

THE IMPACT OF THE INTEGRATION OF IOT AND BUSINESS INTELLIGENCE IN SMART CITY LOGISTICS: A CONCEPTUAL FRAMEWORK

Asterios Stroumpoulis, Evangelia Kopanaki

Department of Business Administration, University of Piraeus, Greece

Abstract

Purpose

This research examines the impact of Digital Transformation in the field of Smart City Logistics. For several years now, there has been a significant intensification of urbanization, with the concentration of a large population in urban centres. This trend is escalating private vehicle ownership, traffic congestion and parking saturation, followed by consumer pressures for on time delivery of goods, highlighting the need for a sustainable solution.

The aim of this paper is to contribute to the research on the effective interaction between new technologies and urban supply chain management. Specifically, the paper seeks to explore how IoT and business intelligence systems can empower City Logistics and enhance the sustainability and social value of supply chains.

Design/methodology/approach

The research methodology followed, initially relies on an extensive literature review. The aim of the literature review is to cover a wide range of information and data to ensure the objectivity and validity of the research under study. Furthermore, to better explain the subjects of study, the paper examines relevant theories such as “legitimacy”, “stakeholders” and “socio-technical” theory. Based on these theories and on the results of the literature, it develops a theoretical framework.

Findings

Smart city logistics represents a proactive and progressive approach to optimize urban freight transport in the face of increasing urbanization and evolving consumer demands. By harnessing the power of technology, sustainability and collaboration, cities can create more resilient, efficient, environmentally and socially sustainable logistics systems that meet the needs of both businesses and residents, while ensuring the long-term sustainability of urban ecosystems. Therefore, the conceptual framework will work as a roadmap (for both practitioners and academics) for using these technologies in city logistics planning and operations.

Originality/value

The aim of the proposed framework is to promote an understanding of the complex interplay between IoT, BI systems and social implications of City Logistics, taking into consideration the challenges and technological difficulties that may arise. Digital Transformation through new technologies brings revolutionary changes in the logistics sector, which acquires different operational characteristics and is transformed into Logistics 4.0, increasing business value and leading to more sustainable smart cities.

Keywords

Internet of Things, Business Intelligence Systems, Sustainability, Smart City Logistics

Introduction

This research examines the impact of Digital Transformation in the field of Smart City Logistics. For several years now, there has been a significant intensification of urbanization, with the concentration of a large population in urban centers and capital city regions. This trend is escalating private vehicle ownership, traffic congestion and parking saturation, issues further exacerbated by remote work and online ordering, followed by consumer pressures for on time delivery of goods. Illegal occupation of unloading areas further complicates these problems, highlighting the need for a sustainable solution.

Digital Transformation, in particular IoT, and business intelligence systems can play a key role in managing logistics in urban centers and enhance the efficiency of last mile delivery. Smart City Logistics is emerging as a strategic response, leveraging technology for optimized freight transport and promoting collaboration for sustainable urban freight transport systems, among various stakeholders, practitioners and businesses.

Business-to-Customer (B2C) distribution channels are the main interaction between businesses and customers, directly affecting the efficiency and reliability of supply services and thus customer satisfaction and competitive advantage (Sharma et al., 2022). These distribution channels are called last-mile delivery channels because they largely run within urban areas. In recent years, mainly due to the large increase in online sales of products, the last mile has become critical to the viability of

businesses (Viu-Roig & Alvarez-Palau, 2020). These channels offer a reduction in delivery/distribution costs and a direct response to growing consumer expectations for faster delivery. Examples include online purchase and in-store pick-up, automated delivery systems, automatic collection boxes and minimum purchase levels for free delivery, etc.

All of the above will lead to an increase in traffic compliance, as more and more vehicles engage in activities within these channels, including private individuals picking up products from points of sale or courier services (Kimpton et al., 2021). The combination of the above has also contributed to the "illegal" occupation of the loading/unloading zones, which are intended exclusively for commercial vehicles and restricted to specific time intervals. As a result, commercial vehicles are not able to park in the designated places and end up parking illegally, further increasing traffic difficulties within the urban center (Malik et al., 2017).

