Investigating Barriers and Challenges to Artificial Intelligence (AI) Implementation in Logistic Operations: A Systematic Review of Literature

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Abstract

The aim of this research is to investigate barriers and challenges associated with Artificial Intelligence (AI) adoption and implementation in the logistics operations. A systematic literature review was conducted to assess the major categories of challenges as well as specific challenges for each category published in peer-reviewed articles that are relevant to logistics operations. A total of 114 articles from six (6) electronic databases (i.e., IEEE Xplore, Science Direct, Elsevier's Scopus, Web of Science. Springer link, Google Scholar) were analyzed. Based on the findings, 7 major categories of barriers and challenges of AI adoption and implementation in the logistic are identified:(organisational and managerial challenges, technological challenges, economic challenges, data challenges, environmental challenges, social challenges, political, legal, and ethical challenges). Similarly, 16 specific challenges such as lack of top management support, internal requirement-organizational strategy, real-time response, disconnected systems, technology complexity, skill and expertise, high investment, operational costs, AI infrastructure, data standardization, scalability factors, data privacy and security, and insufficient operational warehouse space were identified. This research provides a further benchmark for decision making for logistics operation managers to deal with challenges and barriers in the adoption of AI in supply chain management.

Key Words:

Artificial intelligence; Logistics operations, Challenges, Implementation

1. Introduction

Artificial intelligence (AI), which can be understood as the theory and development of computer systems able to perform tasks normally requiring human intelligence, has been forecasted as a technology that will revolutionize business activities and engagement thereby, ushering in a radical change in the way business is traditionally conducted (Halaweh 2018; Tizhoosh and Pantanowitz 2018, 2018; Sun and Medaglia 2019). AI impact is projected to be valued like other leading technologies of the modern times that has enriched productivity of business (Klumpp 2018; Petit 2017; Fors et al. 2015; Sun and Medaglia 2019). Advantages of AI in terms of productivity, efficiency, and global economic growth are significant and has been projected to deliver progressives global economic activity in the coming years (Pavaloiu 2016; Davenport and Ronanki 2018; Jarrahi et al. 2018; Dwivedi et al. 2019). Logistic operations being an important business segment in the supply chain management (SCM) of organizations is seen as an area wherein AI will be vital for the improvement of efficiency, accuracy, and speed of service delivery (Dubey et al. 2020). AI is also envisioned as a technology that can be used to optimize operations and improve management strategies in response to the increasing complexity in interconnectivity (Modgil et al. 2021; Haddud et al. 2017; Lee and Lee 2015; Jindal et al. 2021; Zhang 2019).

Application of AI technology falls into several categorizes which include (1) Intelligent operation rule management, (2) Intelligent warehouse location, (3) Intelligent decision-making assistance, (4) Image recognition, and (5) Intelligent scheduling. In Logistics industry, artificial intelligence technology also focuses on the fields of intelligent search, reasoning planning, and intelligent robots (Grzeszick et al., 2016; Dwivedi et al., 2019; Dubey et al., 2020). AI can also be observed as a set of technologies that are interrelated with the aim to solve complex problems (Zhang et al., 2014). It is believed that companies that apply extensive use of AI are receiving a great advantage in terms of decreased downtime, improved efficiency, and increased customer satisfaction (Chen et al., 2015). There are numerous examples and possibilities for applying robots in logistics such as intelligent robots for collecting, commissioning, and sorting of goods; robots for unloading containers based on optical character recognition) (OCR) technology (Klumpp 2017; Chung 2021).

AI in logistics can also provide optimal solutions for vehicle routing and consequently reduce cost, ensure predictive forecasting for demand, accelerate decision-making, and increase customer satisfaction through the personalization of logistics services (Fors et al. 2015; Petit, 2017; Klumpp 2018). However, in as much as AI benefits are overwhelming, adoption and implementation in the logistic operations are still in its infancy (Kaplan & Haenlein 2020). Hence, a better understanding of barriers and challenges is vital to appropriately harness the potential benefits based on available resources that will maximize returns. Therefore, this literature review aims to provide a further benchmarking on decision making for logistics managers in the supply chain management.

2. Materials and methods

This research was conducted utilizing a systematic literature review process following the guidelines provided by Kitchenham et al. (2015). The following major stages was adopted for the systematic literature review

(1) Research Questions. This comprises a set of formulated research questions based on the main objective of the research.
(2) Literature Search Approach. The literature search approach involves the initial search procedures for key studies utilizing terminologies, literature resources and relevant information.
(3) Selection of Studies. This involves the definition of criteria for inclusion and exclusion of studies.
(4) Data Synthesis. This involves the procedure used for synthesizing data gathered to address the stated research questions.
(5) Discussion and conclusion. This involves the examination and consideration of results from the synthesis and analysis of the data extracted.

2.1 Research. Questions (RQ)

The research questions centers specifically on major problem of the research which is determined the barriers and challenges hindering the adoption and implementation of AI in the logistics operations of the supply chain management. The stated research questions, strategy for analysis, and criteria are enumerated in table (1).

Table 1. Questions and Analysis Criteria

Questions	Strategy	Description
Research Question one (RQ1)		What are the categories of challenges to AI adoption and implementation in logistics operation in the supply chain management for the past 10 years (2013-2022)?
	Analysis	Number of studies, and date of publication

	Criteria	Database, location
Research question two (RQ2)		From the perspective of each category, what are the specific challenges that impedes adoption and implementation of AI in the logistics operations in the supply chain management?
	Analysis	Content analysis
	Criteria	Specific areas, sections, departments in logistics transport.

2.2 Literature Search Approach

The literature search approach detailed by Achimugu et al. (2014), which include search strings, literature sources, and search process was followed.

Search String

According to Rowley and Slack (2004), search strings should be specific. Hence, the following key words were included in the search strings.

