Study of disruptive trends in digitalization in the era of Industry 4.0

Nilakantha Kuila, Ajinkya Patki, Yash Ozarkar, Yashraj Gite

Abstract— With the fourth Industrial Revolution transforming the ways of businesses, there has been an eminent contribution of various emerging technologies that support the transformational journey. Additive Manufacturing, Big Data Analytics, Robotics and Automation, Augmented reality, UAVs have further added to the betterment of the industrialization. Various economies and industries have had their share of impact due to these technologies and have to respond differently to adapt these to gain a competitive advantage in the market.

Index Terms—Industry 4.0, Additive manufacturing, Robotics and Automation, Supply Chain, Big Data Analytics

1 Introduction

In 2011, a consortium of business, political, and academic leaders coined the word "Industry 4.0," with the aim of improving the productivity of Germany's manufacturing industry **(Kagermann & Wahlster, 2013**). The use of intelligent technology such as robots, artificial intelligence, self-learning devices, crewless aerial vehicles, big data, and the internet of things (IoT) has shifted dramatically as a result of "Industry 4.0." **(DHL, 2016**). The rise in industrial challenges compelled market leaders to look outside the box and embrace cutting-edge production innovations in order to compete in today's dynamic business climate **(PWC, 2016**). The supply chain in every industry has become increasingly important as it has grown significantly **(DHL,2016**). As a result, multiple methods must be adopted to support the supply chain. To begin, there are problems with supply chain visibility. It is critical to make supply chain processes more transparent so that clients and consumers are aware of what is going on in the industry (**Deloitte, 2015**). The latest epidemic of pollution linked to Roman salad in the United States is an outstanding indication of the supply chain's lack of exposure **(Ali & Ali, 2017**). Critics claim that if traceable and trackable services had been available, this problem might have been avoided. Another factor is the ever-increasing population, which places pressure on manufacturers to meet the market demand while retaining product quality and service (**Sagar & Singh, 2012).** To address these problems, state-of-the-art and fast-paced supply chain facilities must be implemented.

2 Research Objectives

The aim of research goals is to operationalize research issues, which is an important step in turning the questions into a research project (**Saunders et al., 2012).** The study's research priorities are closely related to the research issues which express "how" the research will be conducted. This study context's research priorities are as follows:

1. To recognise the core obstacles that the global manufacturing sector is currently facing in managing their sourcing and supply chain policies in light of Industry 4.0.
2. From an Industry 4.0 view, explore the emerging technologies that Manufacturing Industries can leverage to gain competitive advantage
3. To evaluate how the global manufacturing sector should minimize the effect of emerging technologies on their procurement and supply chain strategy from an Industry 4.0 perspective.

3 Industry 4.0

It can be claimed that the facets of business 4.0 and digitalisation can be used to analyze important causes of disruptive developments. Digitalisation, on the other hand, has been identified as a major disruptive factor that has been studied in a variety of sectors, including manufacturing, pharmaceutical, banking, and FMCG. Manufacturing companies all over the world are dealing with a slew of issues that could jeopardize their procurement and supply chain strategies. A thorough examination of emerging patterns affecting logistics, sourcing, and supply chains in the next five to ten years will yield predictable project outcomes.

Big Data provides creative quantity software to assist companies in identifying patterns, gaining new ideas, personalizing services, improving policy-making, forecasting emerging events, and gaining comparative advantages (**Hofmann et al., 2019)**. Around 2021 and 2026, supply chain survey respondents predicted that big data (51 percent) and data analytics (44 percent) will have a huge effect on their policies, with 35 percent predicting the most substantial potential change from big data in predictive demand modeling (**JLL, 2016**). The Internet of Things, which digitizes millions of artifacts and processes, is often tied to big data (**Deloitte, 2014**). As a result, Big Data will have a significant impact in the coming years, accelerating the expected demand outcome and logistics transformation (**DHL,2016a**). According to **Genpact (2014**), in the logistics and supply chain industries, companies expect to use Big data to increase visibility, flexibility, and integration of global supply chain and logistical networks in order to effectively manage market volatility and cost variability.