To address these challenges, Industry 4.0 technologies play a key role in the transformation of distribution channels, in terms of business optimization. In this context, the use of new technologies is of particular interest to both researchers and practitioners. All the technologies are based on the digital connectivity of the participants, supporting management structures and data analysis algorithms (Silva et al., 2023). Thus, in recent years there has been a strong interest in the integration of these technologies and the evaluation of optimal combinatorial frameworks for the operation of city logistics. Therefore, Digital Transformation through new technologies brings revolutionary changes in the logistics sector, which acquires different operational characteristics and is transformed into Logistics 4.0, increasing business value and leading to more sustainable smart cities (Sharma et al., 2022).

The aim of the proposed study is to contribute to the research on the effective interaction between new technologies and urban supply chain management. Specifically, the paper seeks to explore how IoT and business intelligence systems can empower City Logistics and enhance the sustainability and social value of supply chains.

In conclusion, smart city logistics represents a proactive and progressive approach to optimize urban freight transport in the face of increasing urbanization and evolving consumer demands. By harnessing the power of technology, sustainability and collaboration, cities can create more resilient, efficient, environmentally and socially sustainable logistics systems that meet the needs of both businesses and residents, while ensuring the long-term sustainability of urban ecosystems.

Literature Review

The research methodology followed in this study, initially relies on an extensive literature review (Nightingale, 2009) The purpose of the literature review is to develop the topic only in terms of literature, i.e. without collecting new data. The sources of the literature are primary, i.e. articles, publications, reports, conference proceedings, theses and dissertations, which help to clarify the concepts as well as to better understand the issues under consideration. The aim of the literature review is to cover a wide range of information and data to ensure the objectivity and validity of the research under study (Kilibarda et al., 2020).

This research analyzes the topics of Industry 4.0 and Smart City Logistics. It also tries to explain how this combination could lead stakeholders to increase their social value and companies to increase their business value. Authors, in order to better understand, examine, clarify these specific concepts and build a conceptual framework, had to conduct an extensive literature review.

Therefore, the purpose of the literature review allows academics to examine and understand the main topics and theories associated with the phenomenon under study and to develop a conceptual framework.

Smart City Logistics

The concept of "smart city" implies that there is collaboration between the new means of transport, Information Technologies and energy systems (Russo et al., 2016).

According to Shee et al. (2021), they define that "smart cities deploy digital and communication technologies in city-wide activities to improve efficiency, manage complexity and enhance quality of life, leading to sustainable city operations". The topic of urban freight transport is not something new to the academic community, since it has been on the agenda for at least two decades. According to Taniguchi et al. (2003) city logistics are defined as "the process for totally optimizing the logistics and transport activities by private companies with the support of advanced information systems in urban areas considering the traffic environment, its congestion, safety and energy savings within the framework of a market economy". Moreover, they define that "smart logistics" possess different types of auto-identification tags and sensors, in order to gather real-time data about physical environments and communicate data with different stakeholders within their collaboration network (Shee et al., 2021).

Smart city logistics is a complex concept and it is also a multidimensional system, which deals with many and different challenges from diverse stakeholders engaged in the aspects of social, political, economic activities (Fernandez-Anez et al., 2018). To keep it simple, this research focuses on logistics service providers (especially the 3PL provides – Third Party Logistics) who are associated with city logistics.

Industry 4.0 and City Logistics

During the last decades, there has been a tremendous technological evolution, which led to the development of the concept of “Logistics 4.0”, which has highlighted the importance of integrating the new technologies into the management of the transport system. Previous surveys have stated that the use of new information technologies are able to contribute to optimizing vehicle routing, truck filling rates, packaging processes, handling operations and parking, as well as dealing successfully with economic costs, energy consumption and reducing greenhouse gas emissions (El Yadari et al., 2024). According to Autry et al. (2010), Supply Chain Technologies are defined as “the tools and techniques that may be implemented to effectuate integrated supply chain management within or across organisational boundaries” (Autry et al., 2010, p. 523). While there is a debate among scholars on how this technology adoption and use of information technologies will improve supply chain resilience (Kamalahmadi and Parast, 2016), research is still to be defined what extent these technology-enabled smart logistics can benefit smart cities.