Artificial Intelligence/challenges/barriers/logistics/ Supply chain management

AI /Implementation/ Adoption/Transport Challenges

AI/ implementation/Warehouse Challenges

The key search words were: “artificial Intelligence,” “AI,” “logistics,” “supply chain,” “management,” “adoption,” “implementation,” “warehouse,” “transport,” “challenges”. These key words were selected to create broadened scope for outcomes dealing with the main research emphasis which is to identify challenges to AI adoption and implementation in the logistics operations. To search for relevant studies, Boolean operators were employed to gather literature that is as appropriate as possible, “AND” and/or “OR” operators were used for databases and search engines which include IEEE Xplore, Science Direct, Elsevier's Scopus, Web of Science, Springer link, and Google Scholar

2.2.2 Literature resources

In order to locate relevant studies, a proper search engine (s) was selected as well as search strings with broad based databases for the primary search. The databases selected with broad coverage of peer-reviewed literature for the stated research questions include IEEE Xplore, Science Direct, Elsevier's Scopus, Web of Science, Springer link, and Google Scholar. These databases were investigated using search strings specifically looking for contributions relevant to the research question. Search strategies were established to ascertain studies on AI technology implementation. The databases searched include IEEE Xplore, Science Direct, Scopus, Springer link, Web of Science, and Google Scholar. For a precise search, the following keywords were used: “Artificial intelligence in logistics,” “Supply chain management,” “Implementation,” “Logistics operation,” “Challenges.” Search included research publications from 2013- 2021. In terms of language restrictions, searches were limited to articles in English language (**Table 2**).

2.2.3 Selection of Studies

Selection of studies was primarily focused on published articles specifically on AI adoption and implementation challenges in the logistics operations for the enhancement of efficiency and accuracy in the areas of transport and warehousing operations

2.2.4 Inclusion and exclusion measures

For inclusion measures, the following criteria was followed:

-Peer-reviewed articles and conference proceedings published from 2013 to 2022

-Systematic literature reviews with stated research questions, literature search process, and data analysis.

For exclusion measures, the following criteria was followed:

- Any articles or conference proceedings before 2013 were excluded, thereby restricting the search to the last 10 years.

- Articles with that lacks defined research questions, defined search process, and data analysis.

As shown in figure (1) and summarised in Table 2, 600 articles were accessed from six (6) databases

Specifically, from (IEEE Xplore, Science Direct, Scopus, Springer Link, Web of Science, and Google Scholar).

Using the criteria of exclusion and inclusion, the initial screening of articles resulted to 375 articles being selection. Furthermore, two subsequent phases were conducted. The first phase involves screening for titles and abstracts and the second phase involves reading the main text. The first phase of screening for titles and abstracts resulted to 175 articles being selected after discarding articles due to a lack relevance to the study's title. The second phase of screening focused on main text reading. This involved evaluation of contents of discussions relating to the study's title focusing on barrier and challenges to AI implementation in the logistics operations, this phase of screening resulted selection of 114 articles most relevant to the research topic and research questions.

Table 2. Summary of the databases and searches

		Initial Screening	First Screening:	Second Screening	
Databases	Articles Initially retrieved	Excluded After Screening	Titles and Abstracts	Main text reading	Main selected articles
IEEE Xplore	90	62	38	13	13
Science Direct	130	52	35	10	10
Elsevier's Scopus,	120	65	42	12	12
Web of Science	88	62	30	11	11
Springer link	117	80	20	5	5
Google Scholar	100	54	35	10	8
Total	600	375	175	114	114

3. Results

The section presents results based on the data gathered from peer-reviewed articles and conference proceedings published from 2013 to 2022.

3.1 Data Synthesis

As suggested by Denyer and Tranfield (2009), synthesis of data involved the extraction of literature according to time span and distribution of studies by year, and thematic analysis of the data to respond to the stated research questions mainly focusing on the challenges impending the adoption and implementation of AI in the logistics operations.

3.2. Time span and distribution of studies by year

Figure 2 presents the time span and distribution of studies. As shown in figure (2), the time span of this literature review was from 2013 to 2022, encompassing peer-reviewed journals identified through search from databases. Accordingly, five (5) studies was extracted in 2013, seven (7) studies in 2014, 19 studies in 2015, nine (9) studies in 2016, 11 in 2017. Similarly, 16 studies was extracted in 2018, 10 studies in 209, 13 studies in 2020, 20 studies in 2021, and four (4) studies in 2022 respectively. Based on the extracted studies, 2021 has the largest number of publications dealing with AI adoption and implementation barriers and challenges.

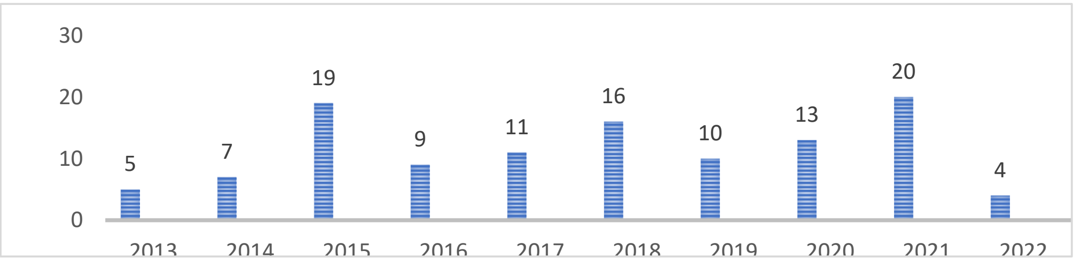

Figure 2. Time span and distribution of studies by year

3.3. Analysis of categories of AI challenges

Table 3 shows the summary of categories of AI challenges and specific challenges for each category extracted from the assessed articles. Out of the 114 articles assessed, eight (8) categories of AI adoption and implementation challenges and 16 specific challenges or barriers was identified.

