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Evaluation of Industry 4.0 on Sustainable Supply Chain of manufacturing companies: A Thematic Literature Review.

Purpose of this paper:
As past industrial revolutions gave way to the technological era known as Industry 4.0, increased desire for horizontal, vertical, and end-to-end digital integration became prevalent. Adopting Industry 4.0 has significant impact on supply chain network sustainability, according to previous research. However, very little study has been done on how to use Industry 4.0 technology to successfully manage supply chain network sustainability. The goal of this paper is to provide a thematic analysis of existing research on Industry 4.0's impact on manufacturing supply chain sustainability.

Design/methodology/approach:
The various themes emerging from existing literature were identified and discussed using distinct keywords linked to the research topic, with the goal of providing a deeper knowledge of such themes and any gaps in literature to indicate topics for further research. For the literature review, a combination of keywords related to the issue were utilised to find relevant material. ProQuest, Science Direct, IEEE Explore, Scopus, Wiley Online Library (WOL), Google Scholar, and Web of Science were used to choose peer-reviewed journal papers after a thorough screening process. The screening process included applying inclusion and exclusion criteria, removing duplicate articles, evaluating journal abstracts and titles, and reading complete texts. A total of 63 journal articles were found relevant and appropriate for the review of existing literature as a result of this method.

Findings:
Significant themes emerging from the literature study were recognised and discussed, with pertinent comments given to identify future research areas. The primary themes are: supply chain transformation, Industry 4.0 technologies, the use of big data in Industry 4.0 for a sustainable supply chain, Industry 4.0 benefits and challenges, Industry 4.0 enablers, and the connection between Industry 4.0 and sustainable supply chains.

Value:
The paper will add to the body of knowledge and debate surrounding Industry 4.0 and Supply Chain Sustainability. A survey of the literature indicated research gaps, particularly in the manufacturing industry. Future study will be possible due to the emerging themes.

Research limitations/implications (if applicable):
The literature review was limited to articles published in seven databases. Further research on the subject could focus on including more databases for literature search.

Practical implications (if applicable):
The discussion of these emergent themes will be useful for both academicians and industry practitioners to identify areas for more research and collaboration.

Keywords- Industry 4.0, Supply Chain, Sustainability, Sustainable Supply Chain, Supply Chain Sustainability, Manufacturing.

References:

1. Ghadimi, P.; Wang, C.; Lim, M.K.; Heavey, C. Intelligent sustainable supplier selection using multi-agent technology: Theory and application for Industry 4.0 supply chains. Comput. Ind. Eng. 2019, 127, 588–600.
2.
3. Dubey, R., Gunasekaran, A., Childe, S. J., Wamba, S. F., & Papadopoulos, T. (2016). "The impact of big data on world-class sustainable manufacturing". The International Journal of Advanced Manufacturing Technology, 84(1-4), 631-645.
4.
5. Wamba, S.F., Akter, S., Coltman, T. and Ngai, E.W.T. (2015), “Information technology-enabled supply chain management”, Production Planning & Control, 26(12), pp. 933–944.

Evaluation of Industry 4.0 on Sustainable Supply Chain of manufacturing companies: A Thematic Literature Review.

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INTRODUCTION

From product procurement to product processing and distribution, the supply chain and its effective management are critical to the end-to-end manufacturing process. At every stage of the production process, the supply chain must be sustainable. As a result, it's critical to comprehend the aspects that influence supply chain sustainability.

The United Nations' sustainability and development goals, which explain the many indicators for achieving sustainability in general and specifically in relation to supply chain management, are a valuable and practical reference point for understanding sustainability. The United Nations' Sustainable Development Goals (SDGs) provide direction on how to exploit technical advancements in a sustainable manner, ensuring that the economic, social, and governance aspects of any approach that promotes sustainability are all taken into account. (Dubey et al., 2016; Fawcett and Waller, 2014) Economic, social, and environmental considerations (also referred to as ESG – Economic, Social, and Governance) are important to the concept of sustainability. The environmental side of Industry 4.0 has gotten more attention, whilst the social aspect has gotten less. The majority of Industry 4.0 studies have focused on the manufacturing sector while ignoring supply chain systems, necessitating additional study to close this gap. (Man and Strandhagen, 2017).

From the first to the second and third industrial revolutions, manufacturing has gone from mechanisation to electrification technology to computerization and digital manufacturing, resulting in Industry 4.0. Autonomous machines, advanced robotics, big data analytics (BDA), and the internet of things (IoT), to name a few, have all emerged as part of the fourth revolution. (Gunasekaran et al., 2016; Wamba et al., 2017).