Finally, the concept of Logistics 4.0 (which is derived from Industry 4.0) is the latest version of logistics concepts, since the early 21st century. Its focus is on digitising processes and using advanced technologies such as IoT for real-time monitoring. Mainly, its focus is on using big data analysis for predictive sourcing and transport planning (El Yadari et al., 2024). The adoption of L4.0 relies on the use of several new information technologies.

Business Intelligence Systems

Business intelligence (BI) systems can revolutionize city logistics, boosting efficiency, reducing costs and improving service quality. A key advantage of BI in city logistics is its ability to analyze data in real time. For example, traffic management systems equipped with BI tools can process real-time traffic data to optimize delivery routes, reducing travel time and fuel consumption. This not only leads to significant cost savings but also mitigates environmental impacts. In addition, BI systems facilitate demand forecasting by examining historical data and current trends, allowing logistics managers to anticipate peak delivery times and allocate resources more efficiently (Jalil et al., 2019). Integration with the Internet of Things (IoT) and smart systems further enhances the potential of BI in city logistics. By integrating BI with IoT devices, real-time data from traffic sensors, smart grids and other sources can be leveraged to provide a comprehensive view of logistics operations (Baars & Ereth, 2016).

Finally, BI promotes better collaboration and communication between the different stakeholders involved in the city's logistics (Rouhani et al., 2016). The transparency provided by BI (Bordeleau et al., 2018) builds trust between stakeholders, leading to improved collaboration in supply chain initiatives and overall, more efficient and effective supply chain operations.

Internet of Things

IoT technologies are truly important for the supply chains since they have the ability to offer several benefits in comparison to the traditional methods used for monitoring. For example, in comparison with traditional package loggers, IoT devices offer a wider and more effective range of connectivity possess greater on-board processing power (Markovic et al., 2020). This fact triggers computations to be performed by the IoT devices itself, enabling them to act as location and context aware devices, which are able to document and react to changes in their physical surroundings.

Therefore, nowadays there are Internet-based cloud technologies, big data analytics and business intelligence, which all together support the concept of Smart City Logistics, using IoT technology at its core (Tjahjono et al., 2017). According to Hopkins and Hawking (2018) there are GPS-connected in-cabin IoT retina scanners, which are able to monitor driver fatigue by checking blink frequency, and that there are also IoT systems in fleet management, which can monitor truck idle time through GPS. Moreover, IoT systems and route optimisation techniques can reduce costs and improve the overall supply chain efficiency (Shee et al., 2021).

However, in the field of smart city logistics and urban freight transport, there are essential urban freight data from logistics companies, which are most of the times not available to public authorities. This is happening, because all the associated data are owned by companies, (e.g., freight operators, telecommunication providers, data-oriented technology companies) which are not willing to share them and make them public (Otte and Meisen, 2020).

Therefore, the application of BI and IoT will drive and provide better connectivity of all participants inside the supply chain, real-time information sharing and appropriate decision-making, which will lead to significant improvement in flow realization efficiency (Batarliené and Bazaras, 2023).

Sustainability and Smart City Logistics

City logistics and urban freight transport are at the core of urban economies, but at the same time, they deal with plenty environmental challenges (Schliwa et al., 2015). In addition, an activity of efficient urban freight transportation supports not only the distribution of the goods/services but also the urban development and finally contributes to environmental sustainability (El Yadari et al., 2024). Indeed, developing and improving freight transport procedures will help companies to minimize their greenhouses emissions, by optimizing traffic flows (fleet management) and minimizing traffic jams.

Cities, however, apart from the distribution of goods and services, they need to offer firstly quality of life for their residents and every other group of stakeholders (Pereira et al., 2023). In particular, cities must deal with every kind of threat to quality of life including road congestion, emissions and pollutants, energy (fuel, electricity), water consumption, product repairs, returns and recycling.

Social sustainability, on the other hand, is the one with the less attention within a supply chain (Mani et al., 2018) because of its difficulty to measure and define its dimensionality (Touboulic and Walker, 2015) and inadequate information to measure it. However, it is truly important and this significancy has been identified by all the stakeholders, who put pressure to the companies to take care of that issue (Stroumpoulis et al., 2024).

