IOSR Journal of Business and Management (IOSR-JBM)
e-ISSN:2278-487X, p-ISSN: 2319-7668. Volume 27, Issue 5. Ser. 1 (May. 2025), PP 27-36
www.iosrjournals.org

An Analysis Of The International Trade Transformation In The Era Of The Fourth Industrial Revolution (4IR)

Pradeep Kumar Gupta
Doctoral Student, Manipal Globalnxt University, Malaysia

Abstract
In the last decade, Fourth Industrial Revolution (4IR) drastically attracted researchers across the globe to evaluate its impact on global business. This research paper will analyze the key technologies in 4IR and its impact on the volume and structure of international trade. A systematic literature review concludes the theory that 4IR has created both positive and negative impacts on the volume and structure of international trade. Though the overall volume of global trade has increased in the era of Industry 4.0 due to reduced trading costs and more efficient manufacturing processes, however for a few goods it has declined due to distributed manufacturing and conversion of goods into digital form. The structure of international trade has also changed due to the breakthrough technologies that transformed the global supply chain processes.

Keywords: *Industrial revolution 4.0; IR 4.0; Fourth Industrial Revolution; 4IR; Industry 4.0; International trade; Global trade; Global Economy; Breakthrough technologies*

Date of Submission: 22-04-2025 Date of Acceptance: 02-05-2025

I. Objective

The world is becoming highly interconnected. As an increased number of business conglomerates explore international expansion opportunities, the need to adapt to a global market is the necessity of the time. While technology has always been a boon to international business, the fourth industrial revolution (4IR) has dramatically transformed the face of international trade. The current study has been conducted with the objective to examine the key innovations and technologies from the Fourth Industrial Revolution and its impact on international trade. The key focus was to understand the positive impacts 4IR has created on the volume and structure of international trade. The negative impact and challenges due to 4IR have not been overlooked as well. The study will be concluded with recommendations for further study.

II. Research Design & Methods

This research paper is based on available literature and online resources. Research papers and online resources were first selected based on the keyword search and then further filtered based on the relevance of the abstract. The references were mentioned in the bibliography section at the end; however, key citations were made within the text.

Source of Information	Keywords Used	Number of Resources Shortlisted	Number of Resources rejected	Number of Resources used for the study
Research Papers, Internet Articles	4IR, Impact on International Trade, Global Trade, Fourth Industrial Revolution, Industry 4.0	22	8	14

III. Background

"Globalization is a fact of economic life" – Carols Salinas. In the 21st century globalization is an irreversible trend that brings with it a level of economic expansion, growth, and accessibility that is unprecedented in the history of mankind. Various technological, economic, and political forces are shaping today's global marketplace. Since starting technology has played a key role in the expansion of global trade in terms of speed, volume, and cost reduction. The face of global trade has significantly changed from the first industrial revolution until now.

Over many centuries, human societies across the globe have established progressively closer contacts. Recently, the pace of global integration has dramatically increased (globalpolicy.org: downloaded). Globalization is a process of interaction and integration among the people, companies, and governments of different nations, a process driven by international trade and investment and aided by information technology (Globalization101:

downloaded). The term Globalization encompasses a range of social, political, and economic changes. Because of globalization, the economies of the world are being increasingly integrated, for example, mobile phones and the internet have brought people closer (UKEssays, 2017: downloaded).

Technology has been the primary driver of global trade. Advancements in digital technology, the internet, Artificial Intelligence, and IoT have dramatically transformed economic life. Digital technologies have produced different types of economic actors like consumers, investors, retailers, financial institutions, and regulatory authorities. Moreover, it created valuable new tools for identifying and pursuing economic opportunities, including faster and more informed analyses of economic trends around the world, easy transfers of assets, and collaboration with distant partners (Rebecca et al., 2022).

The Fourth Industrial Revolution has not only expanded the possibilities of digital transformation but also increased its importance to manufacturing, with an emphasis on globalization, international trade, and foreign direct investments. 4IR combines and connects digital and physical technologies including artificial intelligence, the Internet of Things, additive manufacturing, robotics, cloud computing, and others to drive more flexible, responsive, and interconnected enterprises capable of making more informed decisions (Tim et al., 2018).