Through autonomous administration, networked decentralised operations, and real-time information for all stakeholders, Industry 4.0 provides the incentive, tools, and influence for the digitization of the supply chain. To achieve the sustainability and long-term positive consequences of employing Industry 4.0 digital technologies, the supply chain process must be flexible, adaptable, cost-effective, and resilient. As a result, the necessary digital connection between the manufacturer, suppliers, and customers becomes seamless, and information flows freely. Ivanov (2018).

The following literature review themes emerged from the consulted article publications: Supply chain transformation, Technologies relevant to Industry 4.0, The use of big data in Industry 4.0 for Sustainable Supply Chain, Benefits and challenges of implementing Industry 4.0, Industry 4.0 enablers, The connection between Industry 4.0 and sustainable supply chains. These topics came from the literature review, which indicated areas for additional investigation in the current literature in the field of study. These themes also aid in addressing concerns and allowing for a better knowledge of areas where more research is required.

Literature Search Criteria

Industry 4.0, Supply Chain, Sustainability, Sustainable Supply Chain, Supply Chain Sustainability, Manufacturing were used in the literature search for this study. ProQuest, Science Direct, IEEE Explore, Scopus, Wiley Online Library (WOL), Google Scholar, and Web of Science were among the databases and sources consulted. The keywords were used alone and in combination to conduct the literature search. Tables 1.1 and figure 1.1 show the results of the various searches.

Table 1.1 shows the number of results retrieved from ProQuest, Science Direct, IEEE Explore, Scopus, Wiley Online Library (WOL), Google Scholar, and Web of Science on December 31, 2021, using PICO key search phrases and Boolean operators.

S/N	Search Terms	ProQuest	Science Direct	IEEE Explore	Scopus	WOL	Google Scholar	Web of Science	Total
S1	Industry 4.0	1,413	364	107	395	168	9,420	396	11,867
S2	Evaluation of Industry 4.0	666	304	4	39	129	4,880	35	6,057
S3	Supply Chain	335,226	195,668	5,271	49,970	67,291	854,000	58,337	1,565,763
S4	Sustainable Supply Management (SSM	5,713	107,527	1,109	1,680	46,528	576,000	15,847	754,404
S5	Sustainable OR Sustainability	1,061,149	554,177	22,186	419,937	259,704	1,500,000	552,751	4,369,904
S6	Sustainable Supply Chain (SSC)	1,123	572	441	9,989	24,894	319,000	10,751	366,770
S7	Supply Chain Sustainability (SCS)	1,133	1,159	212	256,981	24,887	192,000	9,954	486,326
S8	S2 AND S3 AND S6	128	65	25	157	10	1,740	2	2,127
S9	S2 AND S4 AND S7	107	67	18	131	10	1,440	2	1,775
S10	S8 AND S9	136	158	18	131	15	255	2	715

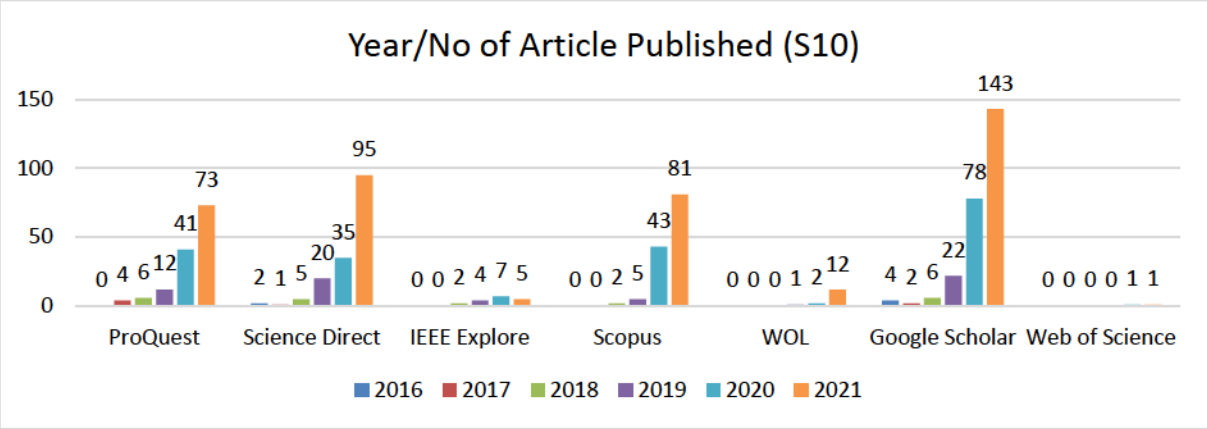

Figure 1.1 shows the number of relevant articles published per year from 2016 to 2021 within the area of research.