There is also, the last pillar of sustainability, that of economic dimension, which is generally measured through different aspects such as, labour productivity, profit, market share and gross revenues (Shee et al., 2018). There are surveys, which have proved that there are no economic success paying attention both at the impact of environment and society (Stroumpoulis and Kopanaki, 2024). Therefore, a smart city should pay attention to each of these three dimensions for the benefits of residents and its stakeholders.

Theories examining the impact of IoT and BI in Smart City Logistics

Furthermore, to better explain the subject of study and more specifically the social impact of city logistics' problems, the paper examines relevant theories such as Socio-Technical Theory (Sony and Naik, 2020), Legitimacy theory (Deegan, 2014) and Stakeholders' theory (Freeman et al., 2010). Based on these theories and on the results of the literature, it develops a theoretical framework. The aim of this framework is to promote an understanding of the complex interplay between IoT, BI systems and social implications of City Logistics, taking into consideration the challenges and technological difficulties that may arise.

Legitimacy Theory & Stakeholder's Theory

This theory states that all interested stakeholders who are in the task environment of the companies and not just the direct ones should benefit from the existence. According to Freeman's definition (1983 p.89x), the stakeholders are defined as "those groups without whose support, the organization would cease to exist". Therefore, each one of the stakeholders should have access to information, which is related to any environmental and social issue. Finally, on the survey which was conducted by Amosh and Mansor (2018), they stated that there is a lack of extensive research examining the social pillar of sustainability.

The "Legitimacy theory" is truly important for the social dimension of each aspect, because it states that the managers of an institution (company, NGO, etc.) should pay attention to the continuity and survival of their operations, but at the same time must reassure that their organization appears to be operating in alignment with the society. By operating in that way, the organization will earn the status of the "legitimate". Therefore, based on this theory, organizations are part of a broader social system and they do not have any specific right to resources (Deegan, 2014). So, firms have to earn this right and only a "legitimate organization" is able to maintain this right.

Socio-Technical Theory

According to Bostrom and Heinen (1977), socio-technical systems theory states that an information system has two pillars, that of the technical and social subsystem. The social subsystem focuses on a more human dimension, while the technical subsystem focuses on its technical resources and capabilities. This theory states also that the pillars are interconnected and constitute a collective whole. Therefore, the system's overall performance is depending primarily on a functionality of a connection rather than their individual properties (Sony and Naik, 2020).

Theoretical Framework Development

As mentioned in previous section, to examine and analyze the benefits from the adoption of those technologies, this study uses the Socio-Technical, Legitimacy and Stakeholders' theories as a theoretical background.

There are many groups of stakeholders inside a city logistics system, including residents, local authorities, customers, companies shippers and freight carriers. However, one of the most important is that of local authorities, which play a key role in designing and implementing policy interventions, with the aim of a better and more sustainable community (Janjevic et al., 2019). On the other hand, private companies, which operate inside this system, are trying to perform their logistics operations, and increasing their performance.

Different surveys claim that cooperation between different groups of stakeholders and their participation in the development of cities' policies can reduce the negative impact of logistics activities and, therefore, can contribute to a more efficient and sustainable city logistics environment (Dohn et al., 2022). According to Bachofner et al. (2022), it is truly important for public authorities to take into consideration all stakeholders, because in that way, companies would be able to improve the efficiency of implemented "last-mile" operations. But, on the other hand, this cooperation is rarely undertaken.

Moreover, another important issue, is the lack of crucial and significant data on urban freight flows in cities and the lack of knowledge in each stage of the operations, is an important hurdle for the unbiased ex-ante evaluation of city logistics policies (Janjevic et al., 2019). In addition, the increase of the performance of the fleet depends on real and on-time data about the traffic, which will be used to create and update the routing and scheduling plan (Grzybowska and Barceló, 2012).

Therefore, there are going to be many perceived benefits from the implementation of specific information technologies inside the city logistics, which include increased transparency of delivery processes, which will lead to more aware customers and enhance the monitoring procedures by logistics companies, as well as improved efficiency and sustainability through reduction in paper-based records (Markovic et al., 2020).

