The Current Association between Machine learning Techniques and Digital Smart Supply Chain 4.0 in Managing Transportation Distribution Risk

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Abstract

Monitoring supply chain transportation through distribution transportation network is a challenging issue that must be properly and effectively monitored. Disruption risk has led to a significant growth in freight network requirements in smart supply chain management. Several researches provided enabling models to assess freight and traffic transportation risks in supply chain. Yet, the key challenge within the supply chain management is elaborating advanced technologies in distribution network and disruption risks mitigation. This paper presents a literature review on the explored relation between disruptions risks in smart supply chain transportation, industries and organizations throughout the world to enhance the effectiveness of distribution networks. This study explores the necessity of collaboration between smart supply chain management and transportation distribution network during disruptions. Within this context, different research requirement were thoroughly investigated to highlights all aspects and criteria including advanced management, decision-making tools, enabling technologies, risk management approaches, ISO39001, ISO14001, sustainability, resilience and Covid-19 implications. Foreseeing several significant challenges, this study examines the need of cooperation between academics and manufacturers to provide new approaches to manage distribution network in supply chain during disruption from different aspects. The results of this paper serves as a succinct reference guide for academics and companies seeking to implement viable and innovative future transportation solution and approaches.

Keywords

Transportation network, Smart supply chain, Disruption, Risk management, advanced technologies.

1. Introduction

Management of transportation operations in supply chain are recentely operating in different environment due to globalization, innovative technological improvements (Venkadavarahan and Marisamynathan 2021), sustainable

expectation (de la Torre et al. 2021), and the ongoing economic and social ezgulations (Pani and Sahu 2019). Which presents a diverse set of challenges and prospects for decision makers. Nowadays supply chain operations are maintained using a range of novel and creative technologies (Büyüközkan and Göçer 2018). Freight and traffic transport are crucial component of modern society, and the relevance of transportation safety, cost, benifits and impacts cannot be emphasized (Kin et al. 2017). In logistics management, supply chain transportation network planning is a vital concern (Zhang et al. 2021), as disruption risk assessment present a significant concern in managing effective supply chain. Recentely, the Europen desicionsupport system (DSS) is known as one of valuable reference for companies, authorities, and the transport industry, as it integrates data on accidents origin, hazards, measurements, and the core analytic frameworks for road safety performance (Martensen et al. 2019). It offers substantial information about transport parameters including their challenges and vulnerabilities for drivers, pedastrians, infrastructure, vehicles, equipement and measures. In order to explore the combination between transportation system, sustainability and supply chain managment with the concepts of sustainability, it is essential to clarify the elements and features of distribution transportation network (Gudmundsson et al. 2016), as their structure depends entirely on the perspective of each fields. Many studies have developed different frameworks to fit changing requirements of transportation parameters in supply chain. Different technologies emphasized a range of basic transportation patterns, disruption, accident, cost, sustainability and injury severity. Several approaches and techniques have been conducted for evaluating transport safety risk, in order to predict transportation accidents with artificial neural networks models (S Shah et al. 2017), machine learning (Spielman et al. 2018), convolutional neural network and deep learning architecture (Gutierrez-Osorio and Pedraza 2020). Young and al (2014) examined datasets that are used to create, evaluate, and test machine learning models. Different studies addresses current technological advances in freight logistics and transport distribution network (Wang and Sarkis 2021). Furthermore, the transport and logistics sector is experiencing a revolution from a centralized and computerized structure to a distributed and digital network (Orji et al. 2020). Some studies examined and described machine learning techniques that aimed to reduce the transport accident risks (Hu et al. 2020), but few studies integrated freight transport in supply chain risks. Given the complex and the rising transportation disruption risks in supply chain logistics. It is critical for organizations and companies to construct a flexible and efficient supply chain network and develop a strategic transportation plan (Hosseini et al. 2020). In emerging economies, the evaluation of freight transport network is a challenging issue (Venkadavarahan and Marisamynathan 2021). As a result, there is a scarcity of researches about the supply chain attributes in freight distribution system and their implications on operations, structure, risk management and sustainability. There has been very little research that addresses the growing need of integrating advanced technologies, in managing freight transportation disruption risk in supply chain. This study addresses this concern by discussing the fields' requirement and opportunities to be integrated in future studies to assess distribution network and disruption risk in digital supply chain management using advanced technologies. Therefore, development of research in this context will be considerably motivated by the relevance and the significance of future approach to enhance the organization supply chain performance. To provide global interests in reducing transportation disruption risks and the development of advanced management decision-making tools including several criteria (sustainability, resilience, Covid-19, ISO 39001 and ISO 14001). In this paper, Section 2 presents the current situation and challenge of managing transportation disruption in smart supply chain, and the enabling techniques used to evaluate distribution network. Section 3 present the used methodology and the results of the bibliometric analysis to identify the research gaps. In the last section, we provide the future insight of various criteria and requirement to be developed in future approach.