Table 3. Summary of categories of challenges

Category of Challenges	Specific challenges	Reference
Organisational and managerial challenges	Lack of top management support	(Klumpp, 2018; Petit, 2017; Fors et al., 2015; Kircher and Ahlström, 2015; Sun and Medaglia, 2019; Tizhoosh and Pantanowitz, 2018, 2018; Kane et al., 2018; Vogelsang et al., 2019; Abdulrahman et al.,

		2014; Jayanta et al., 2014; Al Sheibani et al. 2018; AlShamsi et al. 2021).
	Internal requirement-Organizational strategy	(Jawandhiya 2018; Xu et al. 2019; Dwivedi et al., 2019; Wirtz et al., 2019).
Technological challenges	Real-time response	(Sah et al., 2021; Sun and Medaglia, 2019)
	Disconnected systems	(Kahn, 2017; Haddud et al., 2017; Yang et al., 2019; Dwivedi et al., 2019. Aoun et al., 2021).
	Technology complexity	(Mathauer and Hoffmann 2019; Gunasekaran et al., 2017; Asare et al., 2016. Hofmann and Osterwalder, 2017).
	Skill and expertise	(Modgil et al., 2021; Haddud et al., 2017; Lee and Lee, 2015; Jindal et al., 2021; Zhang, 2019; Davenport and Ronanki, 2018; Pavaloiu, 2016; Dwivedi et al., 2019).
Economic challenges	High investment	(Tizhoosh and Pantanowitz, 2018, 2018; Sun and Medaglia, 2019; Bughin et al., 2018; Camhi, 2018; Paschen et al., 2019; Alam et al., 2015; Tu, 2018)).
	Operational costs	(Sjøberg, 2019; Mahroof 2019; Sun and Medaglia, 2019; Duan et al., 2019; Iliashenko et al., 2019).
	AI Infrastructure	(Bogna-Mrówczyńska, 2015; Bazzan and Klügl, 2013; Sherman and Chauhan, 2016; Mercan et al., 2018; Stellios et al., 2018; Stores et al., 2017; Mistry et al., 2020; Wang et al., 2021).
Data challenges	Data Standardization	(Tizhoosh and Pantanowitz, 2018; Carlos et al., 2018; Khanna et al., 2013; Xu et al., 2019; Khanna et al., 2013; Xu et al. 2019; Dwivedi et al. 2019).
	Scalability factors	(Varga-Szemes et al., 2018; Sun and Medaglia, 2019).
	Data privacy and security	(Chen et al. 2015; Pahukula et al., 2015; Pattinson and Thompson, 2014; Dawson et al., 2014; Anund et al., 2017; Brown et al., 2017; Childress et al., 2015; Chatfield and Reddick, 2019; Wirtz et al., 2019; Androutsopoulou et al., 2019; Mullet et al., 2021; Naanani and Aziz, 2021; Umran et al., 2021; Wirtz et al. 2019).
Environmental challenges	Insufficient operational warehouse space	(Singh et al., 2021; Helo and Hao 2021; Kua et al. 2021; Rehman et al., 2021; Mercan et al., 2021; Mahroof, 2019).
	Inadequate warehouse structure	(Sjøberg, 2019; Mahroof, 2019; Guo et al., 2016; Venkitasubramony and Adil, 2017; Derhami et al., 2017; Boysen et al., 2017)
	Inventory management issues	(Xu et al., 2019; Sun and Medaglia, 2019).
	Lack of transport drivers' acceptance of autonomous vehicles	(Hoff and Bashir, 2015; Rezvani et al., 2016; Levin and Boyles, 2016; Talebpour and Mahmassani, 2016; Wietholt and Harding, 2016).
Social challenges	Lack of employee cooperation	(Sharma, 2020, Soni et al., 2020; Agrawal et al., 2020; Babic et al., 2020; Metcalf et al., 2019; Sajjadiani et al., 2019).

	Employees training	(Klumpp, 2018; Petit, 2017; Li, 2017; Fors et al., 2018; Thrall et al., 2018; Varga-Szemes et al., 2018; Thrall et al., 2018; Mitchell, 2019; Sharma, 2020).
	Unemployment	(Kianfar et al., 2013; Urciuoli and Hintsa, 2017; Ernst et al., 2019; Owczarek, 2018).
Political, legal, and ethical challenges	Lack of rules on ethics and liability guiding AI technology	(Klumpp, 2018; Petit, 2017; Abdulrahman et al., 2014; Jayanta et al., 2014; Kalyanakrishnan et al., 2018; Fagnant and Kockelman, 2015)
	Lack of trust	(Kwak and Lee, 2021; Al Kurdi et al., 2020; Almaazmi et al., 2021; Alshurideh et al., 2021; Mehrez et al., 2021; Nuseir et al., 2021; AlSuwaidi et al., 2021; Alzoubi and Yanamandra, 2020; Hayajneh et al., 2021; Rajgopal, 2016; Ali et al., 2022; Alnuaimi et al., 2021; AlShehhi et al., 2021; Alzoubi et al., 2021).

4. Discussion

This section presents discussion based on research questions.

Research Question one (RQ1): What are the categories of challenges to AI adoption and implementation in logistics operation in the supply chain management for the past 10 years (2013-2022)?

One hundred and fourteen articles were assessed within the time span of this research (2013 to 2022). Out of the 114 articles assessed, seven (7) categories of AI adoption and implementation challenges was identified. This include organisational and managerial challenges, technological challenges, economic challenges, data challenges, environmental challenged, social challenges, political, legal, and ethical challenges.

Research Question two (RQ2): From the perspective of each category, what are the specific challenges that impedes adoption and implementation of AI in the logistics operations in the supply chain management?

Out of the seven categories of challenges, 16 specific challenges were identified. Kene et al. (2018) point out that lack of organizational and management support impedes digital transformation (AI) in the logistics operations. Vogelsang et al. (2019) emphasized Organizational and cultural barriers such as keeping traditional roles and no clear vision. Dwivedi et al. (2019) mentioned that organizations should focus on developing and maintaining information resources in order to succeed in exploiting AI technology.

Mathauer and Hoffmann (2019) mentioned that adoption of technology in logistics operations is a struggle for managers. Gunasekaran et al. (2017) and Asare et al. (2016) emphasized that managing the complexities AI technology remains an impediment. Hofmann and Osterwalder (2017) points out that the challenge of digital development business models impedes AI technology. In this case lack of organizational technological readiness may cause a gap between digitalization and digital transformation, which is crucial for organizations to succeed on their AI journey. Dwivedi et al. (2019) emphasized that lack of organizational technological readiness impedes digitalization which is vital for organizations to succeed in AI implementation. Skill and expertise is a vital necessity for AI implementation, hence, the lack of professional and comprehensive talents in logistics operations across the global value chain with ample understanding of data science, information technology significantly impacts adoption and implementation (Modgil et al. 2021; Haddud et al. 2017; Lee and Lee 2015; Jindal et al., 2021). Employees lack of technical knowledge of AI technology hampers implementation (Sun and Medaglia, 2019). This can lead to disappointments when employees cannot use available technology to deliver expected results (Lee and Lee, 2015). Thus, having correct skills and competence needed to manage AI technology remains a major challenge (Davenport & Ronanki 2018; Pavaloiu 2016; Dwivedi et al. 2019).

