

5. Optimization of Vehicle Usage

An important function of various organizations is represented by Logistics whether it is manufacturing, service, private or public. The competition before globalization was limited to a country but with globalization it is just not limited to a country but it includes the whole world. This is the reason, logistics has become supremely important in international business and also an essential element in the development of countries in the previous ten years (Karaduman et al., 2020). It is highly required for the distribution and logistics systems to go for the optimization of cargo vehicle`s capacity, operational error elimination, and maximization of performance by guaranteeing distribution routes; moreover, they help in the reduction of costs, optimization of delivery times and delays, and pollution reduction (Micheli et al., 2020; Trappey et al., 2017). ICT can potentially help in computerized routing, vehicle telematics systems and vehicle scheduling (Bates, Friday, Allen, Mcleod, et al., 2018; Evangelista et al., 2018). Liu et al (2019) indicated that the utilization rate of vehicles is improved by using a dynamic optimization strategy based on the real-time information collected through IoT technology; it not only enhances the utilization rate of the vehicles but helps to reduce the cost, consumption of fuel, and quantity of utilized vehicles as well along with the provision of optimal routing of vehicles. Optimal routing is quite a beneficial aspect of technology by which the logistics` service efficiency is ensured (Liu et al., 2019). Applications of IoT were discussed by Macaulay et al. (2020) for asset and fleet management; as per the discussed IoT application, the status (idle or in operation) of ULD, truck, or container could be monitored closely by sensors. Then the data is transmitted for the optimal utilization of the asset. The capacity of each load is measured and insights are provided for non-utilized capacities on the several routes. The central dashboard then identifies non-utilized capacity along regular routes and suggests the optimal routes; in this way, fleet efficiency is enhanced, fuel economy is improved and deadhead miles (almost 10% of truck miles) are reduced (Macaulay et al., 2020). In this way, the less combustion of fuel leads to less carbon footprint and it can be controlled efficiently.

6. Conclusion

ICT has brought drastic innovation to the logistics sector by reducing fuel consumption and enhancing traceability and performance. IoT devices have increased the live route monitoring of vehicles. The companies have developed dashboards to monitor the vehicles and their routes as well, which has significantly improved the performance of the logistics sector. Since the vehicles are optimally used, their fuel consumption also gets optimized, and most importantly, CO_2 emissions and emissions of greenhouse gases are minimized. In this regard, the role of ICT is greater in the logistics sector and thus makes logistics greener.

Conflict of Interest

No conflict of interest was found among the authors of the present review paper.

References

Alataş, S. (2021). The role of information and communication technologies for environmental sustainability: Evidence from a large panel data analysis. *Journal of Environmental Management*, *293*, 112889. https://doi.org/10.1016/J.JENVMAN.2021.112889

Asongu, S.A., Nwachukwu, J.C., & Pyke, C. (2019). The Comparative Economics of ICT, Environmental Degradation and Inclusive Human Development in Sub-Saharan Africa. *Social Indicators Research*, *143*, 1271–1297. https://doi.org/10.1007/S11205-018-2009-X/TABLES/7

Avom, D., Nkengfack, H., Fotio, H.K., & Totouom, A. (2020). ICT and environmental quality in Sub-Saharan Africa: Effects and transmission channels. *Technological Forecasting and Social Change*, *155*, 120028. https://doi.org/10.1016/J.TECHFORE.2020.120028

BasuMallick, C. (2022). *What Is GPRS (General Packet Radio Service)? Meaning, Working, Advantages, and Applications*. Spiceworks. https://www.spiceworks.com/tech/networking/articles/what-is-gprs/

Bates, O., Friday, A., Allen, J., Cherrett, T., McLeod, F., Bektas, T., Nguyen, T., Piecyk, M., Piotrowska, M., Wise, S., & Davies, N. (2018). Transforming Last-mile Logistics: Opportunities for more Sustainable Deliveries Oliver. *5th International Conference on ICT4S*. https://doi.org/10.1145/3173574.3174100

Bates, O., Friday, A., Allen, J., Mcleod, F., Cherrett, T., Wise, S., Piecyk, M., Piotrowska, M., Bektas, T., & Nguyen, T. (2018). ICT for Sustainable Last-Mile Logistics: Data, People and Parcels. *EPiC Series in Computing*, *52*, 49–67. https://doi.org/10.29007/67nl

Baxter, K. (2022). *What Are Sustainable Logistics Practices?* InTek Freight & Logistics. https://blog.intekfreight-logistics.com/what-are-sustainable-logistics-practices

Cano, J.A., Gómez, R.A., & Cortés, P. (2021). ICT validation in logistics processes: Improvement of distribution processes in a goods sector company. *Informatics*, *8*(4). https://doi.org/10.3390/informatics8040075