2. Litterature review

Contemporary freight and traffic transportation research have devoted to the study of potential risks variables that influence road accident mortality, injury severity,sustainability impact and costs and benefits of road system (Agamez-Arias and Moyano-Fuentes. 2017). Over the last years, many studies attempt to compile systematic and comprehensive analysis of several machine-learning models for transportation assessment to analyze their advantages and risks (Boukerche and Wang. 2020). Researchers Wang and Sarkis (2021) examined the recent advancements and the developments in using computer models to predict and review safety approach in current and future transportation networks. Researches utilize different data mining algorithms to identify the most significant elements on automobile accidents. Through the integration of the situations of drivers and pedestrians and the environment of accidents in order to classify the severity of injured of road to evaluate the transport safety (Castro and Kim 2016). Lavrenz et al. (2018) addressed some of the underlying approaches and concerns in conventional time series modeling, as well as the current technology in applying forecasting models in transport safety analysis. Elamrani Abou Elassad et al. (2020) developed and evaluated an aggregation-fused approach based on the usage of several classification models that function on fused

variables, to provide real time accurate transport collision forecasts. Different machine learning techniques have been used for the assessment of transportation safety in order to forecast probable car accidents, some frameworks were elaborated through defining appropriate regulations, focused strategy recommendations and rigorous and realistic diagnostic models (Tao et al. 2016). Different data-mining algorithms were used to build classification models to forecast the collision gravity on roads (Taamneh et al. 2017). Other studies create effective neural network architecture integrating fuzzy sets to decision rules in order to generate an aggregate transport safety rate and score (S. Shah et al. 2017).

The used of machine learning techniques has also gained a lots of attention in predicting and evaluating transport affecting factors (Singh et al. 2019). Some studies focused on forecasting accident potential operating risk (Zhang et al. 2021). Wang et al. (2019) addressed different key technological challenges using a structured machine learning method to identify road hazards and generate risks characteristics, in order to construct an effective and predictable machine learning framework. S. Shah et al. (2017) introduced an analytical technique for monitoring transportation risk assessment with multiple architecture model combining data envelopment analysis and artificial neural networks. Ihueze and Onwurah (2018) applied Arimax modeling technology based on data with independent factors, to investigated transportation collapses to promote and build reliable forecasting approaches for predicting accident rate. Assi et al. (2020) created machine learning algorithm to anticipate accident occurrence and severity using accident characteristics data (vehicle and road metrics). Sangare et al. (2021) combined Gaussian Mixture algorithm with Support Vector Machine to classify and evaluate traffic transport performance. The "Enhanced Expectation-Maximization Clustering" algorithm has been applied to generate a transportation accident-forecasting model (Babu and Tamilselvi, 2019). Deep learning models were also used to properly assess transportation risks on road (Zhang et al. 2021). Yi et al. (2019) conducted a thorough investigation into the deployment of a deep learning architecture for predicting transportation flow in transport network. Sangare et al. (2021) used hybrid models to predict the transportation accident risks on roads.

2.1 Transport disruption risk in supply chain

Smart Supply Chain is an effective process for organizations to invent different sources of profit and economic benefit by combining innovative techniques using creative technology and advanced methodologies (Büyüközkan and Göçer 2018). Machine learning algorithms allow the integration of various data characteristics, which is vital for improving the supply chain research of transportation disruption risk factors (Munger et al. 2020). Given the complex and the rising disruption risks in micro and macro logistics environment in supply chains, transport has become an operational engine. Supply networks are expensive whenever transportation is disrupted, in this context (Paul et al. 2020) focused on using a Bayesian Belief Network to estimate transportation and logistics disruption risks. Kumar and Sharma (2021) generated a decision making model to evaluate and offer recommendations for processing decisions making in case of network disruption. In order to offer additional insight as well as practical consequences for managers responding to supply chain interruptions during emergencies, Aldrighetti et al. (2021) offered a thorough overview assessment of modelling techniques of supply chain network design in manufacturing supply chain and transportation under interruption issues. The model focused on the various expenditures incurred because of ineffective financial investments. The above research, Paul et al. (2020) aimed to analyze the effect of the disruption risks in food supply chain. Using the Generalized Methods of Moments predictor, they found that the damage and disruption of increased stringency measures, the increase of COVID-19 instances, and public funding for Corona virus prevention and productivity expansions are all attributes that affected the supply chain network in food companies. Shankar et al. (2018) analyzed and assessed the long-term freight transportation risks in distribution network, by developing a risk evaluation method to evaluate environmental challenges.

By considering sustainability performance and risk management process, Giannakis and Papadopoulos (2016) offered an implementation strategy, through the investigation of the origins, nature and types of disruption risks in smart sustainable supply chain to provide an effective approaches to address these risks. Wang et al. (2018) and Gonçalves and Portugal (2020) performed a thorough literature investigation the major and the most appropriate techniques to assess transportation risk features including their impact on sustainability and integrating safety transportation in supply chain (Pasquale et al. 2019). The goal of the used approach by Paul et al. (2020), is to use a Bayesian Belief Model to estimate the risk factors of transportation interruption risks. Thorough examination of freight transportation; certain logistic risk factors that are addressed in supply chain management (Bravo and Vidal 2013). On the other hands, some approaches focused on measuring the performance of transporting supply chain network after

an arisen disruptions (Wide 2020), with an emphasis on the stages after disruptions have occurred, rather than emphasizing on risk management methods before a disruptions. Supply chain optimization concepts, are generally intended for decision-making outcomes that are commonly applied as enhanced assistance for organization decisions and perspectives. Transportation activities are frequently a key component of effective supply chain. However, in previous studies the risk management tools have not focused on disruption risk in digital supply chain particularly, and have integrated sustainability, decision-making process, resilience and disruptions separately.