The category of economic challenges constitutes a major impediment to the adoption and implementation of AI in logistics operation in the supply chain management. This category was emphasized by various articles (Tizhoosh and Pantanowitz 2018, 2018; Sun and Medaglia, 2019; Bughin et al. 2018; Camhi 2018; Paschen et al. 2019; Alam et al. 2015Tu, 2018); Sjøberg 2019; Mahroof 2019; Sun and Medaglia 2019; Duan et al. 2019).

High investment in equipment and hardware in AI data processing is a major challenge (Tizhoosh and Pantanowitz 2018, 2018; Sun and Medaglia 2019) AI technology requires a huge amount of resources and as such there is hesitation regarding return on investments (Alam et al. 2015; Tu 2018)).

The issue of operational cost within the organization regarding data transfer is vital consideration that hampers implementation (Sun and Medaglia 2019; Duan et al. 2019; Iliashenko et al. 2019). Soosay et al. (2018), states that in the logistics operations there is low adoption of collaborative planning forecasting and replenishment (CPFR) by upstream actors which is a major economic challenge. This impediment further leads to retailers encountering challenges of investment and time period required to constantly update in-house data management solutions or third-party forecasting systems (Sjøberg 2019; Mahroof 2019; Sun and Medaglia 2019).

In the category of data challenges, the issue of data standardization is a focal point (Tizhoosh and Pantanowitz 2018; Carlos et al. 2018; Khanna et al. 2013; Xu et al. 2019; Khanna et al. 2013; Xu et al. 2019; Dwivedi et al. 2019). Standardizing data or devising infrastructures to deal with computationally rigorous task constitutes complex problem that might not be easily oversee within a certain time frame (Leitao et al. 2016). Similarly, the issue of data privacy and security remains a vital impediment (Dawson et al., 2014; Anund et al. 2017; Brown et al. 2017; Childress et al. 2015; Chatfield and Reddick 2019; Wirtz et al. 2019; Androutsopoulou et al. 2019; Mullet et al. 2021; Naanani and Aziz 2021; Umran et al. 2021; Wirtz et al. 2019). Additionally, global standards and data sharing protocols, security and unclear benefit in digital investment increase the incidence of impediment (Wirtz et al. 2019).

In the category of environmental challenges which involves factors relating to warehousing, the challenge of operational space for AI technology stands out as an impediment to adoption and implementation (Singh et al., 2021; Helo and Hao 2021; Kua et al. 2021; Rehman et al. 2021; Mercan et al. 2021; Mahroof 2019). From a warehouse perspective, the use of AI technology undoubtedly introduces radical changes to the operational design and model of the warehouse (Sjøberg 2019; Mahroof 2019). This, therefore, demands the need for adequate warehouse structure to accommodate AI technologies for picking and ordering activities which is a major focus of warehouse operations (Mercan et al. 2021; Mahroof 2019). Inadequate warehouse structure impedes adoption and implementation as design of warehouses relies on balancing layout configuration, storage density, and flexibility (Venkitasubramony and Adil 2017; Derhami et al. 2017; Boysen et al. 2017; Guo et al. 2016).

Social challenges category involves specific challenges such as lack of employee cooperation, employees training, and unemployment (Sharma 2020, Soni et al. 2020; Agrawal et al. 2020; Babic et al. 2020; Metcalf et al. 2019; Sajjadiani et al., 2019). Employees resistance to change in their traditional working procedures impedes AI industries (Kane et al. 2018; Osmundsen et al. 2018). AI implementation requires allocation of resources massive training of employees to adaption to new work responsibilities (Ni et al. 2017; Wirtz et al. 2019; Sun and Medaglia 2019). Intensive technological skill is vital for AI as huge amount of data is required. This equally will add to the need for training which may not be economically feasible for many logistics organizations (Sun and Medaglia, 2019). Ernst et al. (2019) point out that challenges of AI implementation in the logistics includes the fear of inequality in job creation which involves scenarios where mid-level jobs are substituted by low-end and high-end ones leading to unemployment (Metcalf et al. 2019).

Political, legal, and ethical challenges categories encompasses factors such as Lack of rules on ethics and liability guiding AI technology (Petit 2017; Klumpp 2018; Abdulrahman et al. 2014; Jayanta et al. 2014; Kalyanakrishnan et al. 2018; Fagnant and Kockelman 2015). Lack of specific laws and regulations that encourages motivation is considered as a major challenge to AI implementation (Klumpp 2018). Wirtz et al. (2019) points out that unclear laws or legal ramifications concerning the interplay of ethical issues in AI technology such as social norms and standards in terms of s honesty and loyalty is hampering implementation. Trust in AI technology despite the advantages accounts for a major challenge of AI implementation (Sun and Medaglia 2019). The issue of data sharing and the inability of data protection still constitutes a vital argument towards trust in AI technology as people do not trust certain features embedded in the technology (Schlögl et al. 2019; Lauterbach 2019).

5. Conclusions

This research assessed barriers and challenges to artificial intelligence (AI) implementation in logistic operations through systematic literature review of published articles for the past ten years (2013-2022. About 114 articles was assessed from six (6) data bases (IEEE Xplore, Science Direct, Elsevier's Scopus, Web of Science. Springer link, Google Scholar). Findings revealed seven (7) major categories of barriers and challenges (Organisational and managerial challenges, technological challenges, economic challenges, data challenges, environmental challenged, social challenges, political, legal, and ethical challenges). Under the seven (7) categories, 16 specific challenges were identified (Lack of top management support, Internal requirement- Organizational strategy, Real-time response, Disconnected systems, Technology complexity, Skill and expertise, High investment, Operational costs, AI Infrastructure, Data Standardization. Scalability factors. Data privacy and security. Insufficient operational warehouse space). This research has practical implications for the logistics manager in the sense that it serves as a further benchmark to aid in decision-making concerning AI adoption and implementation in the logistics operations.