Champion, A. (2021). *4 Advantages of Green Logistics In Supply Chain Management & How To Apply Them*. Flowspace. https://flow.space/blog/4-advantages-of-green-logistics-in-supply-chain-management-how-to-apply-them/

Chan, Y.E., Huff, S.L., Barclay, D.W., & Copeland, D.G. (1997). Business Strategic Orientation, Information Systems Strategic Orientation, and Strategic Alignment on JSTOR. *Information Systems Research*, *8*(2), 125–150. https://doi.org/10.1287/isre.8.2.125

Chatti, W. (2021a). Moving towards environmental sustainability: information and communication technology (ICT), freight transport, and CO_2 emissions. *Heliyon*, *7*(10), e08190. https://doi.org/10.1016/j.heliyon.2021.e08190

Chatti, W. (2021b). Moving towards environmental sustainability: information and communication technology (ICT), freight transport, and CO_2 emissions. *Heliyon*, *7*(e08190). https://doi.org/10.1016/j.heliyon.2021.e08190

Chen, H.Y., Das, A., & Ivanov, D. (2019). Building resilience and managing post-disruption supply chain recovery: Lessons from the information and communication technology industry. *International Journal of Information Management*, *49*, 330–342. https://doi.org/10.1016/J.IJINFOMGT.2019.06.002

Dey, A., LaGuardia, P., & Srinivasan, M. (2011). Building sustainability in logistics operations: a research agenda. *The Eletronic Library*, *34*(11), 1237–1259. https://doi.org/10.1108/01409171111178774

Drews, P., & Sagawe, A. (2014). The Role of ICT in Green Logistics: A Systematic Literature Review. In *Information Technology in Environmental Engineering* (pp. 53–65). Springer-Verlag. https://doi.org/10.1007/978-3-642-36011-4

Evangelista, P., Santoro, L., & Thomas, A. (2018). Environmental sustainability in third-party logistics service providers: A systematic literature review from 2000-2016. *Sustainability (Switzerland)*, *10*(5). https://doi.org/10.3390/su10051627

Goh, M., & Fraser, K. (2011). Supply chain innovation for competing in highly dynamic markets: Challenges and solutions. In *Supply Chain Innovation for Competing in Highly Dynamic Markets: Challenges and Solutions* (pp. 123–136). IGI Global. https://doi.org/10.4018/978-1-60960-585-8

Isaksson, K. (2012). *Logistics Service Providers going green – insights from the Swedish market* [Linkoping University]. http://www.diva-portal.org/smash/get/diva2:479727/FULLTEXT01.pdf

Jahan, N., Naveed, S., Zeshan, M., & Tahir, M.A. (2016). How to Conduct a Systematic Review: A Narrative Literature Review. *Cureus*, *8*(11), e864. https://doi.org/10.7759/cureus.864

Jovanovi, I., & Olovi, A. (2017). Ict in Logistics: Possibilities and the Areas of Application. *3rd Logistics International Conference*, 191–196. https://logic.sf.bg.ac.rs/wp-content/uploads/LOGIC_2017_ID_32.pdf

Karaduman, H.A., Karaman-Akgül, A., Çağlar, M., & Akbaş, H.E. (2020). The relationship between logistics performance and carbon emissions: an empirical investigation on Balkan countries. *International Journal of Climate Change Strategies and Management*, *12*(4), 449–461. https://doi.org/10.1108/IJCCSM-05-2020-0041

Kechil, N.A., Zulfakar, M.H., Muhammad, A., Talib, M.S.A., & Nasir, S. (2022). Effects of Information Technology on Logistics Firms' Performance in Shah Alam, Selangor, Malaysia. *Interenational Journal of Academic Research in Accounting, Finance and Management Sciences*, *12*(3), 430–447. https://doi.org/10.6007/IJARAFMS

Khan, S.A.R., Zhang, Y., & Nathaniel, S. (2020). Green supply chain performance and environmental sustainability: A panel study. *Logforum*, *16*(1), 141–159. https://doi.org/10.17270/J.LOG.2020.394

Kwakwa, P.A., Adjei-Mantey, K., & Adusah-Poku, F. (2022). The effect of transport services and ICTs on carbon dioxide emissions in South Africa. *Environmental Science and Pollution Research*, *1*, 1–12. https://doi.org/10.1007/s11356-022-22863-7

Liu, J., Yuan, C., Hafeez, M., & Yuan, Q. (2018). The relationship between environment and logistics performance: Evidence from Asian countries. *Journal of Cleaner Production*, *204*, 282–291. https://doi.org/10.1016/J.JCLEPRO.2018.08.310

Liu, S., Zhang, Y., Liu, Y., Wang, L., & Wang, X.V. (2019). An 'Internet of Things' enabled dynamic optimization method for smart vehicles and logistics tasks. *Journal of Cleaner Production*, *215*, 806–820. https://doi.org/10.1016/J.JCLEPRO.2018.12.254

Macaulay, J., Buckalew, L., & Chung, G. (2020). Internet of Things in Logistics. In *DHL Customer Solutions & Innovation*.