2.2 Machine learning techniques in supply chain transportation

Modeling supply chain parameters in transportation network has become a challenging operation (Tavasszy et al. 2012). There has been a considerable increase in transportation research, thus different studies presented an overview assessment of emerging techniques and used in the implementation of transportation network, analysis with big data modeling (Kaffash et al. 2021), intelligent transportation system (Ullah et al 2020), features extraction, classification techniques in smart sustainable cities (Shafiq et al. 2020). Multiple studies elaborated model for risk prediction in supply chain using artificial intelligent algorithms. The model of Assi et al. (2020) used to investigate performances and it applicability in a real logistics network data by developing and deploying the framework to the problem of forecasting delivery delays. Other researches focused on forecasting the net profit of sustainable freight transport supplied to clients, using the impacting variables in supply chain evaluated by specialists and professionals (Budak and Sarvari 2021). This research by Barua et al. (2020), examined the latest advances in constructing machine-learning methods for assessing the multiple aspects of intelligent fright transportation in supply chain. Some authors have provided essential elements of a transportation automobile tracking services in supply chain, including major features and effective technologies such as Gps and Ble (Salazar-Cabrera et al. 2020). In order to provide diverse variety of service, inexpensive operational costs, and reduced energy requirements. For a logistics network architecture issue in supply chain, Sadeghi et al. (2019) presented a "fuzzy bi-objective mixed-integer non-linear programming" approach. In order to optimize the overall operating revenue and reducing the risk of logistic lead-time across production supply and distribution centers.

The evaluation of freight system in supply chain has been based recently on sustainability drivers and metrics for monitoring their effectiveness in supply chain (Venkadavarahan and Marisamynathan 2021). Different conceptual approach has been proposed to generate an index system to evaluate the relative rates of transportation sustainable achievement in supply chain (Assi et al. 2020). The main issue in freight transport operations result in the evaluating and selecting sustainable solutions for their supply chain (Pani and Sahu 2019). Integrating the sustainable approach, Bandeira et al. (2018) proposed a fuzzy multi-criteria technique to help decision maker identify viable logistics system designs to their company. The used of advanced techniques has been applied to examine supply chain parameters, predict freight travels patterns ((Venkadavarahan and Marisamynatha, 2021), and freight temporal transit characteristics for various manufacturing activities ((Allen et al. 2012), (Tavasszy et al. 2012)). Yamada and Febri (2015) constructed a freight transportation network design that enhanced supply chain performance. The forecasting approach is conducted in analytical programs with optimum requirements, which directly include both supply chain operations and transportation networks. Gunasekaran et al. (2017) provide a comprehensive assessment about the application of information technology in freight network and supply chain management. Recent researches provide systematic overview of works that used machine-learning methods to assist risk management analysis in supply chain, but most of these studies did not integrate freight transport disruption risks in digital supply chain.

3. Methodology and bibliometric analysis

We conducted a systematic literature review in an iterative process that included identifying relevant keywords, sorting the results, analyzing the literature, and comparing the findings to other similar literature studies. The papers selection method was based on three different steps. The first step (1) we to identify the selected criteria of papers including studies published from 2014 to 2021, paper in English languages, peer-reviewed papers and high quality conference papers, and we also focused on studies investigating transportation researches in smart supply chain, and disruption management in distribution network. The second step (2) we selected the data source such as Scopus, Springer, Emerald, Taylors and Francis and Science direct, then we defined the keywords list and combinations for instance (“transportation” or “distribution network” and “advanced techniques” or “machine learning”, ‘supply chain” or “logistics” and “disruption”..). The third step (3) was based on paper selection after revision; we assessed 36 publications relevant to recent techniques in freight transportation, 47 papers addressing supply chain

transport disruption risks, and 66 articles relating machine-learning applications in smart supply chain. We excluded some of the papers and updated them with other appropriate papers based on their relevance to our review theme. Overall, we examined at 134 articles. By reviewing the abstracts, the identified papers were examined and evaluated, and then we reviewed the full paper text. Irrelevant publications were removed based on academic assessment and a VOSviewer based information clustering technique. In addition, as seen in Figure 1, the keywords occurrence resulted in a considerable amount of work assessing separately freight distribution networks (1), machine learning approaches (2), and smart supply chain transportations (3).

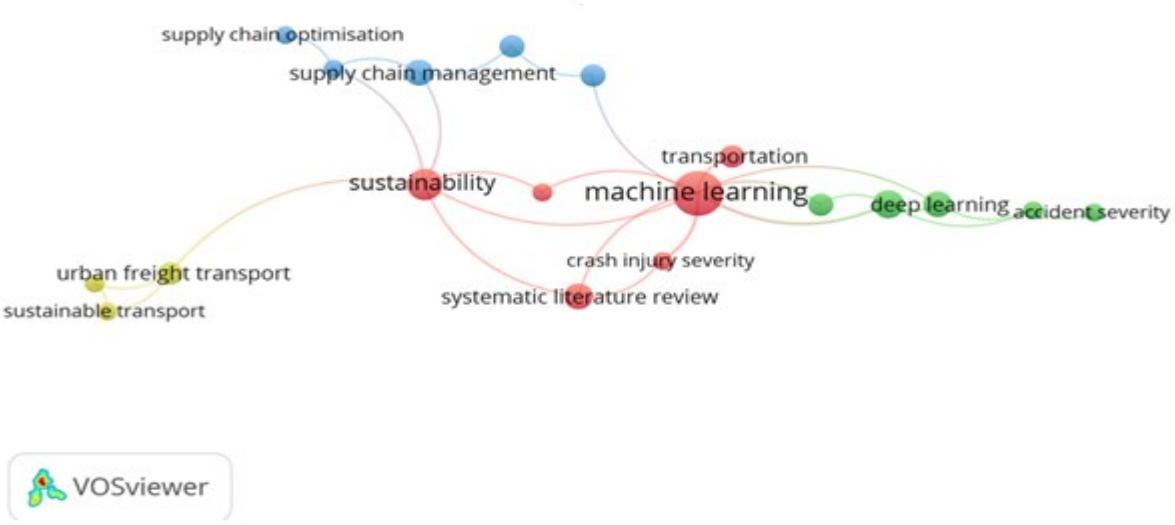

Figure 1. The evaluation of the keywords co-occurrence

Figure 1 presents the occurrence of keywords, to analyze the most frequent terms of the used publications, which helps in classifying the themes of existing studies in supply chain transportation network. Figure 2 illustrates the abstract co-occurrence according on the investigated articles based on the studied data. This figure depicts the association between the terms that emerged simultaneously in the abstract.