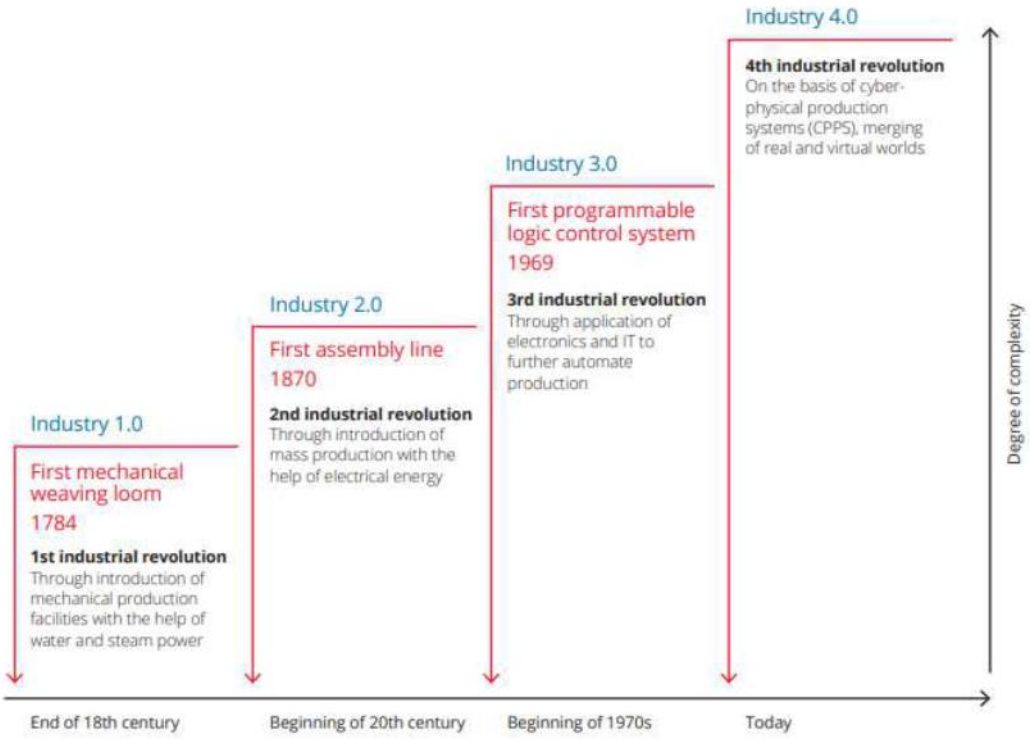
In the next section, we will embark on a brief literature review to explain the Fourth Industrial Revolution (4IR) with its main elements and how it is changing the way companies do business in today's hyper-connected world. Along with that, we will explore the prospects that the fourth industrial revolution brings and the challenges that emerged from this new revolution. The effort is to present a realistic view of the overall impact of 4IR on the global business world. Finally, we will conclude the dialogue with a suggestion on the scope of future research.

IV. Literature Review

For many centuries, daily usable things, agriculture production, clothes, houses, and weapons were manufactured by hand or with the help of domestic animals. By the end of the 18th century, manufacturing began to change dramatically with the introduction of the first Industrial Revolution, and manufacturing operations rapidly developed from there (Thangaraj et al., 2018). While the time taken for the next industrial revolution is reduced from the first to the fourth industrial revolution however the output is exponentially increased.

Brief History of the Industrial Revolution

According to the Oxford Dictionary, the word "Industry" means the "economic activity engaged in the processing of raw materials and the development of goods in the factories". The root of the term comes from the 15th century. The word "Revolution" means, "A sudden and great change" as per the Cambridge Dictionary. The technological advances in manufacturing processes ultimately drove all industrial revolutions.



Industrial Revolution at a glance - Gallagher et al. (2017)

In 1970, the third Industrial Revolution began with the invention and manufacturing of electronic devices, such as the transistor and, integrated circuit chips, which made it possible to fully or partially automate an individual machine to work without a machine operator (Ashwani et al., 2020). The development of software systems on top of the electronic hardware was the next big achievement. Software applications, such as material requirements planning (MRP) and enterprise resources planning (ERP) enable humans to plan, schedule, and track product flows through the factory. The focus was to reduce manufacturing costs which resulted in many big players outsourcing manufacturing to low-cost countries with better control of the production process using the software. The advancement of high-speed internet and telecommunication also made it possible to outsource the service sector like call center operations, Information technology, entertainment, and media to offshore or nearshore locations.