The willingness of supply chain members to share data online is a significant roadblock to big data adoption (**SMMT, 2017a**). In an industrial management survey, 75% of respondents believed that digital business practices expose them to increased data security and morale threats (**Accenture, 2017**). The cost of required IT integration investments carries a financial risk (**DHL, 2016a; SMMT, 2017a**). According to the SMMT survey,

70% of respondents planned to spend heavily in internal IT integration with their supply chain partners and 53% in external integration (**SMMT, 2017a**). Despite this, small businesses have defined investment finance as an issue. Furthermore, some businesses are cautious in their approach to IT integration between suppliers and customers because they lack the courage to embrace expanded data sharing (**SMMT, 2017a**). Companies will place a premium on data processing and data infrastructure skills, resulting in a scarcity of technological resources and capacity to formulate and implement technical strategies. Employers must also ensure that their employers can compete using Big Data **(PricewaterhouseCoopers, 2016a**). Big Data enables companies to center decision-making on relationships, resulting in decisions that are focused on cause-driven understanding in our society (**Fawcett and Waller, 2014**). The capacity of computational human data to lead to larger and more nuanced perspectives will minimize this weakness (**Fawcett & Waller, 2014).**

4 ADDITIVE MANUFACTURING

According to **Khan and Mohr (2015**), 3D printing can be used to create highly customized, complex, yet low-volume objects. Different people have different ideas about whether the supply chain can be widely implemented.

According to AT Kearney, a consulting company, 3D printing would be less necessary than other disruptive innovation in the near term (**AT Kearney, 2015**). However, according to a survey by Ernst and Young, 38 percent of companies expect to use 3D printing in their production series over the next five years (**Ernst and Young, 2020**), and this trend will continue for at least another five years until they are widely available. Between now and 2025, McKinsey estimates that the 3D printing market will grow from USD 180 billion to USD 490 billion (**McKinsey 2013; DHL 2016b**). Despite the fact that the use of 3-D printing has increased over time, there are still a slew of problems that need to be addressed. In 2020, Stratasys, a consulting company, published a study and found four major obstacles that manufacturing companies are currently facing.

1. Equipment Expense
2. Manufacturing Cost
3. Postprocessing Demand
4. Limited Materials are the four major difficulties inferred. The same survey, on the other hand, mentions the possible advantages of 3-D printing. They (**Stratasys, 2020**) discovered the following as the most frequent responses: interface complexity (33 percent), speed (26 percent), and customisation capability (13 percent) (10 percent). The freedom of design complexity (28%) and speed (25%) were especially important to respondents from the aerospace industry. Other industries, such as medical (25 percent) and consumer goods, continued to benefit greatly from pace (32 percent). Security concerns are a major point of contention in the 3D printing debate (Khan and Mohr, 2015). Arms can be made, and legal checks relating to normal supply chains can be avoided (Khan and Mohr 2015). **Ben-Ner and Siemsen (2017**) also believe that the production of fake components will increase as anyone with access to CAD design and a printer will be able to produce parts. With 3D printers, the design, production, and distribution processes may be combined, potentially creating a hole in the purchasing process (Khan and Mohr, 2015). As a result of the current legal system's failure to recognize the copying of physical objects as to who is responsible for defective goods or the manufacture of harmful products, liability issues which arise (DHL, 2016b).

5 ROBOTICS

Robotics will have a significant impact on logistics and supply chain management, with a period of less than five years to comprehend them (**DHL, 2016a**). Around 2010 and 2014, annual global sales of industrial robots increased by 17%, with 2.3 million units estimated to be sold (**AT Kearney, 2015**). Three key forces are behind this exponential trend: the e-commerce revolution, a decrease in the amount of workers employed, and increased investment on robotic science (**DHL, 2016c**). The workforce for online retail in Europe is expected to rise by 10% a year, as on-line retail needs more labor per item sold than brick-and-mortar retail (**Forrester, 2015; DHL, 2016c**). It's seen in the 700 percent increase in the number of warehouse staff since 2000. (**Galluzzo, 2015**). At the same time, the number of logistics workers in the Western world is decreasing due to demographic decline, and Germany is expected to face a ten-million-person labor shortage (**Strack et al., 2014; Chung, 2016; DHL, 2016c**). However, the current pace of e-commerce growth and labor market demands in logistics cannot be sustained **(Galluzzo, 2015**). Fortunately, the amount of funding available for robotics has been important, reducing the detrimental effects of labor shortages (DHL, 2016c). This funding has been confirmed by government stimulus programs, venture capital investments, and major players such as Google and Amazon (DHL, 2016c). Furthermore, advances in Artificial Intelligence (AI) have resulted in more advanced robotics that can perform high-level movement and sequence transformation tasks without the need for human intervention (AT Kearney, 2015). Automatic engineering, according to Gartner Inc. and Oxford University analysts, will replace a third of the workforce in a decade (Galluzzo, 2015). The use of robotics poses a danger to public safety (Galluzzo, 2015). Traditional industry robots are usually kept in cages which can be turned off if their operators cannot see the world around them in the office. Galluzzo (2015) and DHL (2015) are two examples of this. Legal limitations are still a major concern when it comes to robot-human collaboration (DHL, 2016c). As they train to become more autonomous, robots can be considered less under the control of human owners in terms of liability. Where a lawful individual bears the brunt of a consequence, current laws on liability are called into question (**European Commission 2016b**). There will also be regulatory and legislative issues to contend with. Since robots are capable of doing manual and repetitive labor and eliminating blue-collar workers, governments, unions, and society as a whole would weigh an optimal level of automation against worker safety (DHL, 2015). The time it takes for employees to recognize robots as peers and create a mechanism for human-robot communications, teamwork, and collaboration will also be a management challenge (DHL ,2015).