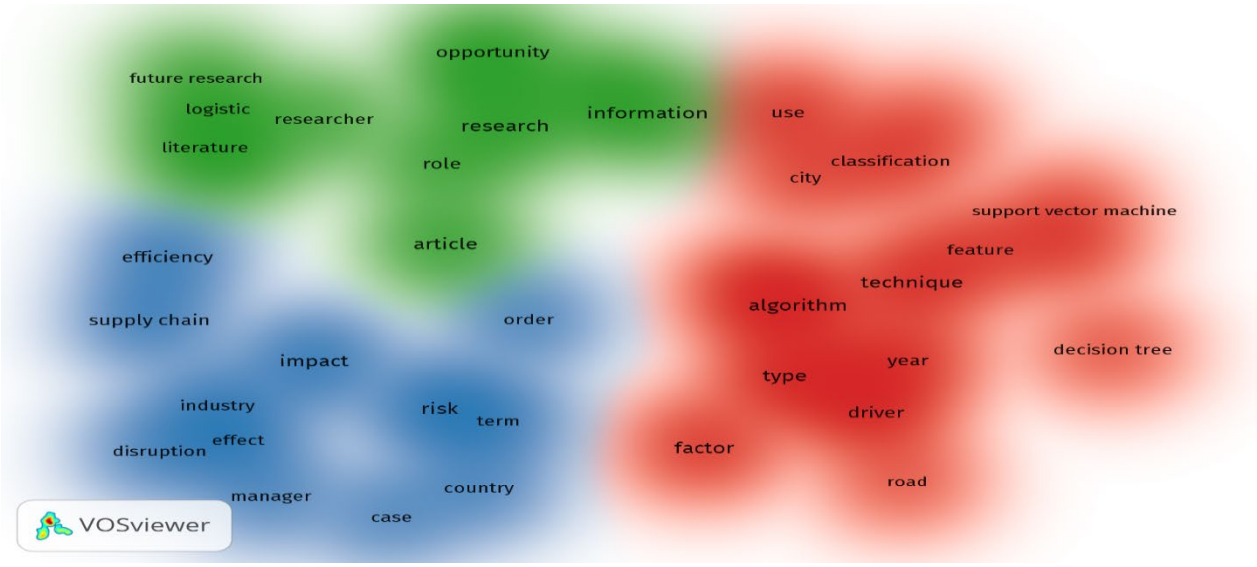

Figure 2. Visualization the abstract co-occurrence density

We can emphasize the use of the terms "Technique", "algorithm", “Disruption” and "supply chain" which together form a significant research core. As a consequence of the findings of this study (Figure 1 and Figure 2), we can notice the absence of sophisticated technology terminology connected to freight transportation disruption in the supply chain. In this context, this void provides an opportunity for combined investigations to develop a new creative research approach. Furthermore, the availability of such research attracts the attention of organizations, companies, and governments, resulting in new researchers collaborations in this fields, as it integrates freight transportation, disruption risks, network planning, safety and supply chain optimization. Machine learning approaches, on the other hand, are employed to assess transportation safety and infrastructure. Hence, current findings in machine learning approaches can help organizations to create and improve their supply chais by assessing disruption threats in their distribution n networks.

4. New reasearch avenues and approach requirements

Supply chain disruption mitigation requires the integration of supply chain distribution network architecture from the perspective of increased perseverance, cultivating logistics performance, promoting collaborative, advanced supply chain decision-making process, and using advanced technologies and techniques. This collaboration promotes smart risk management awareness in digital supply chain transportation system. In this section, we present the future studies requirements and opportunities to be integrated in future frameworks for managing transport disruptions in digital supply chain using emerging approaches.

4.1 Decision making and advanced management integration

Advanced management is required to establish efficient transportation systems, as it is deployed throughout the integration of digital logistics to conduct effective strategies, management, supervision, and control of logistics operations (Pan et al. 2021). The implementation of transportation regulations and the creation of infrastructure architecture initiatives, such as new transport monitoring solutions, constitute the most important step of organization’s social management. To accomplish data exchange and collaboration in efficient transportation and smart supply chain, a management information process is vital to prevent disruptions (Ding et al. 2021). Collaborative management incorporates legislative measures such as smart methods, special road networks, and transportation operations to successfully manage transportation for the economic benefits of the organization (Chen et al. 2021). The distribution network management for logistics operations are asked to implement effectively the 5G network, which enables the program function efficiently, and reduce considerably the resources requirements (Di 2020). In

smart transportation, advanced management is performed to establish, manage, and coordinate materials and resources. It also collaborates with different techniques and technologies to help the distribution network in supply chain operate properly and smoothly (Song et al. 2021). It is a research requirement to seek out how to integrate information and communication technologies and advanced management to develop innovative logistics operations in smart supply chain to manage disruptions.