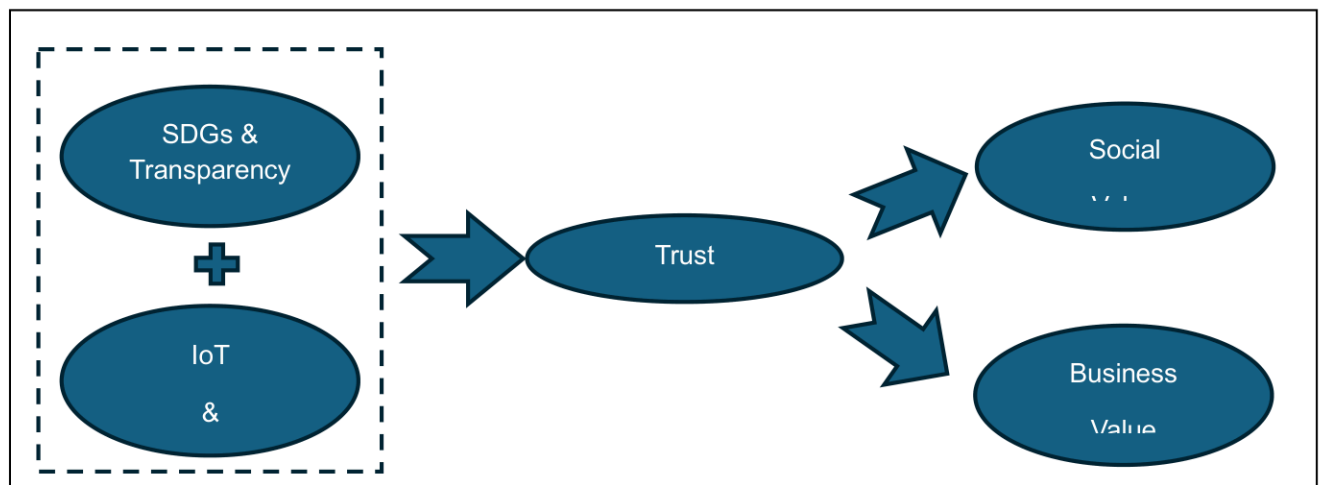


Figure 2: Conceptual Framework

Based on the previous sections, authors developed the above conceptual framework (Figure 1), which is based on the socio-technical theory. Regarding the technical pillar, it will include all the technological capabilities and infrastructures that enable smart city logistics (IoT and BI).

- *IoT technology*: which is consisted of devices (such as sensors, RFID, GPS) (Ahmed et al., 2023) & connectivity (real-time monitoring, cloud platforms) (Antonova et al., 2021).
- *Business Intelligence systems*: which are based on big data analytics and predictive models, in order to visualize their results in real-time dashboards for better decision-support systems (Mohammed et al., 2024).

Therefore, the technical subsystem will ensure efficiency, optimization, and sustainability at the system performance level. It will provide companies the necessary tools in order to monitor, analyse, and optimize flows in real-time. Based on that companies will be able to better address congestion, emissions, and service quality to their customers and local communities.

On the other hand, there is the social pillar, which includes the integration of sustainable policies and the collaboration with the stakeholders (local authorities, customers, residents, organizational) and institutional aspects of smart city logistics. Based on the transparency and compliance with regulations

of all reports and data, trust will be developed among the stakeholders, maintaining in that way a legitimate social “license” to operate (Barykin et al., 2023).

Therefore, the social subsystem will ensure that the adoption of those technologies will be aligned with the values of each society. It will address legitimacy, trust-building, and cooperation between all players of this supply chain with competing objectives.

This combination of the two dimensions (social and technical) inside the logistics companies develops the conditions for transparency and trust, which are both central keys in both Legitimacy and Stakeholder Theory (Reid et al., 2024). From the technical aspect, IoT technologies and Business Intelligence systems could generate accurate, timely, and verifiable data and information about all the logistics operations. This combination produces data and provides a transparent foundation that can be accessible to authorities, customers, employees, NGOs and communities. However, transparency and trust alone are not sufficient; they must be embedded in organizational practices that facilitate dialogue, accountability, and collaboration (Brun et al., 2020). So, the social pillar of proposed framework will ensure that the technological system will produce accurate and transparent data, which will be communicated effectively, governed responsibly, and will be aligned with the values of the different groups of stakeholders inside the supply chain and society.