Often, as new white-collar jobs are created to conform with robotics, there is a risk of talent shortages, but no talent pool with the necessary skills and expertise exists to fill them (World Economic Forum 2016). Capital risks (DHL, 2016c) will also be a problem. SMEs will fight to justify the strong initial robotics investment (DHL, 2016a).

7 INTERNET OF THINGS

Cyber-physical devices are considered as the foundational concept of the internet of things, and they are transforming physical objects into a variety of smart goods (**Li and Li, 2017**). As a result, the principle between vertical integration of content and information flows serves as a pillar in the field of digitalisation. In addition, IoT has allowed cloud computing, Big Data Analytics, mobile, and digital social networks to work together (**Ernst and Young, 2016**). Many of these various ideas have been considered parallel technologies that are shaping the modern paradigm of digitalisation from a theoretical standpoint (**Klötzer and Pflaum, 2017**). Supply chain convergence has played a major role in the development of the food supply chain by including integrated processes as well as artificial intelligence and big data analytics, which are further increasing supply chain productivity (**Kittipanya-Ngam and Tan, 2020**). In this current situation, the Internet of Things technology plays a key role in the organization's future market (Educba, 2020). Technology has a major impact on both ordinary citizens and practitioners. The Internet of Things offers several benefits and bonuses that would benefit both businesses and the general public (**Educba, 2020**).
IoT can generate and process massive amounts of data. Transportation protection is generally absent in IoT networks, as are unsecure Web interfaces, device security, and inadequate permissions. As a result, data centers are said to have issues with security, user confidentiality, data access, and server infrastructure (**Gartner, 2014).** The benchmarks are yet to be developed. IoT labs and other academic institutions predict that IoT technology will not advance until 2020, with widespread adoption not needed until 2030. Legal appeals can still be filed before the situation is resolved (**Ruan et al., 2012).**

8 CONCLUSION

The core difficulties that the manufacturing sector faces in handling procurement and supply chain policies in the light of Industry 4.0 were investigated in this report. The report further looked at the new benefits that the multinational manufacturing industry should take advantage of when it comes to sourcing and supply chain management. Furthermore, within the framework of Industry 4.0, this research sought to analyze and appraise how the global production sector mitigates the impact of emerging developments in sourcing and supply chain strategies. 3D printing, blockchain technology, and digitalisation in different industries such as manufacturing, pharmaceutical, retail, and FMCG are the key disorderly trends found in the form of industry 4.0. Furthermore, it can be inferred that the word digitisation refers to a set of mega-trends and innovations that are forming a new type of supply chain, the modern supply chain, in the present and future. Since it has changed markets, their operational systems, and their interactions with all stakeholders, digitalisation has been a major step in the industrialisation of countries. To achieve a comparative edge in their respective markets, modern industrial companies employ a variety of innovations and novel operating methods. Despite the high cost of modern technology, it provides reliability and cost savings, so many businesses are quickly embracing it to improve their business success. It's important to remember that adopting Industry 4.0 is a major organizational transition, so change management is essential for reaping the benefits of emerging technology and inventions. Manufacturing companies should strive for decentralized decision-making and a flat hierarchy in order to improve change management and organizational structure agility (**Soosay and Kannusamy, 2018**). Researchers have discovered that creating interdisciplinary project teams is critical for spinning off business divisions and developing them into entrepreneurial units. The teams should have the experience and skills to integrate technologies while also providing direction and training to other teams such as finance, customer care, and supply chain management (**Holmström et al., 2016**).