Inclusion Criteria:

- ☐ Date: articles/ peer-reviewed journals published between 2016 and 2021, this date range was chosen because the literature search reveals a very small number of relevant articles in the area of research interest were published prior to 2016.
- ☐ Language: studies in English. Type of studies: Quantitative and Qualitative research
- ☐ Study Design: Interpretive/case study/Discourse analysis
- ☐ Context: studies/research relating to Industry 4.0, its implementation and impact on supply chain sustainability

Measurement: Studies associated with the impact of Industry 4.0 on supply chain sustainability, studies that highlight the benefits of Industry 4.0, studies that examine Industry 4.0 implementation challenges, studies relating to Industry 4.0 and manufacturing

Outcome: Evaluation of Industry 4.0 impacts on supply chain sustainability (S10 in Table 1.1)

Exclusion Criteria: Studies not related to Industry 4.0, Studies in non-manufacturing sectors, Studies that exclude sustainability, especially in the Supply Chain Management (SCM).

Documentation of Search: the search process is documented in Table 1.1

Literature Search Outcomes

After applying the inclusion and exclusion criteria to the final search results, a total of 148 journals were found out of the original 3,902. The abstracts of these 148 journals were then studied to assess how well they fit into the research topic. This increased scrutiny resulted in the removal of more articles for evaluation, and at the end of the process, 63 journals were deemed suitable for the literature review.

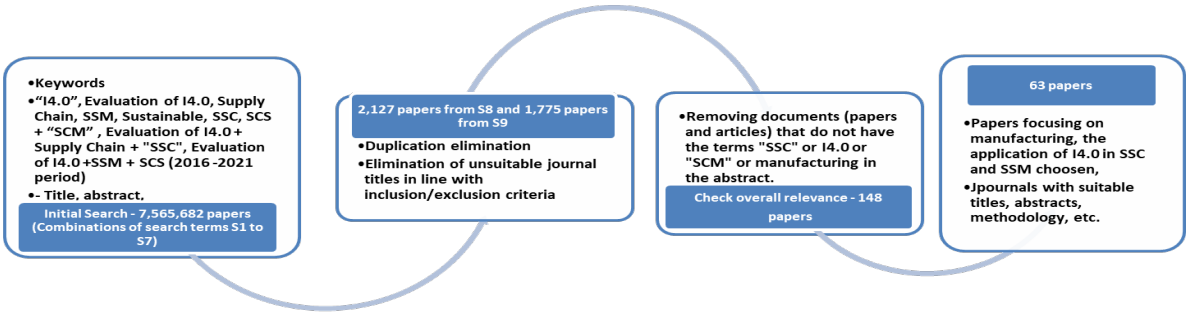

Figure 1.2 Literature search results showing stages of literature selection for review