4.2 Smart distribution network in digital supply chain

Advanced technology, information, and smart sensors are revolutionizing the transportation infrastructure (Zhang et al. 2021). Depending on different dataset, the science community has assisted in introducing valuable transportation systems and computer technology solutions at a frightening rate (Chen et al. 2021). Smart transportation systems in digital supply chain contributes to smart disruption management using and incorporating many technologies: Internet - of - things, advanced analytics, cloud technology, intelligent systems, and efficient decision-making systems) (Boukerche and Wang 2020). This integration empowers the distribution network to share information, respond quickly (Song et al. 2021), and integrate resources during disruption, its purpose is to create a more flexible, consistent, effective, and secure freight transportation services to enables the interaction across transportation network operators (Wang et al. 2020). This also offers a faster reaction to disruption incidents. Further innovations, such as cloud computing, virtualization, and machine learning, allow sensor logistic operation to be more proactive. Some difficult disruption risks and issues can be addressed by combining these innovative information and communications technologies, as it can assist in making informed decisions and devise the appropriate enterprise resource planning system (Dubey et al. 2021). Network optimization challenges in transportation can be addressed using these advanced technologies; we can predict potential conditions, make accurate decisions, examine and detect legitimate and incorrect data (Song et al. 2021). With Internet - of - things devices and technologies, we can help smart distribution in supply chain become more effective, precise, and smart regarding disruptions (Pacella and Papadia 2021).

4.3 Risk management approach

The COVID-19 pandemic has had a substantial impact on all areas and fields of supply chain. It has expanded swiftly over the world, exacerbated institutional disparities, and had enormous social and economic implications (Grillo-Núñez et al. 2021). Disruptions like COVID-19 epidemic have directly revealed the fragility of the current supply chains, which is primarily leading to a shortage management of transparency, data traceability, and clarity. Different studies established models to evaluate the decision-making operations and offers rules requirement for judgments making during crisis (Kumar and Sharma 2021). Most of those studies offered additional perspectives and practical consequences for practitioners responding with supply chain interruptions during emergencies. Hence, future framework can provide insights on risk management during transportation disruption in smart supply chain. On the other hand, in accordance with ISO 39001 for "Road Traffic Safety Management Systems", it has developed rules to guarantee secure actions designed to reduce transportation accidents and disruptions (Conca et al. 2016). These requirements present an opportunity for further researches, as they are designed for network management, authorities, and private businesses to establish a consistent management approach for significantly reducing risks techniques.

4.4 Sustainability and resilience

Resilience is a key component of digital supply chain for controlling and reducing disturbances. Several techniques and mitigation measures are used to boost the supply chain resilience in order to mitigate towards interruption (Ivanov and Rozhkov 2020). Certain studies focused on the after disruption efforts to stabilize and restore the distribution network in adaptive resilience approaches. when significant disruptions occur, architectural network adaptation may be required by incorporating supply chain aspects and emergency transportation arrangements (Moosavi and Hosseini 2021). The detailed examination of resilience and network disruption risks in supply chain management can present a major aspect that characterizes future studies and makes a significant contribution through the integration of advanced technologies in this analysis. Hence, many studies elaborated approaches to contribute in the decision-making strategies during disruption risk that includes resilience (Aldrighetti et al. 2021), but most of studies have not included transportation disruption in digital supply chain. Others approaches have taken into account sustainability and resilience considerations to anticipated disruption costs and preventive robustness development (Moosavi and Hosseini 2021). Sustainable development have also emerged as a vital feature of transport networks, emphasizing that the effects of environmental and social impacts of transportation operations. Administration and legislator

determinations on sustainable mobility are varied. Recently, their emphasis has been on reducing congestion in metropolitan regions and providing innovative transportation systems to conventional models that generate harmful emissions (de la Torre et al. 2021). Several initiatives, strategies and decisions are based on organization's interests for network infrastructure, modalities of transportation, and purchasing patterns among other considerations (Santilli et al. 2021). As a result, using technologies like machine learning techniques helps to assist in decision-making aspects for managing sustainable and resilient transport in smart supply chain distribution during disruptions. Subsequently, companies nowadays are increasingly embracing standards management solution such as ISO 9001 and ISO 14001 accreditation (Toporowicz et al. 2021), which provide an opportunity for organizations to promote their sustainable performance and enhance their international image through the integration of environmental requirements. Thus, this context offers a significant axis of research for future studies to incorporate and merge distribution network in smart supply chain management during disruption. New advanced management and decision-making tools can be taking into consideration including advanced technologies for risk management with sustainable and resilience criteria, Covid-19, ISO 39001, ISO 9001 and ISO 14001 requirements.

5. Conclusion

Our study emphasizes the necessity to understand the disruption risk mitigation in smart supply chain and distribution network. It underlines this challenge from the perspective of enhanced resilience, promoting sustainable transportation system, developing advanced techniques to assess transportation risks and integrating different risk management approaches. This collaboration enhances the performance of organization and sustain the supply chain transportation preventative measures, which promotes risk identification and remediation. This paper discusses the techniques and approaches used in transportation and logistics assessment in supply chain. Particularly, we investigated and reviewed studies and implementations of machine learning techniques for freight transportation, and risk management approaches during disruptions. This study presents new insights for managing transport disruption in digital supply chain using enabled technologies, with the integration of multiple criteria and requirements. We points out advanced management solutions and decision-making process merging sustainability, resilience, ISO 39001, ISO 14001 V 2015, Covid-19 implications and risk management and smart supply chain approaches. Furthermore, these directions present many limitations, such as assuring supply chain features dependability, costs of integrating advanced technologies in transportation network, connecting and collecting transport data infrastructure, luck of applications in transportation technologies, also such multi criteria programs are often difficult to generate and predict.