References

Abdulrahman MD, Gunasekaran A, Subramanian N. Critical barriers in implementing reverse logistics in the Chinese manufacturing sectors. *International journal of production economics*. 2014 Jan 1; 147:460-71.

Achimugu P, Selamat A, Ibrahim R, Mahrin MN. A systematic literature review of software requirements prioritization research. *Information and software technology*. 2014 Jun 1;56(6):568-85.

Agrawal A, Gans J, Goldfarb A. How to win with machine learning. *Harvard Business Review*. 2020 Sep.

Alam A, Besselink B, Turri V, Mårtensson J, Johansson KH. Heavy-duty vehicle platooning for sustainable freight transportation: A cooperative method to enhance safety and efficiency. *IEEE Control Systems Magazine*. 2015 Nov 6;35(6):34-56.

Ali I, Phan HM. Industry 4.0 technologies and sustainable warehousing: a systematic literature review and future research agenda. *The International Journal of Logistics Management*. 2022 Feb 22.

Al Maazmi, J., Alshurideh, M., Al Kurdi, B., & Salloum, S. A. The Effect of Digital Transformation on Product Innovation: *A Critical Review. In Advances in Intelligent Systems and Computing:* Vol. 1261 AISC. 2021.

Al Nuaimi M, Alzoubi HM, Ajelat D, Alzoubi AA. Towards intelligent organisations: an empirical investigation of learning orientation's role in technical innovation. *International Journal of Innovation and Learning*. 2021;29(2):207-21.

Al Sheibani S, Cheung Y, Messom C. Artificial Intelligence Adoption: *AI-readiness at Firm-Level.* InPACIS 2018 (p. 37).

Al Shurideh M, Al Kurdi B, Salloum SA, Arpaci I, Al-Emran M. Predicting the actual use of m-learning systems: a comparative approach using PLS-SEM and machine learning algorithms. *Interactive Learning Environments*. 2020 Oct 1:1-5.

Al Suwaidi FA, Alshurideh M, Kurdi BA, Salloum SA. The impact of innovation management in SMEs performance: A systematic review. *In International Conference on Advanced Intelligent Systems and Informatics* 2020 Oct 19 (pp. 720-730). Springer, Cham.

AlSuwaidi SR, Alshurideh M, Kurdi BA, Aburayya A. The main catalysts for collaborative R&D projects in Dubai industrial sector. *In The International Conference on Artificial Intelligence and Computer Vision* 2021 Jun 28 (pp. 795-806). Springer, Cham.

Alzoubi HM, Alshurideh M, Ghazal TM. Integrating BLE Beacon Technology with Intelligent Information Systems IIS for Operations' Performance: A Managerial Perspective. *In The International Conference on Artificial Intelligence and Computer Vision 2021* Jun 28 (pp. 527-538). Springer, Cham.

Alzoubi HM, Elrehail H, Hanaysha JR, Al-Gasaymeh A, Al-Adaileh R. The Role of Supply Chain Integration and Agile Practices in Improving Lead Time During the COVID-19 Crisis. *International Journal of Service Science, Management, Engineering, and Technology* (IJSSMET). 2022 Jan 1;13(1):1-1.

Alzoubi HM, Yanamandra R. Investigating the mediating role of information sharing strategy on agile supply chain. *Uncertain Supply Chain Management*. 2020:273-84.

Androutsopoulou A, Karacapilidis N, Loukis E, Charalabidis Y. Transforming the communication between citizens and government through AI-guided chatbots. Government information quarterly. 2019 Apr 1;36(2):358-67.

Anund A, Fors C, Ahlstrom C. The severity of driver fatigue in terms of line crossing: a pilot study comparing day-and nighttime driving in simulator. *European transport research review*. 2017 Jun;9(2):1-7.

Aoun A, Ilinca A, Ghandour M, Ibrahim H. A review of Industry 4.0 characteristics and challenges, with potential improvements using blockchain technology. *Computers & Industrial Engineering*. 2021 Dec 1; 162:107746.

Asare AK, Brashear-Alejandro TG, Kang J. B2B technology adoption in customer driven supply chains. *Journal of Business & Industrial Marketing*. 2016 Feb 1.

Babic B, Chen DL, Evgeniou T, Fayard AL. A better way to onboard ai understand it as a tool to assist rather than replace people. *Harvard Business Review*. 2020 Jul 1;2020(July-August):2-11.

Bazzan AL, Klügl F. Introduction to intelligent systems in traffic and transportation. Synthesis Lectures on Artificial *Intelligence and Machine Learning*. 2013 Dec 20;7(3):1-37.

Bonkenburg T. Robotics in logistics: A DPDHL perspective on implications and use cases for the logistics industry. DHL *Customer Solutions & Innovation:* Bonn, Germany. 2016 Mar;4.

Boysen N, Briskorn D, Emde S. Sequencing of picking orders in mobile rack warehouses. *European Journal of Operational Research.* 2017 May 16;259(1):293-307.

Brown M, Funke J, Erlien S, Gerdes JC. Safe driving envelopes for path tracking in autonomous vehicles. Control *Engineering Practice*. 2017 Apr 1; 61:307-16.

Bughin J, Hazan E, Ramaswamy S, Chui M, Allas T, Dahlstrom P, Henke N, Trench M. *Artificial intelligence: the next digital frontier.*

Bughin J, Seong J, Manyika J, Chui M, Joshi R. Notes from the AI frontier: Modelling the impact of AI on the world economy. *McKinsey Global Institute*. 2018 Sep

Bughin J, Hazan E, Lund S, Dahlström P, Wiesinger A, Subramaniam A. Skill shift: Automation and the future of the workforce. *McKinsey Global Institute. McKinsey & Company*: Brussels, Belgium. 2018 Feb.

Castillo-Villar KK. *Metaheuristic algorithms applied to bioenergy supply chain problems: theory, review, challenges, and future. Energies*. 2014 Nov;7(11):7640-72.

Chatfield AT, Reddick CG. A framework for Internet of Things-enabled smart government: A case of IoT cybersecurity policies and use cases in US federal government. *Government Information Quarterly*. 2019 Apr 1;36(2):346-57.

Childress S, Nichols B, Charlton B, Coe S. Using an activity-based model to explore the potential impacts of automated vehicles. *Transportation Research Record*. 2015 Jan;2493(1):99-106.