Further research is aimed at a deep dive literature review of academic articles and identification of literature gaps even further.

REFERENCES

Ali Z, Sun H, Ali M. The impact of managerial and adaptive capabilities to stimulate organisational innovation in SMEs: A complementary PLSSEM approach. Sustainability. 2017;9(12):2157

Deloitte, 2015. Industry 4.0: Challenges and Solutions for the digital transformation and use of exponential technologies.

Ernst and Young (2016a) The upside of disruption. Available at: http://www.ey.com/Publication/vwLUAssets/EY-the-upside-of-disruption/$FILE/EYthe-upside-of-disruption.pdf (Accessed: 2nd June 2020).

Ezell, S., 2018. Why manufacturing digitalisation matters and how countries are supporting it. Information Technology & Innovation Foundation.

Hofmann, E., Sternberg, H., Chen, H., Pflaum, A. and Prockl, G., 2019. Supply chain management and Industry 4.0: conducting research in the digital age. International Journal of Physical Distribution & Logistics Management.

Holmström, J., Holweg, M., Khajavi, S.H. and Partanen, J., 2016. The direct digital manufacturing (r) evolution: definition of a research agenda. Operations Management Research, 9(1-2), pp.1-10.

Kagermann, H. & Wahlster, W., 2013. Recommendations for implementing the strategic initiative INDUSTRIE 4.0,

s.l.: ACATECH.

Kittipanya-Ngam, P. and Tan, K.H., 2020. A framework for food supply chain digitalisation: lessons from Thailand. Production Planning & Control, 31(2-3), pp.158-172.

Klötzer, C. and Pflaum, A., 2017. Toward the development of a maturity model for digitalisation within the manufacturing industry's supply chain.

M. Khan, X. Wu, X. Xu and W. Dou, "Big data challenges and opportunities in the hype of Industry 4.0," 2017 IEEE International Conference on Communications (ICC), Paris, 2017, pp. 1-6, doi: 10.1109/ICC.2017.7996801.

Rozkwitalska, M. and Slavik, J., 2017. Around learning and Industry 4.0 in management theory. Int. J. Contemp. Manage, 16(4), pp.185-206.

Saunders, M., Lewis, P. and Thornhill, A. (2012) Research Methods for Business Students. 6th edn. Harlow: Pearson Education.

Soosay, C. and Kannusamy, R., 2018. Scope for industry 4.0 in agri-food supply chain. In 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 (pp. 37-56). Berlin: epubli GmbH.

Varadarajan, K. (1966) 'Groups for which Moore spaces M (□□ □□' Ann. Math 2(84), pp.368-371.

WEB BASED REFERENCES

Arthur, C. & Shuhui, R. (2020). In China, robot delivery vehicles deployed to help with COVID-19 emergency. Available: https://www.unido.org/stories/china-robot-delivery-vehicles-deployed-help-covid-19-emergency. Last accessed 11th september 2020.

AT Kearney (2015) Digital Supply Chains: Increasingly Critical for Competitive Advantage', Available at: https://www.atkearney.co.uk/documents/10192/650043 3/Digital+Supply+Chains.pdf/a1 2fffe7-a022-4ab3-a37c-b4fb986088f0 (Accessed: 19 August 2020).

Deloitte (2014). https://www2.deloitte.com pdf. Available: https://www2.deloitte.com/content/dam/Deloitte/ch/Documents/manufacturing/ch-en-manufacturing-industry-4-0-24102014.pdf. Last accessed 21st Oct 2020.

DHL (2013) Big Detain Logistics, Germany: DHL, Available at: http://www.dhl.com/content/dam/downloads/g0/about_us/innovation/CSI_Studie_BIG_ DATA.pdf (Accessed 18 July 2020).

DHL (2014a) Unmanned Aerial Vehicles in Logistics, Germany: DHL, Available at: http://www.dhl.com/content/dam/downloads/g0/about_us/logistics_insights/dhl_trend_r eport_uav.pdf (Accessed 23 August 2020)

DHL (2014b) Self-Driving Vehicles in Logistics, Germany: DHL, Available at: http://www.dhl.com/content/dam/downloads/g0/about_us/logistics_insights/dhl_self_dri ving_vehicles.pdf (Accessed 25 October 2020).