Reference

Agamez-Arias, A.-M., Moyano-Fuentes, J. Intermodal transport in freight distribution: a literature review. *Transport Reviews* 37, 782–807. , 2017.

Aldrighetti, R., Battini, D., Ivanov, D., Zennaro, I. Costs of resilience and disruptions in supply chain network design models: A review and future research directions. *International Journal of Production Economics* 235, 108103. , 2021.

Allen, J., Browne, M., Cherrett, T.. Survey Techniques in Urban Freight Transport Studies. *Transport Reviews* 32, 287–311. , 2012

Assi, K., Rahman, S.M., Mansoor, U., Ratrout, N.. Predicting crash injury severity with machine learning algorithm synergized with clustering technique: A promising protocol. *International Journal of Environmental Research and Public Health* 17, 1–17. , 2020.

Babu, S.N., Tamilselvi, J. Generating road accident prediction set with road accident data analysis using enhanced expectation-maximization clustering algorithm and improved association rule mining. *Journal Europeen des Systemes Automatises* 52, 57–63., 2019.

Bandeira, R.A.M., D'Agosto, M.A., Ribeiro, S.K., Bandeira, A.P.F., Goes, G.V. A fuzzy multi-criteria model for evaluating sustainable urban freight transportation operations. *Journal of Cleaner Production* 184, 727–739. , 2018.

Barua, L., Zou, B., Zhou, Y. Machine learning for international freight transportation management: A comprehensive review. *Research in Transportation Business & Managemen*t 34, 100453. , 2020.

Boukerche, A., Wang, J. Machine Learning-based traffic prediction models for Intelligent Transportation Systems. *Computer Networks* 181, 107530. , 2020.

Bravo, J.J., Vidal, C.J.. Freight transportation function in supply chain optimization models: A critical review of recent trends. *Expert Systems with Applications* 40, 6742–6757. , 2013

Budak, A., Sarvari, P.A. Profit margin prediction in sustainable road freight transportation using machine learning. *Journal of Cleaner Production* 314, 127990. , 2021.

Büyüközkan, G., Göçer, F Digital Supply Chain: Literature review and a proposed framework for future research. *Computers in Industry* 97, 157–177. ., 2018.

Castro, Y., Kim, Y.J. Data mining on road safety: factor assessment on vehicle accidents using classification models. *International Journal of Crashworthiness* 21, 104–111. , 2016.

Chen, X., Zhang, S., Ding, X., Kadry, S.N., Hsu, C.. IoT cloud platform for information processing in smart city. *Computational Intelligence* 37, 1428–1444. , 2021

Conca, A., Ridella, C., Sapori, E. A Risk Assessment for Road Transportation of Dangerous Goods: A Routing Solution. *Transportation Research Procedia* 14, 2890–2899, 2016

de la Torre, R., Corlu, C.G., Faulin, J., Onggo, B.S., Juan, A.A., Simulation, Optimization, and Machine Learning in Sustainable Transportation Systems: Models and Applications. *Sustainability* 13, 1551. 2021.

Di, H.. Logistics management inventory model based on 5G Network and Internet of Things system. *Microprocessors and Microsystems* 103429. , 2020

Ding, Y., Jin, M., Li, S., Feng, D. Smart logistics based on the internet of things technology: an overview. *International Journal of Logistics Research and Applications* 24, 323–345. , 2021

Dubey, R., Bryde, D.J., Blome, C., Roubaud, D., Giannakis, M. Facilitating artificial intelligence powered supply chain analytics through alliance management during the pandemic crises in the B2B context. *Industrial Marketing Managemen*t 96, 135–146. , 2021.

Elamrani Abou Elassad, Z., Mousannif, H., Al Moatassime, H. A real-time crash prediction fusion framework: An imbalance-aware strategy for collision avoidance systems. *Transportation Research Part C:* Emerging Technologies 118, 102708. , 2020.

Giannakis, M., Papadopoulos, T. Supply chain sustainability: A risk management approach. *International Journal of Production Economics* 171, 455–470. 2016.

Gonçalves, F. dos S., Portugal, L. da S. Traffic impact studies committed to sustainability: The case of Rio de Janeiro. *Journal of Environmental Management* 253, 109573. 2020.

Grillo-Núñez, J., Mendo, T., Gozzer-Wuest, R., Mendo, J.. Impacts of COVID-19 on the value chain of the hake small scale fishery in northern Peru. *Marine Policy* 134, 104808. , 2021

Gudmundsson, H., Hall, R.P., Marsden, G., Zietsman, J. *Sustainable Transportation, Springer Texts in Business and Economics*. Springer Berlin Heidelberg, Berlin, Heidelberg. , 2016.

Gunasekaran, A., Subramanian, N., Papadopoulos, T.. Information technology for competitive advantage within logistics and supply chains: A review. *Transportation Research Part E: Logistics and Transportation Review* 99, 14–33. , 2017.

Gutierrez-Osorio, C., Pedraza, C. Modern data sources and techniques for analysis and forecast of road accidents: A review. *Journal of Traffic and Transportation Engineering* (English Edition) 7, 432–446. 2020.

Hosseini, S., Ivanov, D., Dolgui, A. Ripple effect modelling of supplier disruption: integrated Markov chain and dynamic Bayesian network approach. *International Journal of Production Research* 58, 3284–3303. , 2020.