Chen H, Long C, Jiang HB. Building a Belief–Desire–Intention Agent for Modelling Neural Networks. *Applied Artificial Intelligence*. 2015 Sep 14;29(8):753-65.

Chen J, Zhao W. *Logistics automation management based on the Internet of things. Cluster Computing*. 2019 Nov;22(6):13627-34.

Chung SH. Applications of smart technologies in logistics and transport: A review. Transportation Research Part E: *Logistics and Transportation Review*. 2021 Sep 1; 153:102455.

Coppola P, Silvestri F. Autonomous vehicles, and future mobility solutions. In Autonomous vehicles and future mobility 2019 Jan 1 (pp. 1-15). *Elsevier.*

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*. 2021 Jul 4;24(4):323-45.

Duan Y, Edwards JS, Dwivedi YK. Artificial intelligence for decision making in the era of Big Data–evolution, challenges, and research agenda. *International Journal of Information Management*. 2019 Oct 1; 48:63-71.

Davenport TH, Ronanki R. Artificial intelligence for the real world. *Harvard business review*. 2018 Jan 1 ;96(1):108-16.

Dawson D, Searle AK, Paterson JL. Look before you (s) leep: evaluating the use of fatigue detection technologies within a fatigue risk management system for the road transport industry. *Sleep medicine reviews*. 2014 Apr 1;18(2):141-52.

Denyer, D., & Tranfield, D.). Producing a systematic review. In D. A. Buchanan & A. Bryman (Eds.), The sage handbook of organizational research methods (pp. 671– 689). *Sage Publications* Ltd. 2009.

Derhami S, Smith JS, Gue KR. Optimising space utilisation in block stacking warehouses. *International Journal of Production Research*. 2017 Nov 2;55(21):6436-52.

Dubey R, Gunasekaran A, Childe SJ, Bryde DJ, Giannakis M, Foropon C, Roubaud D, Hazen BT. Big data analytics and artificial intelligence pathway to operational performance under the effects of entrepreneurial orientation and environmental dynamism: A study of manufacturing organisations. *International Journal of Production Economics*. 2020 Aug 1; 226:107599.

Dwivedi YK, Hughes L, Ismagilova E, Aarts G, Coombs C, Crick T, Duan Y, Dwivedi R, Edwards J, Eirug A, Galanos V. Artificial Intelligence (AI): Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice, and policy. *International Journal of Information Management*. 2021 Apr 1; 57:101994.

Ernst E, Merola R, Samaan D. Economics of artificial intelligence: Implications for the future of work. *IZA Journal of Labor Policy*. 2019 Jun 1;9(1).

Fagnant DJ, Kockelman K. Preparing a nation for autonomous vehicles: opportunities, barriers, and policy recommendations. Transportation Research Part A: *Policy and Practice*. 2015 Jul 1; 77:167-81.

Fors C, Kircher K, Ahlström C. Interface design of eco-driving support systems–Truck drivers' preferences and behavioural compliance. *Transportation Research Part C: Emerging Technologies*. 2015 Sep 1; 58:706-20.

Galceran E, Cunningham AG, Eustice RM, Olson E. Multipolicy decision-making for autonomous driving via changepoint-based behavior prediction: Theory and experiment. *Autonomous Robots*. 2017 Aug;41(6):1367-82.

García J, Florez JE, Torralba Á, Borrajo D, López CL, García-Olaya Á, Sáenz J. Combining linear programming and automated planning to solve intermodal transportation problems. *European Journal of Operational Research*. 2013 May 16;227(1):216-26.

Grigorescu S, Trasnea B, Cocias T, Macesanu G. A survey of deep learning techniques for autonomous driving. *Journal of Field Robotics*. 2020 Apr;37(3):362-86.

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*. 2017 Mar 1; 99:14-33.

Guo X, Yu Y, De Koster RB. Impact of required storage space on storage policy performance in a unit-load warehouse. *International Journal of Production Research*. 2016 Apr 17;54(8):2405-18.

Haddud, A., Desouza, A., Khare, A., Lee, H., Desouza, A., & Lee, H.). Things integration in supply chains Examining potential benefits and challenges associated with the *Internet of Things integration in supply chains*. 2017

Halaweh M. Artificial intelligence government (Gov. 3.0): The UAE leading model. *Journal of Artificial Intelligence Research.* 2018 Jun 20; 62:269-72.

Helo P, Hao Y. Artificial intelligence in operations management and supply chain management: an exploratory case study. *Production Planning & Control*. 2021 Jan 31:1-8.

Hofmann E, Osterwalder F. Third-party logistics providers in the digital age: towards a new competitive arena. *Logistics.* 2017 Dec;1(2):9.

Hoff KA, Bashir M. Trust in automation: Integrating empirical evidence on factors that influence trust. *Human factors*. 2015 May;57(3):407-34.

Iliashenko O, Bikkulova Z, Dubgorn A. Opportunities, and challenges of artificial intelligence in healthcare. InE3S Web of Conferences 2019 (Vol. 110, p. 02028). EDP Sciences.

Jarrahi MH. Artificial intelligence and the future of work: Human-AI symbiosis in organizational decision making. *Business horizons*. 2018 Jul 1;61(4):577-86.

Jindal, A.; Sharma, S.K.; Sangwan, K.S.; Gupta, G. Modelling Supply Chain Agility Antecedents Using Fuzzy DEMATEL. Procedia CIRP 2021, 98, 436–441.

Kalyanakrishnan S, Panicker RA, Natarajan S, Rao S. Opportunities, and challenges for artificial intelligence in India. *In Proceedings of the 2018 AAAI/ACM conference on AI, Ethics, and Society* 2018 Dec 27 (pp. 164-170).

Kane GC, Palmer D, Phillips AN, Kiron D, Buckley N. Coming of age digitally. *MIT Sloan Management Review and Deloitte Insights*. 2018 Jun;59(5):1-0.

Kaplan J. Artificial intelligence: *Think again. Communications of the ACM*. 2016 Dec 20;60(1):36-8.

Kaplan AM, Haenlein M. Users of the world, unite! The challenges and opportunities of social media. *Business horizons*. 2010 Jan 1;53(1):59-68.