In the early 21st century, the fourth industrial revolution made exponential advancements in the digital world with high-speed connectivity across the globe. 4IR brings cutting-edge technologies like additive manufacturing, advanced robotics, artificial intelligence (AI), Internet of Things (IoT) and other cognitive technologies, advanced materials, and augmented reality. 4IR has the enormous potential to change the way globalization of manufacturing and consumption of goods and services take place in the global markets (Muhammad et. al, 2021).

A few researchers across the globe have addressed the evolution of the 4IR phenomenon and its contribution to international business activities. Especially the major drivers of 4IR that highlight its involvement in transforming the current business practices by streamlining both the production and supply chain networks (Özüdoğru et al.,2018). Mamad (2018) has talked about how Industry 4.0 works and has elaborated on this subject in detail through an exhaustive literature review. McKinsey's (2016) research paper defended how 4IR has changed the manufacturing industry to fit customer needs and how companies can derive profit from these upcoming innovations by showing application opportunities.

Muhammad et al. (2021) have predicted that the fourth industrialization will drastically change global value chains by transforming its practices and objectives. Moreover, the purpose is not limited to monetary rewards, but this includes new trends such as gaining efficiency, creating, and sustaining global competitive advantages, finding new ways of production, generating innovations, stimulating automation and learning, or even increasing customer implications in the production processes.

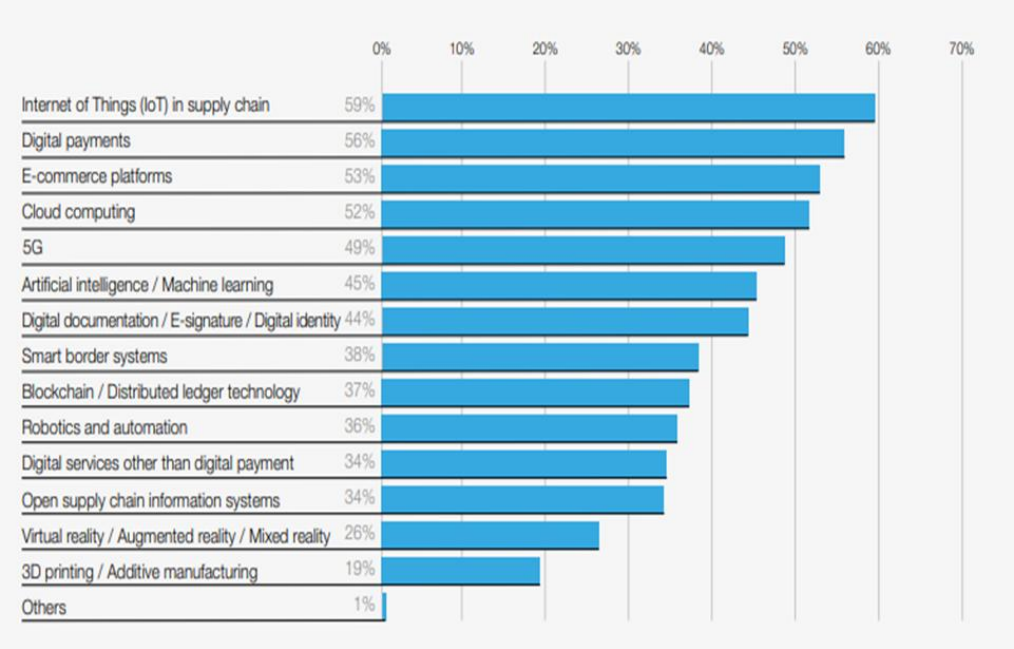
Fourth Industrial Revolution Key Technologies

In the era of 4IR, manufacturing is increasingly powered by information. Substantial amounts of data is produced from businesses around the world, in real-time, around the clock. Artificial Intelligence is at the heart of the Fourth Industrial Revolution, allowing manufacturers to not only gather all that data but use it – to analyze, predict, understand, and report. Industry 4.0 is not characterized by a single technology but by the seamless integration of several systems, tools, and innovations. Some of the key 4IR technologies that transformed the face of Industry and global trade are:

S. No	Technology Name	Description
1	Digitization	Digitization or Digital transformation refers to a process for storing and converting various types of information into digital formats, which can be stored on hardware.
2	Cloud Computing	Cloud Computing refers to a method to store, control, and process information on Internet-hosted, integrated distributed servers, which can be accessed from anywhere.
3	Big Data	Big data refers to large amounts of data sets that may be collected, stored, organized, and analyzed to identify patterns, trends, interactions, and possibilities, either formal or unstructured.
4	Internet of Things (IoT)	The Internet of Things is a term that refers to the connection from a sensor or device to the Internet.
5	Artificial intelligence (AI)	The concept of artificial intelligence refers to a machine's ability to carry out tasks and take actions that usually require a degree of human intelligence.
6	Machine Learning (ML)	Machine learning refers to the ability, without being specifically taught or programmed, of computers to learn and improve themselves using creative intelligence.
7	Block Chain	A blockchain is a decentralized, distributed, and public digital ledger that is used to record transactions across many computers so that the record cannot be altered retroactively without the alteration of all subsequent blocks and the consensus of the network.
8	Virtual Reality (VR)	Virtual Reality (VR) is a computer-generated environment with scenes and objects that appear to be real, making the user feel they are immersed in their surroundings.
9	Augmented Reality (AR)	Augmented reality is an interactive experience that enhances the real world with computer-generated perceptual information
10	Additive Manufacturing (AM)	Additive manufacturing, also known as 3D printing, is a process used to fabricate a physical object from a three-dimensional digital model, typically by laying down and bonding a large number of successive thin layers of materials.

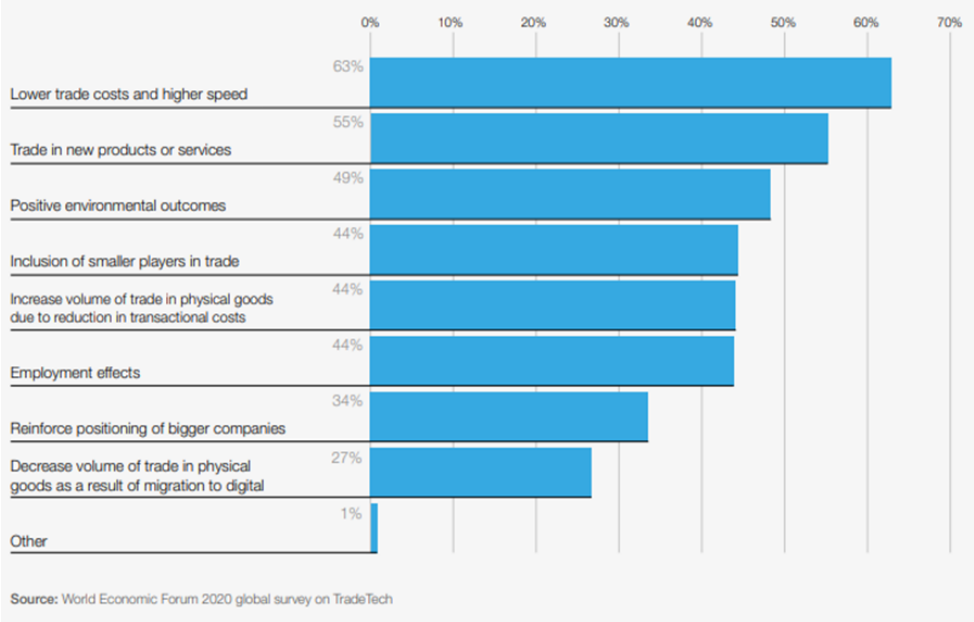
4IR Key Technologies (Source: Ashwani et al., 2020)

For many companies, Industry 4.0 is still the "next thing" they should focus on, or the trend they are currently adopting their strategy to. While many companies are still in the middle of this fourth industrial revolution, the next revolution is already well on its way—Industry 5.0 (5IR). The concept of Industry 5.0 is a relatively new one. According to the European Union Industry 5.0 - "provides a vision of industry that aims beyond efficiency and productivity as the sole goals and reinforces the role and the contribution of industry to society." and "It places the wellbeing of the worker at the center of the production process and uses new technologies to provide prosperity beyond jobs and growth while respecting the production limits of the planet." (Jeroen, 2022)