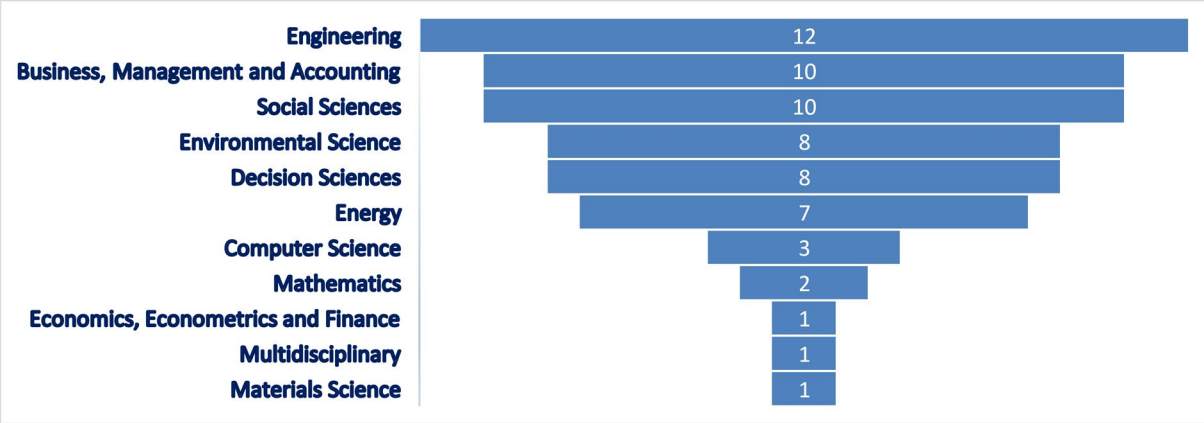

Figure 1.3 Contributions from different subject areas

Sustainable Supply Chains

Few practical attempts have been done in the past in the context of supply chain sustainability (SCS) and Industry 4.0, as scholars have focused on the importance of incorporating sustainability into supply chains. As a result, many efforts were focused on Industry 4.0 technology rather than the whole concept of Industry 4.0. (Duarte and Cruz-Machado, 2017). A conceptual model was suggested, however, that incorporates Industry 4.0 concepts into green and lean supply chains. Supply chain is viewed as an extension of Industry 4.0, with value chain creation activities involving retailers, wholesalers, vendors, end clients, and producers, with the goal of synchronising demand and supply (Stefanou, 1999). Furthermore, as a fundamental component of a sustainable supply chain 4.0, businesses should accomplish closed loop life cycles for products. Bag et al, (2018) analysed the literature in the context of sustainable and Industry 4.0 supply chains, established a reference framework, and identified 13 enablers that influenced supply chain sustainability (SCS), which are:; Government support, third-party audits, corporate governance, vertical integration, horizontal integration, human capital focus, information

transparency, standardisation and reference architecture, management commitment, change management, improved IT security and standards, law and policy regarding employment, and support of research institutes and universities. Ivanov (2018) redefined sustainability, I.40, and self-adaptation as drivers for supply chain structural dynamics and resilience. This author believed that supply chain resilience and sustainability were linked, so he looked into the factors that influence the structural design of resilient supply networks in order to limit the ripple effect and increase sustainability. As a result, Industry 4.0 plays a crucial role in supply chain structural dynamics, as it allows for flexible customised production at the expense of mass production.

Industry 4.0 Technologies

The goal of Industry 4.0 is to improve digitization and, as a result, horizontal (via functional parts) and vertical (through the full value chain, from product acquisition to production, distribution, and customer service) business process integration. Real-time access to all data-related activities, inbound/outbound logistics, market requirements, and product–customer connections will be accessible along these lines.