Kianfar R. On Cooperative Control of Automated Driving Systems from a Stability and Safety Perspective. *Chalmers Tekniska Hogskola* (Sweden); 2014.

Kitchenham BA, Budgen D, Brereton P. Evidence-based software engineering and systematic reviews. *CRC press*; 2015 Nov 4.

Klumpp M. Automation and artificial intelligence in business logistics systems: human reactions and collaboration requirements. *International Journal of Logistics Research and Applications*. 2018 May 4;21(3):224-42.

Klumpp M. Artificial divide: the new challenge of human-artificial performance in logistics. Innovative Produkte und Dienstleistungen in der Mobilität 2017 (pp. 583-593). *Springer Gabler*, Wiesbaden.

Knoll D, Prüglmeier M, Reinhart G. Predicting future inbound logistics processes using machine learning. *Procedia CIRP*. 2016 Jan 1; 52:145-50. Kua, J.; Arora, C.; Loke, S.W.; Fernando, N.; Ranaweera, C. Internet of Things in Space: *A Review of Opportunities and Challenges from Satellite-Aided Computing to Digitally Enhanced Space Living*. arXiv 2021, arXiv:2109.05971.

Kwak, Y.H.; Lee, J. Toward Sustainable Smart City: Lessons From 20 Years of Korean Programs. *IEEE Trans. Eng. Manag*. 2021, 1–15.

Lai, P. (2017). The Literature Review of Technology Adoption Models and Theories for the Novelty Technology. *Journal of Information Systems and Technology Management*, 14(1). doi: 10.4301/s1807-17752017000100002

Lauterbach A. Artificial intelligence and policy: quo vadis. *Digital Policy, Regulation and Governance*. 2019 May 13.

Lee CK, Lv Y, Ng KK, Ho W, Choy KL. Design and application of Internet of things-based warehouse management system for smart logistics. *International Journal of Production Research*. 2018 Apr 18;56(8):2753-68.

Lee J, Suh T, Roy D, Baucus M. Emerging technology, and business model innovation: The case of artificial intelligence. *Journal of Open Innovation: Technology, Market, and Complexity*. 2019 Sep;5(3):44.

Lee CK, Lv Y, Ng KK, Ho W, Choy KL. Design and application of Internet of things-based warehouse management system for smart logistics. *International Journal of Production Research*. 2018 Apr 18;56(8):2753-68

Levin MW, Boyles SD. A multiclass cell transmission model for shared human and autonomous vehicle roads. Transportation Research Part C: *Emerging Technologies*. 2016 Jan 1; 62:103-16.

Li BH, Hou BC, Yu WT, Lu XB, Yang CW. Applications of artificial intelligence in intelligent manufacturing: *a review. Frontiers of Information Technology & Electronic Engineering*. 2017 Jan;18(1):86-96.

Luo J, Chong AY, Ngai EW, Liu MJ. Reprint of “Green Supply Chain Collaboration implementation in China: The mediating role of guanxi.” Transportation Research Part E: *Logistics and Transportation Review*. 2015 Feb 1; 74:37-49.

Mahroof, K. A human-centric perspective exploring the readiness towards smart warehousing: The case of a large retail distribution warehouse. *International Journal of Information Management* 2019, pp. 45, 176–190. https://doi.org/10.1016/j. ijinfomgt.2018.11.008.

Maheut JP, Garcia Sabater JP. Algorithm for complete enumeration based on a stroke graph to solve the supply network configuration and operations scheduling problem. *Journal of Industrial Engineering and Management*. 2013;6(3):779-95.

Mathauer M, Hofmann E. Technology adoption by logistics service providers. *International Journal of Physical Distribution & Logistics Management*. 2019 Jun 13.

Mercan, S.; Cain, L.; Akkaya, K.; Cebe, M.; Uluagac, S.; Alonso, M.; Cobanoglu, C. Improving the service industry with hyper-connectivity: IoT in hospitality. *Int. J. Contemp. Hosp. Manag*. 2021, 33, 243–262.

Mistry, I.; Tanwar, S.; Tyagi, S.; Kumar, N. Blockchain for 5G-enabled IoT for industrial automation: A systematic review, solutions, and challenges. Mech. Syst. *Signal Process*. 2020, 135, 106382.

Mitchell R, Michalski J, Carbonell T. *An artificial intelligence approaches*.

Modgil S, Singh RK, Hannibal C. Artificial intelligence for supply chain resilience: Learning from COVID-19. The *International Journal of Logistics Management*. 2021 Jul 27

Mrówczyńska B. Multicriteria vehicle routing problem solved by artificial immune system. *Transport Problems*. 2015;10.

Mukhutdinov D, Filchenkov A, Shalyto A, Vyatkin V. Multi-agent deep learning for simultaneous optimization for time and energy in distributed routing system. *Future Generation Computer Systems*. 2019 May 1; 94:587-600.

Mullet V, Sondi P, Ramat E. A review of cybersecurity guidelines for manufacturing factories in industry 4.0. *IEEE Access.* 2021 Feb 3; 9:23235-63.

Naanani A. Security in Industry 4.0: Cyber-attacks and countermeasures. *Turkish Journal of Computer and Mathematics Education* (TURCOMAT). 2021 Apr 28;12(10):6504-12.

Ni J, Hu J. Dynamics control of autonomous vehicle at driving limits and experiment on an autonomous formula racing car. *Mechanical Systems and Signal Processing*. 2017 Jun 1; 90:154-74.

Oleśków-Szłapka J, Stachowiak A. The framework of logistics 4.0 maturity model. In International conference on intelligent systems in production engineering and maintenance 2018 Sep 17 (pp. 771-781). *Springer,* Cha

Owczarek L. *The Impact of Artificial Intelligence technologies on the Employment in Transportation & Logistics Industry in Poland and Ireland*. 2018.

Pahukula J, Hernandez S, Unnikrishnan A. A time-of-day analysis of crashes involving large trucks in urban areas. *Accident Analysis & Prevention*. 2015 Feb 1; 75:155-63.

Paschen J, Kietzmann J, Kietzmann TC. Artificial intelligence (AI) and its implications for market knowledge in B2B marketing. *Journal of Business & Industrial Marketing.* 2019 Aug 5.