Hu, Q., Cai, M., Mohabbati-Kalejahi, N., Mehdizadeh, A., Alamdar Yazdi, M.A., Vinel, A., Rigdon, S.E., Davis, K.C., Megahed, F.M. A Review of Data Analytic Applications in Road Traffic Safety. Part 2: Prescriptive Modeling. *Sensors* 20, 1096. , 2020.

Ihueze, C.C., Onwurah, U.O.. Road traffic accidents prediction modelling: An analysis of Anambra State, Nigeria. *Accident Analysis and Prevention* 112, 21–29. , 2018.

Ivanov, D., Rozhkov, M.. Coordination of production and ordering policies under capacity disruption and product write-off risk: an analytical study with real-data based simulations of a fast moving consumer goods company. *Ann Oper Res* 291, 387–407., 2020.

Kaffash, S., Nguyen, A.T., Zhu, J. Big data algorithms and applications in intelligent transportation system: A review and bibliometric analysis. *International Journal of Production Economics* 231, 107868. , 2021.

Kin, B., Verlinde, S., Macharis, C.. Sustainable urban freight transport in megacities in emerging markets. *Sustainable Cities and Society* 32, 31–41. , 2017.

Kumar, B., Sharma, A. Managing the supply chain during disruptions: Developing a framework for decision-making. *Industrial Marketing Management* 97, 159–172. , 2021.

Lavrenz, S.M., Vlahogianni, E.I., Gkritza, K., Ke, Y. Time series modeling in traffic safety research. *Accident Analysis & Prevention* 117, 368–380. , 2018.

Martensen, H., Diependaele, K., Daniels, S., Van den Berghe, W., Papadimitriou, E., Yannis, G., Van Schagen, I., Weijermars, W., Wijnen, W., Filtness, A., Talbot, R., Thomas, P., Machata, K., Aigner Breuss, E., Kaiser, S., Hermitte, T., Thomson, R., Elvik, R.. The European road safety decision support system on risks and measures. *Accident Analysis & Prevention* 125, 344–351. 2019.

Moosavi, J., Hosseini, S. Simulation-based assessment of supply chain resilience with consideration of recovery strategies in the COVID-19 pandemic context. *Computers & Industrial Engineering* 160, 107593. , 2021.

Munger, E., Choi, H., Dey, A.K., Elnabawi, Y.A., Groenendyk, J.W., Rodante, J., Keel, A., Aksentijevich, M., Reddy, A.S., Khalil, N., Argueta-Amaya, J., Playford, M.P., Erb-Alvarez, J., Tian, X., Wu, C., Gudjonsson, J.E., Tsoi, L.C., Jafri, M.S., Sandfort, V., Chen, M.Y., Shah, S.J., Bluemke, D.A., Lockshin, B., Hasan, A., Gelfand, J.M., Mehta, N.N,. Application of machine learning to determine top predictors of noncalcified coronary burden in psoriasis: An observational cohort study. *Journal of the American Academy of Dermatology* 83, 1647–1653. 2020.

Orji, I.J., Kusi-Sarpong, S., Huang, S., Vazquez-Brust, D. Evaluating the factors that influence blockchain adoption in the freight logistics industry. *Transportation Research Part E: Logistics and Transportation Review* 141, 102025. , 2020.

Pacella, M., Papadia, G. Evaluation of deep learning with long short-term memory networks for time series forecasting in supply chain management. *Procedia CIRP* 99, 604–609. , 2021.

Pan, S., Trentesaux, D., McFarlane, D., Montreuil, B., Ballot, E., Huang, G.Q.. Digital interoperability in logistics and supply chain management: state-of-the-art and research avenues towards Physical Internet. *Computers in Industry* 128, 103435. , 2021

Pani, A., Sahu, P.K. Planning, designing and conducting establishment-based freight surveys: A synthesis of the literature, case-study examples and recommendations for best practices in future surveys. *Transport Policy* 78, 58–75. , 2019.

Pasquale, C., Sacone, S., Siri, S., Ferrara, A.. Traffic control for freeway networks with sustainability-related objectives: Review and future challenges. *Annual Reviews in Control* 48, 312–324 , 2019.

Paul, S., Kabir, G., Ali, S.M., Zhang, G. Examining transportation disruption risk in supply chains: A case study from Bangladeshi pharmaceutical industry. *Research in Transportation Business & Management* 37, 100485, 2020.

Sadeghi, A., Sinaki, R.Y., Suer, G., Çelikbilek, C. Fuzzy Bi-Objective Model for a Supply Chain Network Design Problem Considering Stochastic Transportation Leadtime. *Procedia Manufacturing* 39, 1517–1524, 2019.

Salazar-Cabrera, R., Pachón de la Cruz, Á., Madrid Molina, J.M. Sustainable transit vehicle tracking service, using intelligent transportation system services and emerging communication technologies: A review. *Journal of Traffic and Transportation Engineering* (English Edition) 7, 729–747. , 2020.

Sangare, M., Gupta, S., Bouzefrane, S., Banerjee, S., Muhlethaler, P.. Exploring the forecasting approach for road accidents: Analytical measures with hybrid machine learning. *Expert Systems with Applications* 167, 113855–113855. , 2021.

Santilli, D., D'Apuzzo, M., Evangelisti, A., Nicolosi, V. Towards Sustainability: New Tools for Planning Urban Pedestrian Mobility. *Sustainability* 13, 9371. , 2021.