Source: World Economic Forum 2020 global survey on Trade Tech

The global survey conducted by the World Economic Forum in 2020, clearly depicts that key disruptive technologies that have the most impact on global trade are IoT, digital payment, e-commerce, and cloud computing. More than half of respondents have accepted that IoT, digital payment, and e-commerce have changed the face of global trade. Global e-commerce companies like Amazon, Alibaba, eBay, Tamu, and many more have exponential growth with the help of 4IR technologies.



Source: World Economic Forum 2020 global survey on Trade Tech

While 4IR technologies contributed to many benefits to global trade, however, according to the WEF 2020 global survey on Trade Tech, the major (63% of responses) contributions by the technologies in trade are lower trade cost and higher speed. The second significant outcome with 55% responses, was the emergence of new digital products and services. Positive environmental gains from more efficient logistics coordination were in third place with approximately. half of them responded in favor. 4IR technologies also empowered smaller players to be part of global trade by using cloud technologies and global e-commerce applications.

History International Trade

The history of international trade goes long back to ancient times. The Silk Road was the first major trade route that connected the East and the West. It was an important trade route for over 2,000 years, connecting Asia with Europe via the Middle East. Wonnacott et al. (2023) have described international trade as economic transactions that are made between countries. The purpose of international trade is to provide a nation with the commodities it lacks in exchange for those that it produces in abundance and to improve the standard of living of that nation. International trade consists of goods and financial transactions along with economic policies to regulate it.

International trade has a rich history starting with the barter system being replaced by Mercantilism in the 16th and 17th Centuries. The 18th Century saw the shift towards liberalism. The 19thcentury beginning saw the move towards professionalism, which petered down by the end of the century. Since then, there have been many transformations happened in international trade in regulatory, processes, and technological areas. Today's international trade is much more complex than ever have multi-facet factors influencing it.

Fourth Industrial Revolution Impact on International Trade:

4IR brings both opportunities and challenges to international trade. On one side it helps to modernize the production process and self-initiated execution other side it allows the business to undertake the production process across the globe by creating a flexible global supply chain system (Muhammad et al., 2021).

According to Horvàth et al. (2019), there are five key drivers of Industry 4.0:

1. Digitalization
2. Optimization and customization of the production
3. Automation and adaptation
4. Human and machine interactions and collaborations
5. High value-added offers and automatic exchanges of data and communication

The fourth industrialization has contributed to the critical transformation of the international business environment in the different stages of an organization such as human resources, financial systems, management, organizational structure, or production processes. 4IR offers an opportunity to restructure the declining manufacturing industry in the high-cost country and permit it to maintain a strong industrial base in developed countries (Muhammad et al., 2021).

Digital technologies make the costs of cross-border trade decrease (Ismail, 2020). These costs are made up of information, transport, logistics, border-crossing, transaction costs, and costs linked to trade policies. A smooth and inexpensive flow of reliable information will facilitate the search for products, services, and their most optimal manufacturers. Furthermore, it will be easier to establish contact with manufacturers, to verify the reliability and quality of their products, to conduct trade negotiations and sign contracts, to transport, store, and in transit goods, to provide cross-border clearance, and make payments (Rymarczyk, 2021).

Mohamed et al. (2022) pointed out that, fourth Industrial technologies create an ongoing impact on how businesses fundamentally manufacture goods and services. 4IR will impact global trade in various ways- lowering overall transaction costs, improving the overall trade and logistic process, changing the like of business from goods to services, and reengineering the production process by using more automation and self-orchestrated production techniques. This will create a substantial impact on international trade.

Another common trend identified in Industry 4.0 is shifting the production facilities closer to customers in order to better serve the local markets. This will simplify the global value chain (GVC) and encourage businesses to move from centralized production to distributed production. This could be possible through the 4IR technologies. This will also help to customize and personalize the production output based on the needs of local customers which was not possible in centralized production. This whole scenario will impact the volume of global trade as the trade flow will be impacted due to the shift in the movements of the inputs and regional sourcing. Moreover, this will change the trade participation for both countries and the Company's level.