Through this framework and based on the Legitimacy theory, logistics companies can gain and maintain their “license” of legitimacy to operate inside the cities, by being alignment with social norms and any regulatory requirements and needs. Simultaneously, based on the Stakeholder’s Theory logistics companies are trying to involve all different groups and develop trust across their ecosystem. This could be achieved with different means in each group. *Logistics employees* will be able to use monitoring tools in order to improve safety and workload distribution rather than surveillance. *Customers and citizens*, based on transparency of the delivery procedures will be more confident about the service quality. *Local authorities* will have open access in sustainability reports and metrics, which will strengthen credibility.

As transparency and trust grows from the above combination, stakeholders recognize that logistics providers will create not only better economic results but also, they will increase the social value, by reducing congestion, emissions, developing safer urban environments, and more inclusive governance of urban logistics systems.

Moreover, apart from the social value this specific combination could also increase the business value of logistics companies. The technical dimension will provide efficiency in the system based on real-time optimization of routes, predictive maintenance, and accurate demand forecasting, which will decrease the operational costs and improve the provided service reliability. The social dimension will ensure that the combination of those technologies will be incorporated in organizational culture and in every partner involved. The use of those technologies will allow logistics providers to adapt more quickly to any change of their task environment, leverage collaboration for resource sharing, and align internal operations with sustainability strategies. All the above will lead companies to long-term competitiveness.

To sum up, the socio-technical framework will create two different outcomes. By aligning technical transparency with social engagement, firms create trust, legitimacy, and social value for stakeholders, but simultaneously they enhance operational efficiency, resilience, and overall increase of business value. Those two outcomes will drive logistics companies not only as an efficient partner in smart cities but also as socially responsible players, who are capable of balancing stakeholder needs with economic success.

Conclusion and Future research

To conclude, urban freight logistics and smart city logistics is subject not only to each logistics provider individually but also to local, regional and national authorities from different fields, including transportation, environmental, and economic planning institutions (Shee et al., 2021). Therefore, local authorities have and must play a key role in the design and implementation of new smart city logistics policies. However, the integration of BI and IoT technologies will provide better connectivity of all partners, real-time data sharing and appropriate decision-making information in crucial times, which leads to significant improvement in flow realisation efficiency.

Regarding the next steps of this paper, researchers will develop a real use-case scenario, using questionnaires and interviews in order to identify the problems and develop the user requirements and needs of all the involved stakeholders. The purpose is to develop a technical architecture based on the proposed conceptual framework, which will be able to identify the technical requirements and finally to develop a mobile application in a simple progressive Web-based app developed using HTML and JavaScript.

Acknowledgement

This work has been partly supported by the University of Piraeus Research Center.