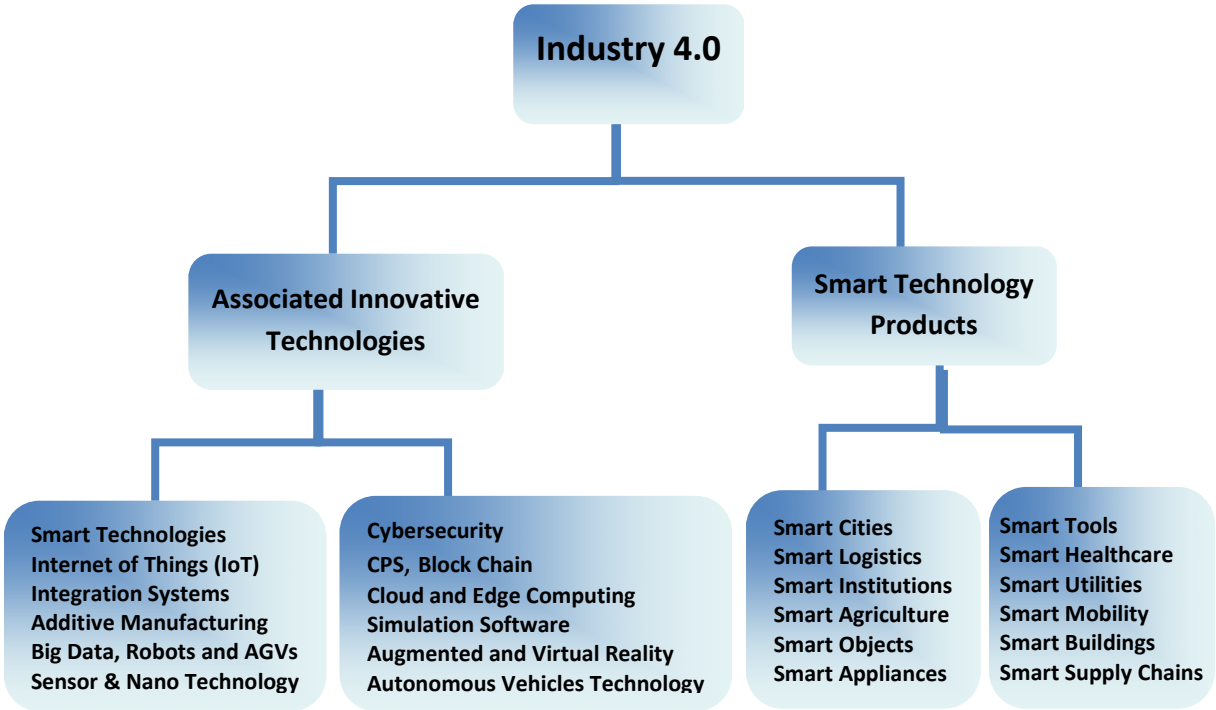

Figure 1.4: Illustration of Industry 4.0 Technologies

Benefits and challenges of implementing Industry 4.0

Information and communication technologies (ICTs) have changed our lives tremendously since the 1980s (Birkel et al. 2019). Interpersonal communication is expanding within the context of cyber-physical production systems (CPPSs) towards unprecedented human-to-machine linkage as well as machine-to-machine direct connections without human intervention. The Industry 4.0 revolution is expected to result in significant changes in industrialization growth, which will have an impact on current industrial sustainability systems and may also result in additional consequences such as increased resource consumption, climate change, and global warming concerns (Mgbemene et al, 2016).

To improve information visibility at various stages of the product life cycle, SC members must collaborate and cooperate. Advances in ICT give up significant opportunities for supply chain intelligence and autonomy, establishing the framework for Industry 4.0 supply chains (SCs). The evaluation and selection of sustainable suppliers has been extensively highlighted as a vital SC decision in the prior literature (Khan et al, 2018). This process has yet to be completed inside Industry 4.0 SCs, where connectivity, real-time information transparency, technical assistance, and decentralisation of members of a physical system

(i.e., supply chain members) are significant design features. In these chains, the benefits of Industry 4.0 include organisations becoming completely digitally connected, minimising carbon footprints, and assisting decision-makers in making dynamic real-time decisions. In order to be competitive, sustainable, and robust in the long run, supply chains will need to be flexible, sensitive, cost-effective, and strong (Ivanov, 2018). The ability to add key performance indicators (KPIs) to monitor sustainability in a virtual learning environment is equally crucial in the Industry 4.0 setting (Chaim et al. 2018).

Connecting Industry 4.0 And Sustainable Supply Chains

Industry 4.0 has been proved to bring a variety of commercial benefits, including operational and value chain optimization (Strange and Zucchella, 2017). Volkswagen, Daimler, and BMW are among the German firms that have adopted Industry 4.0, while China's government just launched the "Made in China 2025" project, which intends to improve manufacturing in China by increasing digitalization. The US, France, the UK, Japan, and Singapore have all taken similar actions. As indicated by the expanding number of studies that relate industry 4.0 and sustainability, one of the cornerstones of smart factories is sustainability (Khan et al. 2021). This, in turn, aims to improve economic and environmental aspects while also highlighting concerns, viewpoints, and research recommendations for future research in the field of industry 4.0 and sustainability.

In terms of rising resource consumption, global warming, and climate change issues, Industry 4.0 could accelerate industrialisation and jeopardise the viability of existing manufacturing supply networks. As a result, adopting management approaches for industrial supply chains that incorporate sustainability and address the digital transformation toward Industry 4.0 is important for the sustainable supply chain 4.0 research. Qualities like sustainable products/operations, lean processes, and IT must be implemented into industrial supply chains to achieve sustainability. Industry 4.0 has been demonstrated in a sustainable supply chain through the use of continuous manufacturing processes and 3D printing technologies, as well as CPS, IoT, big data, and process analytical tools. They improve productivity and flexibility by allowing mass customization of products and reducing material waste throughout product life cycles, resulting in more environmentally and energy efficient manufacturing. As a result, supply chain sustainability must examine how suppliers are managed, supply network design, and the development and delivery of sustainable products, among other things.