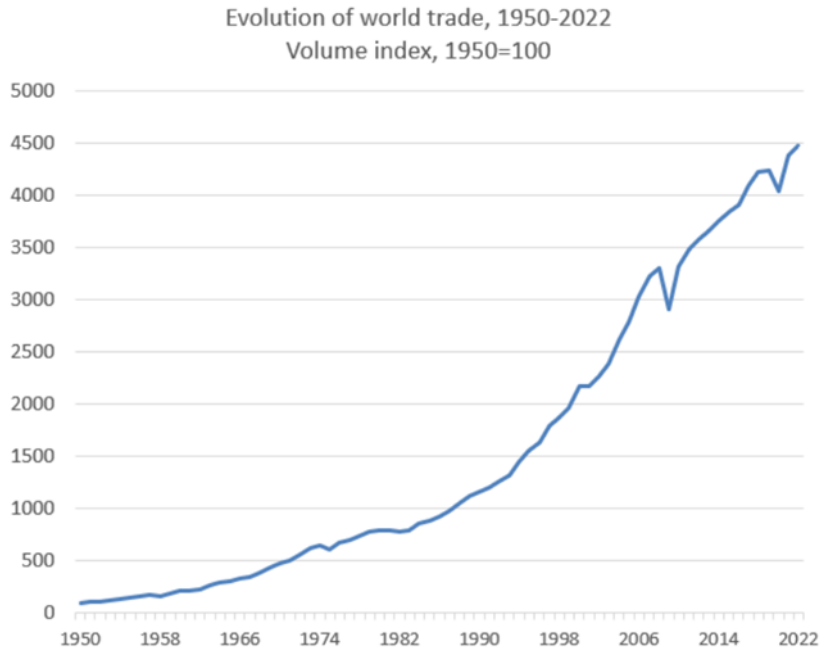
4IR technologies like big data, the Internet of Things (IoT), and cloud computing have greatly helped international corporations to manage the flow of the supply chain between the head office and transactional points like branch offices, terminal operators, shippers, customs agents, insurance agent and many other involved entities

in the trading process. International trading supply chain flow requires perfect coordination, reporting, and monitoring between the parent entity and transactional firms and their branches (Rymarczyk, 2021).

Online platforms play a major role in providing information on markets and potential partners for exporting or importing goods and in establishing contacts between exporters and importers, manufacturers, and consumers. The platforms help to overcome the barrier of information asymmetries as regards the quality of goods and reliability of their providers, thus increasing trust and confidence between partners (Rymarczyk, 2021).

Fourth Industrial Revolution Impact on the Volume of International Trade:

The breakthrough technologies from the fourth industrial revolution have helped to reduce the trading cost drastically which causes an increase in the volume of trade (Ismail, 2020). There will be an increase in trade volume for some goods, and a decrease in others, while some goods will gradually disappear from global trade. According to the WTO report (2018), for those goods whose costs are higher in terms of transport, logistics, information, regulations, and transactions, there will be an increase in trade.

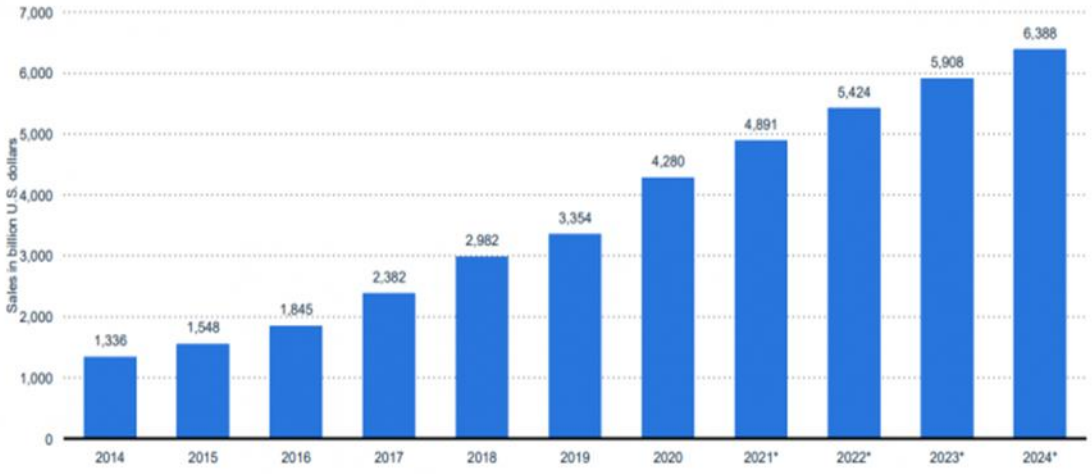


Source: World Trade Organization (wto.org, 2023)