References

- Ahmed, N., Gharghan, S.K. and Mutlag, A.H., 2023. IoT-based child tracking using RFID and GPS. *International Journal of Computers and Applications*, 45(5), pp.367-378.
- Al Amosh, H.A.M. and Mansor, N., 2018. Sustainability and corporate reporting: A review on environmental and social accounting disclosure. *International Journal of Accounting, Finance and Business*, 3(8), pp.78-87.
- Antonova, V.M., Malikova, E.E., Panov, A.E., Spichek, I.V. and Malikov, A.Y., 2021. Implementation of IoT technology for data monitoring via cloud services. *T-Comm-Телекоммуникации и Транспорт*, 15(2), pp.46-53.
- Autry, C.W., Grawe, S.J., Daugherty, P.J. and Richey, R.G., 2010. The effects of technological turbulence and breadth on supply chain technology acceptance and adoption. *Journal of Operations Management*, 28(6), pp.522-536.
- Baars, H. and Ereth, J., 2016, June. From Data Warehouses to analytical atoms-the Internet of Things as a centrifugal force in Business Intelligence and Analytics. In *ECIS* (p. ResearchPaper3).
- Bachofner, M., Lemardelé, C., Estrada, M. and Pagès, L., 2022. City logistics: Challenges and opportunities for technology providers. *Journal of urban mobility*, 2, p.100020.
- Barykin, S.E., Strimovskaya, A.V., Sergeev, S.M., Borisoglebskaya, L.N., Dedyukhina, N., Sklyarov, I., Sklyarova, J. and Saychenko, L., 2023. Smart city logistics on the basis of digital tools for ESG goals achievement. *Sustainability*, 15(6), p.5507.
- Batarliené, N. and Bazaras, D., 2023. Solutions to the problem of freight transport flows in urban logistics. *Applied Sciences*, 13(7), p.4214.
- Bordeleau, F.E., Mosconi, E. and Santa-Eulalia, L.A., 2018. Business Intelligence in Industry 4.0: State of the art and research opportunities.
- Bostrom, R.P. and Heinen, J.S., 1977. MIS problems and failures: A socio-technical perspective. Part I: The causes. *MIS quarterly*, pp.17-32.
- Brun, A., Karaosman, H. and Barresi, T., 2020. Supply chain collaboration for transparency. *Sustainability*, 12(11), p.4429.
- Deegan, C., 2014. An overview of legitimacy theory as applied within the social and environmental accounting literature. *Sustainability accounting and accountability*, pp.248-272.
- Dohn, K., Kramarz, M. and Przybylska, E., 2022. Interaction with city logistics stakeholders as a factor of the development of Polish cities on the way to becoming smart cities. *Energies*, 15(11), p.4103.
- El Yadari, M., Moufad, I., Jawab, F. and Arif, J., 2024, May. Logistic 4.0 implementation for efficient urban freight transport: A systematic literature review. In *2024 IEEE 15th International Colloquium on Logistics and Supply Chain Management (LOGISTIQUA)* (pp. 1-8). IEEE.
- Fernandez-Anez, V., Fernández-Güell, J.M. and Giffinger, R., 2018. Smart City implementation and discourses: An integrated conceptual model. The case of Vienna. *Cities*, 78, pp.4-16.
- Freeman, R.E. and Reed, D.L., 1983. Stockholders and stakeholders: A new perspective on corporate governance. *California management review*, 25(3), pp.88-106.
- Freeman, R.E., Harrison, J.S., Wicks, A.C., Parmar, B.L. and De Colle, S., 2010. Stakeholder theory: The state of the art.
- Grzybowska, H. and Barceló, J., 2012. Decision support system for real-time urban freight management. *Procedia-Social and Behavioral Sciences*, 39, pp.712-725.
- Hopkins, J. and Hawking, P., 2018. Big Data Analytics and IoT in logistics: a case study. *The International Journal of Logistics Management*, 29(2), pp.575-591.
- Jalil, N.A., Prapinit, P., Melan, M. and Mustafa, A.B., 2019, November. Adoption of business intelligence-Technological, individual and supply chain efficiency. In *2019 International Conference on Machine Learning, Big Data and Business Intelligence (MLBDBI)* (pp. 67-73). IEEE.
- Janjevic, M., Knoppen, D. and Winkenbach, M., 2019. Integrated decision-making framework for urban freight logistics policy-making. *Transportation Research Part D: Transport and Environment*, 72, pp.333-357.
- Kamalahmadi, M. and Parast, M.M., 2016. A review of the literature on the principles of enterprise and supply chain resilience: Major findings and directions for future research. *International journal of production economics*, 171, pp.116-133.
- Kilibarda, M., Andrejić, M. and Popović, V., 2020. Research in logistics service quality: A systematic literature review. *Transport*, 35(2), pp.224-235.
- Kimpton, A., Pojani, D., Ryan, C., Ouyang, L., Sipe, N. and Corcoran, J., 2021. Contemporary parking policy, practice, and outcomes in three large Australian cities. *Progress in Planning*, 153, p.100506.