Industry 4.0 And Supply Chain Sustainability Enablers

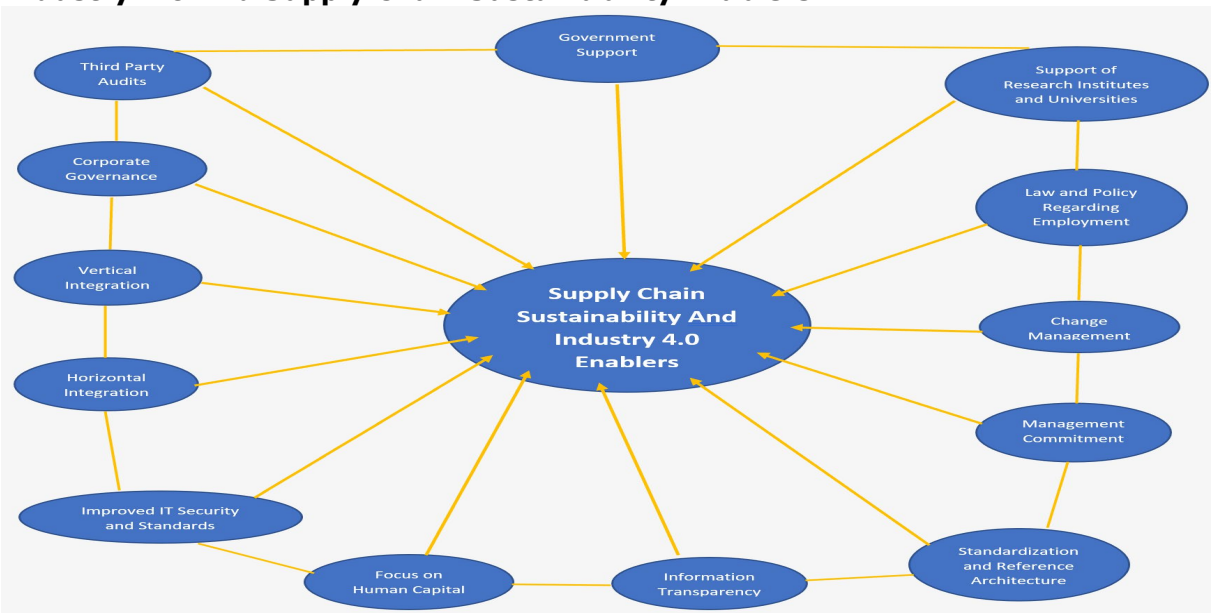

Figure 1.5: Illustration of Supply Chain Sustainability (And Industry 4.0) Enablers (Adapted from Bag, 2018)

The following Industry 4.0 enablers, as depicted in Figure 1.9, were derived from previous debates and research, and lead to supply chain sustainability: Government help, Assistance from research institutes and universities, Law and policy regarding employment, Improved IT security and standards, Information transparency**,** Management commitment, focus on human capital, Horizontal integration, Vertical integration, Corporate governance, Change management, Third-party audits, Standardization and reference architecture (Sung, 2018). Despite the use of terms like industrial sustainability, clean production, green manufacturing, eco-manufacturing, and Clean Engineering in the literature, the term Sustainable Supply Management (SSM) is the most appropriate for developing and addressing the social, environmental, and economic aspects of sustainability. SSM is closely associated with Industry 4.0, which promotes organisational sustainability as one of its cornerstones. Industry 4.0 has a lot of potential for the development of sustainability because of its industrial flexibility and the ability to utilise renewable energy sources.

The Use Of Big Data In Industry 4.0 For Sustainable Supply Chain (SSC)

Big Data (BD) has become a valuable asset for businesses due to the rapid advancement of information and communication technologies (ICTs). Volume, variety, velocity, authenticity, and value have all been used to describe BD (Wamba et al., 2015; Assunço et al., 2015; Emani et al., 2015). Big Data Analytics (BDA) entails the application of advanced analytics techniques to extract useful information from large amounts of data, making data-driven decision-making easier (Tsai et al., 2015). Sensors, barcodes, RFID (Radio Frequency Identification), IoT, and other technologies have been widely used in supply chain management (SCM) to integrate and coordinate each chain linkage. As a result, it is no surprise that BDA has transformed supply chains, and its use in SCM has been documented in a number of special issues (Wamba et al., 2015; Gunasekaran et al., 2016; Wamba et al., 2017). BDA is recognized as an emerging supply chain game changer (Fawcett and Waller, 2014; Dubey et al., 2016), allowing firms to survive in today's fast-paced, ever-changing market.

Low adoption, routinization, and absorption of BDA by organisations and supply chain partners and data security vulnerabilities are the key causes for low uptake (Fawcett and Waller, 2014; Dubey et al., 2016). Despite the high hopes for BDA adoption to improve SC performance, just 17% of organisations have used it in one or more supply chain (SC) operations, according to a recent survey (Wang et al., 2016). As a result, Industry 4.0 reveals that it is a manufacturing strategy centred on large economic, environmental, and social benefits, that are the three pillars of sustainability.