From the World Trade Organization (WTO) report it can be observed that there has been exponential growth in world trade from 2010 until now except in 2020 due to COVID. This is mainly from the expansion and commercialization of 4IR technologies. 4IR has enabled many small businesses into global trade through internet networks and cloud applications. Young businesses and startups can trade their products and services to the global marketplace. It has been identified in a research paper (Papachashvili, 2018) that a 10% increase in internet use in the exporting country could increase the number of products traded between the two countries by 0.4 percent. With the same amount of increase in internet usage between the two countries, it has been observed a 0.6% increase in bilateral trade value per product.

Online platforms based on cloud applications have given great benefits by overcoming trust and information issues. These applications have feedback and rating functionality to provide past reviews for consumers along with dispute resolution mechanisms for higher customer satisfaction. An ease in the trade process of intermediate products encourages further simplifying the production processes, not just in the markets for goods but also for services (Digital Dividends, 2016).

Online platforms can reduce the matching and information costs that can affect international trade more than domestic trade and provide mechanisms such as feedback and guarantees that improve consumer trust in online sellers (Shawn, 2017). New methods of trading, such as e-commerce, create both new opportunities and new challenges for traders and policymakers. E-commerce promotes the ability of small and medium-sized enterprises (SMEs) to go from being small players in the domestic market to becoming global exporters (Trade & Competitiveness, 2017).



Global retail e-commerce sales worldwide from 2014 to 2024 (in billion USD)
Source: trade.gov/ecommerce-sales-size-forecast (2021)

Global trade in information technology goods and services will show an upward trend. Trading of information carrier hardware, smartphones, tablets, mobile phones, and other devices with large knowledge content, along with services, which involved the installation and support of technologies (Lula et al., 2019).

IR4 technologies have transformed many traditional goods into their digital form by creating a digital wrapper. Some of the common examples are Smartwatches, Smart houses, AI-enabled robots, Smart driverless cars, smart kitchen appliances, and many others. Lund & Manyika (2016) have emphasized that radio-frequency identification technology (RFI) has enabled transportation more efficient by identifying, tracking, monitoring, and adjusting transport routes. Similarly, traditional warehouse efficiency is enhanced by applying digital components and equipment thus converting into a smart warehouse.

From the WTO report (2018, pp. 91-92) it has been predicted that the volume and share of customized products in the global trade structure will be reshaped by digital technologies. Now consumer with their respective preferences can receive modified goods as per their demand. Through the state-of-the-art global supply network, a consumer in India can order a customized iPhone to the USA, which will be manufactured in China and delivered to the consumer in India.

Flexible production systems, on the other hand, are capable of manufacturing in small batches or even individual items by using reprogrammable robots. With the help of 3D printing, the manufacturing of personalized products can be performed in the vicinity of consumers, by taking direct inputs from customers or via the internet. This production will ensure the high quality of products, close fit to consumer needs, and low transportation and production costs. This boils down to the fact that the majority of international trading costs will be eradicated, thus creating a positive effect on its volume.

Papachashvili (2018) mentioned a negative impact on the global trade volume of certain goods like books, brochures, music stored on CDs, DVDs, and video cassettes, maps, postcards, journals, newspapers, and video games. As these goods will be digitized and can be easily traded through the internet, trading of physical forms of these goods will exponentially decline. Most of these goods will be offered as services like cloud-based online games, video, and music streaming applications, Global Positioning System (GPS) based navigation systems, and e-books. The physical form of maps has drastically decreased since Google Maps and other navigation systems are available on smartphones.