Pattinson W, Thompson RG. Trucks and bikes: sharing the roads. *Procedia-social and behavioral sciences*. 2014 Mar 20; 125:251-61.

Pavaloiu A. The impact of artificial intelligence on global trends. *Journal of Multidisciplinary Developments*. 2016;1(1):21-37.

Petit N. Law and regulation of artificial intelligence and robots-conceptual framework and normative implications. Available at SSRN 2931339. 2017 Mar 9.

Rehman, H.U.; Asif, M.; Ahmad, M. Future applications and research challenges of IOT. In Proceedings of the 2017 *International Conference on Information and Communication Technologies,* ICICT 2017, Karachi, Pakistan, 30–31 December 2017.

Rezvani T, Driggs-Campbell K, Sadigh D, Sastry SS, Seshia SA, Bajcsy R. Towards trustworthy automation: User interfaces that convey internal and external awareness. *In2016 IEEE 19th International conference on intelligent transportation systems* (ITSC) 2016 Nov 1 (pp. 682-688). *IEEE.*

Rowley J, Slack F. Conducting a literature review. *Management research news*. 2004 Jun 1

Sah B, Gupta R, Bani-Hani D. Analysis of barriers to implement drone logistics. *International Journal of Logistics Research and Applications*. 2021 Nov 2;24(6):531-50.

Sajjadiani S, Sojourner AJ, Kammeyer-Mueller JD, Mykerezi E. Using machine learning to translate applicant work history into predictors of performance and turnover. Journal of Applied Psychology. 2019 Oct;104(10):1207.

Schlögl, Stephan, et al. "Artificial intelligence tool penetration in business: Adoption, challenges and fears." *International Conference on Knowledge Management in Organizations*. Springer, Cham, 2019.

Sherman R, Chauhan V. Just my (re-) imagination. *Supply Chain Management Review.* 2016 Mar.

Sjøberg, Merethe. *Artificial intelligence in Norwegian organizations: An exploratory study of challenges in ai adoption*. MS thesis. Universitetet i Agder; University of Agder, 2019.

Soosay, Claudine, and Raja Kannusamy. "Scope for industry 4.0 in agri-food supply chain." *The Road to a Digitalized Supply Chain Management: Smart and Digital Solutions for Supply Chain Management. Proceedings of the Hamburg International Conference of Logistics (HICL), Vol. 25*. Berlin: epubli GmbH, 2018.

Stores, P.; Santana, J.R.; Sanchez, L.; Lanza, J.; Munoz, L. Practical Lessons from the Deployment and Management of a Smart City Internet-of-Things Infrastructure: The Smart Santander Testbed Case. *IEEE Access* 2017, 5, 14309–14322.

Stellios, I.; Kotzanikolaou, P.; Psarakis, M.; Alcaraz, C.; Lopez, J. A survey of iot-enabled cyberattacks: Assessing attack paths to critical infrastructures and services. *IEEE Commun. Surv. Tutorials* 2018, 20, 3453–3495.

Sun TQ, Medaglia R. Mapping the challenges of Artificial Intelligence in the public sector: Evidence from public healthcare. *Government Information Quarterly*. 2019 Apr 1;36(2):368-83.

Talebpour A, Mahmassani HS. Influence of connected and autonomous vehicles on traffic flow stability and throughput. Transportation Research Part C: *Emerging Technologies*. 2016 Oct 1; 71:143-63.

Tizhoosh HR, Pantanowitz L. Artificial intelligence and digital pathology: challenges and opportunities. *Journal of pathology informatics*. 2018;9.

Tu M. An exploratory study of Internet of Things (IoT) adoption intention in logistics and supply chain management: A mixed research approach. *The International Journal of Logistics Management*. 2018 Feb 12.

Umran, S.M.; Lu, S.; Abduljabbar, Z.A.; Zhu, J.; Wu, J. Secure data of industrial Internet of things in a cement factory based on a blockchain technology. *Appl. Sci*. 2021, 11, 6376.

Urciuoli L, Hintsa J. Adapting supply chain management strategies to security–an analysis of existing gaps and recommendations for improvement. *International Journal of Logistics Research and Applications*. 2017 May 4;20(3):276-95.

Venkitasubramony R, Adil GK. Design of an order-picking warehouse factoring vertical travel and space sharing. The *International Journal of Advanced Manufacturing Technology*. 2017 Jul;91(5):1921-34.

Vogelsang K, Liere-Netheler K, Packmohr S, Hoppe U. Success factors for fostering a digital transformation in manufacturing companies. *Journal of Enterprise Transformation*. 2018 Apr 3;8(1-2):121-42.

Wang, K.; Zhao, Y.; Gangadhari, R.K.; Li, Z. Analyzing the adoption challenges of the Internet of things (Iot) and artificial intelligence (ai) for smart cities in China. *Sustainability* 2021, 13, 10983.

Wang, Ye, and Denial Wang. "Multi-agent based intelligent supply chain management." *Proceedings of the Ninth International Conference on Management Science and Engineering Management*. Springer, Berlin, Heidelberg, 2015.

Wietholt T, Harding J. Influence of dynamic traffic control systems and autonomous driving on motorway traffic flow. *Transportation research procedia*. 2016 Jan 1; 15:176-86.

Wirtz BW, Weyerer JC, Geyer C. Artificial intelligence and the public sector—applications and challenges. *International Journal of Public Administration.* 2019 May 19;42(7):596-615.

Zhang, Yun. "The application of artificial intelligence in logistics and express delivery." *Journal of Physics: Conference Series*. Vol. 1325. No. 1. IOP Publishing, 2019.

Zhang S, Lee CK, Chan HK, Choy KL, Wu Z. Swarm intelligence applied in green logistics: A literature review. *Engineering Applications of Artificial Intelligence*. 2015 Jan 1; 37:154-69.

Zhou W, Piramuthu S, Chu F, Chu C. RFID-enabled flexible warehousing. *Decision Support Systems*. 2017 Jun 1; 98:99-112.

Xu F, Uszkoreit H, Du Y, Fan W, Zhao D, Zhu J. Explainable AI: A brief survey on history, research areas, approaches, and challenges. *In CCF international conference on natural language processing and Chinese computing* 2019 Oct 9 (pp. 563-574). Springer, Cham.

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