Mahmood, M.A., & Mann, G.J. (2015). Special Issue: Impacts of Information Technology Investment on Organizational Performance. *Journal of Management Information Systems*, *16*(4), 3–10. https://doi.org/10.1080/07421222.2000.11518263

Maplesden, P. (2022). *7 benefits of RFID in supply chain management and logistics*. TechTarget. https://www.techtarget.com/searcherp/tip/7-benefits-of-RFID-in-supply-chain-management-and-logistics#:~:text=RFID provides logistics managers with,from inventory management to automation.

Micheli, G.J.L., Cagno, E., Mustillo, G., & Trianni, A. (2020). Green supply chain management drivers, practices and performance: A comprehensive study on the moderators. *Journal of Cleaner Production*, *259*, 121024. https://doi.org/10.1016/J.JCLEPRO.2020.121024

Mingay, S. (2007). *Green IT: The New Industry Shock Wave*. Gartner. https://www.gartner.com/en/documents/559709

Mohsin, A.K.M., Tushar, H., Abid Hossain, S.F., Shams Chisty, K.K., Masum Iqbal, M., Kamruzzaman, M., & Rahman, S. (2022). Green logistics and environment, economic growth in the context of the Belt and Road Initiative. *Heliyon*, *8*(e09641). https://doi.org/10.1016/j.heliyon.2022.e09641

Nour, R. (2022). Enhancing the Logistics 4.0 Firms through Information Technology. *Sustainability (Switzerland)*, *14*(15860). https://doi.org/10.3390/su142315860

Pazirandeh, A., & Jafari, H. (2013). Making sense of green logistics. *International Journal of Productivity and Performance Management*, *62*(8), 889–904. https://doi.org/10.1108/IJPPM-03-2013-0059

Perego, A., Perotti, S., & Mangiaracina, R. (2011). ICT for logistics and freight transportation: A literature review and research agenda. *International Journal of Physical Distribution and Logistics Management*, *41*(5), 457–483. https://doi.org/10.1108/09600031111138826

Santos, G. (2017). Road transport and CO2 emissions: What are the challenges? *Transport Policy*, *59*, 71–74. https://doi.org/10.1016/j.tranpol.2017.06.007

Shaikh, N. (2023). *GPS tracking works and how can It help to transportation & logistics business?* Peerbits. https://www.peerbits.com/blog/gps-tracking-mobility-solution-for-transportation-and-logistics.html#:~:text=GPS tracking enables the development,customer service and improves efficiency.

Shee, H.K., Miah, S.J., & De Vass, T. (2021). Impact of smart logistics on smart city sustainable performance: an empirical investigation. *International Journal of Logistics Management*, *32*(3), 821–845. https://doi.org/10.1108/IJLM-07-2020-0282

Sporrer, A. (2021). *How much carbon does the transportation industry emit annually?* FreightWaves. https://www.freightwaves.com/news/how-much-carbon-does-the-transportation-industry-emit-annually

Su, C.W., Xie, Y., Shahab, S., Faisal, C.M.N., Hafeez, M., & Qamri, G.M. (2021). Towards Achieving Sustainable Development: Role of Technology Innovation, Technology Adoption and CO2 Emission for BRICS. *International Journal of Environmental Research and Public Health 2021, Vol. 18, Page 277*, *18*(1), 277. https://doi.org/10.3390/IJERPH18010277

Trappey, A.J.C., Trappey, C.V., Fan, C.Y., Hsu, A.P.T., Li, X.K., & Lee, I.J.Y. (2017). IoT patent roadmap for smart logistic service provision in the context of Industry 4.0. *Journal of the Chinese Institute of Engineers, 40*(7), 593–602. https://doi.org/10.1080/02533839.2017.1362325

Wang, Y., Rodrigues, V.S., & Evans, L. (2015). The use of ICT in road freight transport for CO2 reduction - An exploratory study of UK's grocery retail industry. *International Journal of Logistics Management*, *26*(1), 2–29. https://doi.org/10.1108/IJLM-02-2013-0021

Yingfei, Y., Mengze, Z., Zeyu, L., Ki-Hyung, B., Andriandafiarisoa Ralison Ny Avotra, A., & Nawaz, A. (2022). Green logistics performance and infrastructure on service trade and environment-Measuring firm's performance and service quality. *Journal of King Saud University - Science*, *34*(101683). https://doi.org/10.1016/j.jksus.2021.101683

Yu, Z., Abdul, S., & Khan, R. (2018). The Relationship Between Green Supply Chain Performance, Energy Demand, Economic Growth and Environmental Sustainability: An Empirical Evidence From Developed Coutries. *Scientific Journal of Logistics*, *14*(4), 479–494.