DHL (2014c) Augmented Reality in Logistics Germany: DHL, Available at: http://www.dhl.com/content/dam/downloads/g0/about_us/logistics_insights/csi_augmen ted_reality_report_290414.pdf (Accessed 25 August 2020).

DHL (2015) Internet of Things in Logistics, Germany: DHL, Available at: http://www.dpdhl.com/content/dam/dpdhl/presse/pdf/2015/DHLTrendReport_Internet_ of_things.pdf (Accessed 18 July 2020).

DHL (2016a) Logistics Trend Radar, Germany: DHL, Available at: http://www.dhl.com/content/dam/downloads/g0/about_us/logistics_insights/dhl_logistic s_trend_radar_2016.pdf (Accessed 18 January 2021).

DHL (2016b) 3D Printing and the Future of Supply Chains, Germany: DHL, Available at: http://www.dhl.com/content/dam/downloads/g0/about_us/logistics_insights/dhl_trendre port_3dprinting.pdf (Accessed 22 January 2021).

DHL (2016c) Robotics in Logistics, Germany: DHL, Available at: http://www.dhl.com/content/dam/downloads/g0/about_us/logistics_insights/dhl_trendre port_robotics.pdf (Accessed 22nd october 2020).

EBSCOhost (2017) EBSCO Information Services, Available at: https://www.ebsco.com/products/research-databases/business-source-complete (Accessed: 25 July 2020).

Ernst and Young (2016a) The upside of disruption. Available at: http://www.ey.com/Publication/vwLUAssets/EY-the-upside-of-disruption/$FILE/EYthe-upside-of-

disruption.pdf (Accessed: 2nd November 2020).

Ernst and Young (2016a) The upside of disruption. Available at: http://www.ey.com/Publication/vwLUAssets/EY-the-upside-of-disruption/$FILE/EY- the-upside-of-disruption.pdf (Accessed: 9 November 2020).

Ernst and Young (2016b) How will 3D printing make your company the strongest link in the value chain?, Available at: http://www.ey.com/Publication/vwLUAssets/ey-global-3d-printing-report-2016-full-report/$FILE/ey-global-3d-printing-report-2016- full-report.pdf (Accessed: 22 December 2020).

Ernst and Young (2016c) Digital supply chain: it's all about that data, Available at: http://www.ey.com/Publication/vwLUAssets/Digital_supply_chain_-its_all_about_the_data/$FILE/EY-digital-supply-chain-its-all-about-that-data-final.pdf (Accessed: 22 July 2020).

MSRCOSMOS. (2017). Challenges of the Manufacturing Industry, & Big Data Analytics. Available: https://www.msrcosmos.com/blog/challenges-of-the-manufacturing-industry-big-data-analytics/. Last accessed 21st October 2020.

PWC (2016). Procurement 4.0: Are you ready for the digital revolution?. Available: https://www.strategyand.pwc.com/gx/en/insights/2016/procurement-4-digital-revolution.html. Last accessed 8th January 2021.

StartUS. (2020). Big Data & Analytics Start-ups Impacting Industry 4.0. Available: https://www.startus-insights.com/innovators-guide/5-top-big-data-analytics-startups-impacting-industry-4-0/. Last accessed 21st February 2021.

SMMT (2015) The Future of UK automotive manufacturing in 2025 and beyond', Available at: http://www.apcuk.co.uk/wp-content/uploads/2015/09/AutoAnalysis- report-the-future-of-UK-automotive-manufactuing-October-2015.pdf (Accessed 12 June 2020).

SMMT (2017a) The Digitalisation of the UK Automotive Industry, April 2017, Available at: https://www.smmt.co.uk/wp-content/uploads/sites/2/smmt_the-digitalisation-of-the- uk-auto-industry_kpmg-apr-2017.pdf (Accessed: 30 August 2020).

SMMT (2017b) Delivering UK Automotive Brexit Priorities: SMMT Discussion Paper, 7 July 2017, Available at: https://www.smmt.co.uk/wp-content/uploads/sites/2/SMMT- discussion-paper-Delivering-UK-automotive-Brexit-priorities_July-2017.pdf (Accessed: 11 August 2020).