SCM Driven By Big Data Analytics

The implementation of BDA in addressing various supply chain difficulties is being highlighted increasingly in terms of the several benefits it offers (Babiceanu and Seker, 2016). Because of the rising deployment of various state-of-the-art technologies such as Cyber Physical System (CPS) in Industry 4.0, the logistics/transportation, manufacturing, and warehousing sectors, in particular, are key suppliers of prescriptive analytics (Wang et al., 2016). Prescriptive analytics, on the other hand, are rarely explored in demand management and procurement, notably for demand forecasting and spotting sourcing issues (Ghedini Ralha and Sarmento Silva, 2012).

Optimization is the favoured technique for prescriptive analytics, particularly in the logistics and transportation domains. As previously noted, real-time route planning based on streamlining data has received very little attention in the logistics/transportation literature. However, the use of modelling and simulation to build real-time production control systems based on context-aware data provided by tracking devices such as RFID looks to be highly advanced in the industrial area (Babiceanu and Seker, 2016; Kumar et al., 2016). Transportation controllers and warehouse operators, as suggested in the research, might employ a similar modelling and simulation strategy to solve real-time routing challenges (Wang et al., 2016).

Conclusion

Industry 4.0 ushers in a new era of supply chain revolution via digitization and smart technology. Companies all around the world are gradually adopting such enabling technologies in order to survive in this chaotic and complex environment. Industry 4.0, on the other hand, has a negative impact on a company's supply chain during the pre- and post-implementation phases. Significant problems include job losses, low employee morale, a lack of Industry 4.0 understanding among network vendors, insufficient funds for technical improvements, insufficient specialist suppliers suitable for Industry 4.0 projects, and a lack of IT security policies and processes. These concerns might cause supply chain disruptions throughout the pre- and post-implementation stages of Industry 4.0 adoption. Sung, 2018; Bag et al, 2018).

By managing the many enablers discussed in this article, an organisation can overcome such challenges. The Industry 4.0 project promotes collaboration in the supply chain network between customers and suppliers in order to digitally connect all businesses for long-term growth. Industry 4.0 offers several benefits, including the integration and implementation of smart manufacturing into production processes. Despite these advantages, certain negative consequences might have a significant impact on supply chain sustainability. Industry 4.0 and supply chain sustainability are understudied, according to this survey of recent research and emergent issues. The discovery of the primary enablers for Industry 4.0 and supply chain sustainability has also contributed to the knowledge base.

REFERENCES

1. Assunção, M.D., Calheiros, R.N., Bianchi, S., Netto, M. a. S. and Buyya, R. (2015), "Big Data computing and clouds: Trends and future directions", Journal of Parallel and Distributed Computing, Elsevier Inc., Vol. 79–80, pp. 3–15.
2. Babiceanu, R.F. and Seker, R. (2016), Big Data and virtualization for manufacturing cyberphysical systems: A survey of the current status and future outlook, Computers in Industry, Elsevier B.V., Vol. 81, pp. 128–137.
3. Bag, S.; Telukdarie, A.; Pretorius, J.; Gupta, S. (2018) Industry 4.0 and supply chain sustainability: Framework and future research directions. Benchmarking Int. J.
4. Birkel, H.; Veile, J.W.; Müller, J.M.; Hartmann, E.; Voigt, K.-I. (2019) Development of a Risk Framework for Industry 4.0 in the Context of Sustainability for Established Manufacturers. Sustainability 2019, 11, 384.
5. Chaim, O.; Muschard, B.; Cazarini, E.; Rozenfeld, H. Insertion of sustainability performance indicators in an industry 4.0 virtual learning environment. Procedia Manuf. 2018, 21, 446–453
6. Chien, C., Diaz, A.C. and Lan, Y. (2014), "A data mining approach for analyzing semiconductor MES and FDC data to enhance overall usage effectiveness (OUE)", International Journal of Computational Intelligence Systems, Vol. 7 No. sup2, pp. 52–65.
7. Duarte, S.; Cruz-Machado, V. Exploring Linkages between Lean and Green Supply Chain and the Industry 4.0. Available online: https://link.springer.com/chapter/10.1007/978-3-319-59280-0_103 (accessed on 28 June 2021).
8. Emani, C.K., Cullot, N. and Nicolle, C. (2015), "Understandable Big Data: A survey", Computer Science Review, Elsevier Inc., Vol. 17, pp. 70–81.
9. Ghedini Ralha, C. and Sarmento Silva, C.V. (2012), "A multi-agent data mining system for cartel detection in Brazilian government procurement", Expert Systems with Applications, Vol. 39 No. 14, pp. 11642–11656.
10. Gunasekaran, A., Kumar Tiwari, M., Dubey, R., & Fosso Wamba, S. (2016). "Big data and predictive analytics applications in supply chain management". Computers and Industrial Engineering, 101(C), 525-527.st-ahh.
11. Ivanov, D. Structural Dynamics and Resilience in Supply Chain Risk Management; International Series in Operations Research & Management Science; Springer