- Malik, L., Sánchez-Díaz, I., Tiwari, G. and Woxenius, J., 2017. Urban freight-parking practices: The cases of Gothenburg (Sweden) and Delhi (India). *Research in transportation business & management*, 24, pp.37-48.
- Mani, V., Gunasekaran, A. and Delgado, C., 2018. Enhancing supply chain performance through supplier social sustainability: An emerging economy perspective. *International Journal of Production Economics*, 195, pp.259-272.
- Markovic, M., Jacobs, N., Dryja, K., Edwards, P. and Strachan, N.J., 2020. Integrating Internet of things, Provenance, and blockchain to Enhance trust in Last mile food Deliveries. *Frontiers in Sustainable Food Systems*, 4, p.563424.
- Mohammed, A.K. and Panda, B.B., 2024. Enhancement of predictive analytics using AI models: A framework for real-time decision support systems. *International Journal of Advanced Research in Computer and Communication Engineering*, 13(11), pp.80-90.
- Nightingale, A., 2009. A guide to systematic literature reviews. *Surgery (Oxford)*, 27(9), pp.381-384.
- Otte, T. and Meisen, T., 2020. Digitized urban freight transport: A data-driven maturity model. In *European Transport Conference 2020*.
- Pereira, G.R.B., Guimarães, L.G.D.A., Cimon, Y., Da Silva Barreto, L.K. and Hermann Nodari, C., 2023. Conceptual Model for Assessing Logistics Maturity in Smart City Dimensions. *Administrative Sciences*, 13(4), p.114.
- Reid, A., Ringel, E. and Pendleton, S.M., 2024. Transparency reports as CSR reports: motives, stakeholders, and strategies. *Social Responsibility Journal*, 20(1), pp.81-107.
- Russo, F., Rindone, C. and Panuccio, P., 2016. European plans for the smart city: from theories and rules to logistics test case. *European Planning Studies*, 24(9), pp.1709-1726.
- Schliwa, G., Armitage, R., Aziz, S., Evans, J. and Rhoades, J., 2015. Sustainable city logistics—Making cargo cycles viable for urban freight transport. *Research in Transportation Business & Management*, 15, pp.50-57.
- Sharma, V.P., Prakash, S. and Singh, R., 2022. What prevents sustainable last-mile delivery in industry 4.0? An analysis and decision framework. *Sustainability*, 14(24), p.16423.
- Shee, H.K., Miah, S.J. and De Vass, T., 2021. Impact of smart logistics on smart city sustainable performance: an empirical investigation. *The International Journal of Logistics Management*, 32(3), pp.821-845.
- Silva, V., Amaral, A. and Fontes, T., 2023. Sustainable urban last-mile logistics: A systematic literature review. *Sustainability*, 15(3), p.2285.
- Sony, M. and Naik, S., 2020. Industry 4.0 integration with socio-technical systems theory: A systematic review and proposed theoretical model. *Technology in society*, 61, p.101248.
- Stroumpoulis, A. and Kopanaki, E. DIGITAL TRANSFORMATION & SUSTAINABLE SUPPLY CHAINS: EXPLORING INDUSTRY 4.0 FOR ENHANCED PERFORMANCE, 14th ICLT Conference, November 18 – 22, Seoul 2024.
- Stroumpoulis, A., Kopanaki, E. and Chountalas, P.T., 2024. Enhancing sustainable supply chain management through digital transformation: a comparative case study analysis. *Sustainability*, 16(16), p.6778.
- Taniguchi, E., Thompson, R.G. and Yamada, T., 2003. Predicting the effects of city logistics schemes. *Transport Reviews*, 23(4), pp.489-515.
- Tjahjono, B., Esplugues, C., Ares, E. and Pelaez, G., 2017. What does industry 4.0 mean to supply chain?. *Procedia manufacturing*, 13, pp.1175-1182.
- Touboulic, A. and Walker, H., 2015. Theories in sustainable supply chain management: a structured literature review. *International journal of physical distribution & logistics management*, 45(1/2), pp.16-42.
- Viu-Roig, M. and Alvarez-Palau, E.J., 2020. The impact of E-Commerce-related last-mile logistics on cities: A systematic literature review. *Sustainability*, 12(16), p.6492..