Shafiq, M., Tian, Z., Bashir, A.K., Jolfaei, A., Yu, X.. Data mining and machine learning methods for sustainable smart cities traffic classification: A survey. *Sustainable Cities and Society* 60, 102177. , 2020.

Shafiq, M., Tian, Z., Bashir, A.K., Jolfaei, A., Yu, X. Data mining and machine learning methods for sustainable smart cities traffic classification: A survey. *Sustainable Cities and Society* 60, 102177. 2020.

Shah, S., Brijs, T., Ahmad, N., Pirdavani, A., Shen, Y., Basheer, M. Road Safety Risk Evaluation Using GIS-Based Data Envelopment Analysis—Artificial Neural Networks Approach. *Applied Sciences* 7, 886. 2017.

Shah, S.A.R., Brijs, T., Ahmad, N., Pirdavani, A., Shen, Y., Basheer, M.A. Road safety risk evaluation using GIS-based data envelopment analysis-artificial neural networks approach. *Applied Sciences* (Switzerland) 7, 1–19. 2017.

Shankar, R., Choudhary, D., Jharkharia, S. An integrated risk assessment model: A case of sustainable freight transportation systems. *Transportation Research Part D: Transport and Environment* 63, 662–676. 2018.

Singh, J., Singh, G., Singh, P., Kaur, M. Evaluation and Classification of Road Accidents Using Machine Learning Techniques, in: Shetty, N.R., Patnaik, L.M., Nagaraj, H.C., Hamsavath, P.N., Nalini, N. (Eds.), *Emerging Research in Computing, Information, Communication and Applications, Advances in Intelligent Systems and Computing*. Springer Singapore, Singapore, pp. 193–204. 2019.

Song, Y., Thatcher, D., Li, Q., McHugh, T., Wu, P. Developing sustainable road infrastructure performance indicators using a model-driven fuzzy spatial multi-criteria decision making method. *Renewable and Sustainable Energy Reviews* 138, 110538. 2021.

Spielman, Z., Gertman, D.I., Liu, H., Pray, I., Traiteur, J., Wold, S., Wysmuller, S. Machine learning and big data analytics in support of fleet safety during severe weather. *Advances in Intelligent Systems and Computing* 597, 662–671. 2018.

Taamneh, M., Alkheder, S., Taamneh, S.. Data-mining techniques for traffic accident modeling and prediction in the United Arab Emirates. *Journal of Transportation Safety & Security* 9, 146–166. , 2017

Tao, G., Song, H., Liu, J., Zou, J., Chen, Y.. A traffic accident morphology diagnostic model based on a rough set decision tree. *Transportation Planning and Technology* 39, 751–758. , 2016

Tavasszy, L.A., Ruijgrok, K., Davydenko, I., Incorporating Logistics in Freight Transport Demand Models: State-of-the-Art and Research Opportunities. *Transport Reviews* 32, 203–219. 2012.

Toporowicz, F.Z., Souza, J.T. de, Piekarski, C.M.. The knowledge discovery in databases approach: identifying variables that influence ISO 9001 and ISO 14001 certifications. *Journal of Environmental Planning and Management* 64, 1271–1290. , 2021.

Ullah, Z., Al-Turjman, F., Mostarda, L., Gagliardi, R. Applications of Artificial Intelligence and Machine learning in smart cities. *Computer Communications* 154, 313–323. , 2020.

Venkadavarahan, M., Marisamynathan, S.. Analyzing Urban Freight System, Supply Chain Characteristics and Temporal Travel Pattern in Indian context. *Case Studies on Transport Policy* 9, 348–361. , 2021.

Wang, C., Liu, L., Xu, C., Lv, W. Predicting Future Driving Risk of Crash-Involved Drivers Based on a Systematic Machine Learning Framework. *IJERPH* 16, 334. , 2019.

Wang, J., Lim, M.K., Zhan, Y., Wang, X. An intelligent logistics service system for enhancing dispatching operations in an IoT environment. *Transportation Research Part E: Logistics and Transportation Review* 135, 101886. . 2020.

Wang, Y., Sarkis, J. Emerging digitalisation technologies in freight transport and logistics: Current trends and future directions. *Transportation Research Part E: Logistics and Transportation Review* 148, 102291. 2021.

Wang, Y., Szeto, W.Y., Han, K., Friesz, T.L. Dynamic traffic assignment: A review of the methodological advances for environmentally sustainable road transportation applications. *Transportation Research Part B: Methodological* 111, 370–394. 2018.

Wide, P. Improving decisions support for operational disruption management in freight transport. *Research in Transportation Business & Management* 37, 100540. 2020.

Yamada, T., Febri, Z. Freight transport network design using particle swarm optimisation in supply chain–transport supernetwork equilibrium. *Transportation Research Part E: Logistics and Transportation Review* 75, 164–187. , 2015.

Yi, H., Bui, K.-H.N., Jung, H.. Implementing A Deep Learning Framework for Short Term Traffic Flow Prediction, in: Proceedings of the 9th International Conference on Web Intelligence, Mining and Semantics - WIMS2019. Presented at *the the 9th International Conference, ACM Press,* Seoul, Republic of Korea, pp. 1–8. , 2019

Young, W., Sobhani, A., Lenné, M.G., Sarvi, M. Simulation of safety: A review of the state of the art in road safety simulation modelling. *Accident Analysis & Prevention* 66, 89–103. 2014.

Zhang, Y., Zhang, D., Wang, D.. On migratable traffic risk estimation in urban sensing: A social sensing based deep transfer network approach. *Ad Hoc Networks* 111, 102320. 2021.

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