International Publishing: Cham, Switzerland, 2018; Volume 265, ISBN 978-3-319-69304-0.
12. Khan, Iqra Sadaf, et al. (2021). Industry 4.0 and Sustainable Development: A Systematic Mapping of Triple Bottom Line, Circular Economy and Sustainable Business Models Perspectives. Journal of Cleaner Production, vol. 297, p. 126655, 10.1016/j.jclepro.126655. Accessed 20 Mar. 2021.
13. Khan, Sharfuddin Ahmed, et al. (2018). Supplier Sustainability Performance Evaluation and Selection: A Framework and Methodology. Journal of Cleaner Production, vol. 205, pp. 964–979, 10.1016/j.jclepro.2018.09.144.
14. Lei, N. and Moon, S.K. (2015), "A Decision Support System for market-driven product positioning and design", Decision Support Systems, Elsevier B.V., Vol. 69, pp. 82–91.
15. Liao, Y., Deschamps, F., Loures, E.D.F.R. and Ramos, L.F.P. (2017), "Past, present and future of Industry 4.0: a systematic literature review and research agenda proposal", International Journal of Production Research, Vol. 55 No. 12, pp. 3609-3629, doi: 10.1080/00207543.2017.1308576.
16. Man, Johannes Cornelis de, and Jan Ola Strandhagen. "An Industry 4.0 Research Agenda for Sustainable Business Models." Procedia CIRP, vol. 63, 2017, pp. 721–726, 10.1016/j.procir.2017.03.315.
17. Manavalan, E.; Jayakrishna, K. A review of Internet of Things (IoT) embedded sustainable supply chain for industry 4.0 requirements. Comput. Ind. Eng. 2019, 127, 925–953.
18. Mgbemene, C.A; Nnaji, C. C and Nwozor C, (2016). Industrialization and its Backlash: Focus on Climate Change and its Consequences. Journal of Environmental Science and Technology, 9: 301-316.
19. Schoenherr, T., & Speier Pero, C. (2015. "Data science, predictive analytics, and big data in supply chain management: Current state and future potential". Journal of Business Logistics, 36(1), 120-132.
20. Stefanou, C. Supply chain management (SCM) and organizational key factors for successful implementation of enterprise resource planning (ERP) systems. AMCIS 1999 Proc. 1999, 276, 800–802.
21. Stefanovic, N. (2015), "Collaborative predictive business intelligence model for spare parts inventory replenishment", Computer Science and Information Systems, Vol. 12 No. 3, pp. 911–930.
22. Strange, R. and Zucchella, A. (2017), "Industry 4.0, global value chains and international business", Multinational Business Review, Vol. 25 No. 3, pp. 174-184.
23. Sung, T.K. (2018), "Industry 4.0: a Korea perspective", Technological Forecasting and Social Change, Vol. 132, July, pp. 40-45, doi: 10.1016/j.techfore.2017.11.005.
24. Tan, M. and Lee, W. (2015), "Evaluation and Improvement of Procurement Process with Data Analytics", International Journal of Advanced Computer Science and Applications, Vol. 6 No. 8, pp. 70–80.
25. Waller, M.A. and Fawcett, S.E. (2014). Click Here to Print a Maker Movement Supply Chain: How Invention and Entrepreneurship Will Disrupt Supply Chain Design. Journal of Business Logistics, 35(2), pp.99–102.
26. Wamba, S. F., Ngai, E.W.T., Riggins, F. and Akter, S. (2017), " Transforming operations and production management using big data and business analytics: future research directions", International Journal of Operations & Production Management, 37(1), pp. 2- 9.
27. Wamba, S.F., Akter, S., Coltman, T. and Ngai, E.W.T. (2015), "Information technology-enabled supply chain management", Production Planning & Control, 26(12), pp. 933–944.
28. Wang, G., Gunasekaran, A., Ngai, E.W.T. and Papadopoulos, T. (2016), "Big data analytics in logistics and supply chain management: Certain investigations for research and applications", International Journal of Production Economics, Elsevier, Vol. 176, pp. 98–110.
29. Wang, J., Zhang, L., Duan, L. and Gao, R.X. (2015), "A new paradigm of cloud-based predictive maintenance for intelligent manufacturing", Journal of Intelligent Manufacturing, Vol. March, pp. 1–13.