Fourth Industrial Revolution Impact on the Service Economy:

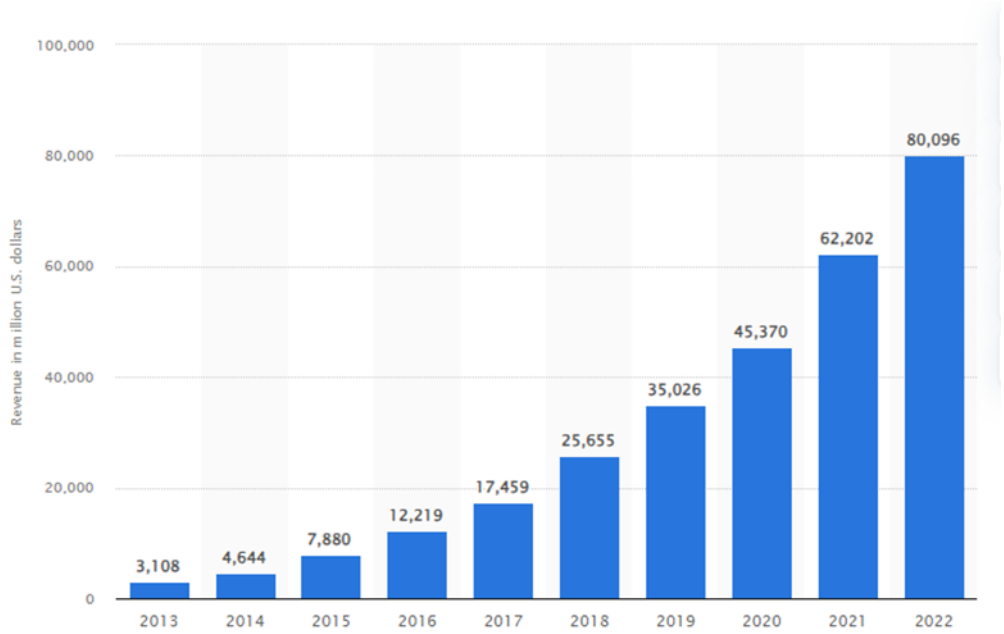
The Fourth Industrial Revolution has opened an enormous opportunity in global service trading. Unlike manufactured goods services do not have a physical form, however, there is a global market to consume it. Rymarczyk (2021) has mentioned the "Servitisation" of International Trade and how 4IR has contributed to the exponential growth of global services. Servitisation can be defined as an industry where the 'product' for sale is a service. In this model company sells the services rather than a physical product. A few examples are AWS selling storage and compute power worldwide, Netflix selling media and entertainment, online advertising on social media platforms, education through e-learning, consulting services, and many more.

4IR has created hyper-connected global networks that enable these services to be provided regardless of physical distance, location, and time zone. Rymarczyk (2021) has pointed out various services which have

increased global trading in the era of 4IR. Information Technology (IT) and Communication Technology are on top followed by sales and marketing, Finance, Insurance, and Business Process Outsourcing (BPO) services. Traditional services like transport and traveling are also transformed into digital but could not surpass prior.

There are a large number of autonomous services, which are on the rise globally. These services are gained by non-standard brokers enabled by online platforms and delivered to individual clients (Axxsys, 2018). Some of these services could be conducted without human effort with the use of 4IR technologies like Artificial Intelligence (AI), Internet of Things (IoT), and Augmented Reality (AR). Auditing, Designing, Programming, Testing, Analyzing, and Accounting are a few more common examples. In the near future Content creation will also be possible with the help of breakthrough technology called Chat GPT.

Some of the business models like Uber and AirBnB, exploited the online digital platform to provide peer-to-peer services using mobile applications. These services allow direct contact to be established between providers and recipients to provide the required services. This has drastically reduced the costs involved in searching for partners and consumers. This also reduces the need for physical infrastructure for consumers to get the services. This sharing economy model is quickly becoming more universal, primarily in transportation services (Uber) and accommodation (AirBnB).



Source: Annual revenue of Amazon Web Services (AWS) from 2013 to 2022 (statista.com)

The above graph shows a continually increased revenue of AWS cloud computing and hosting solutions, from 2013 until today. AWS is one of the biggest service providers in the world, providing services like SaaS (Software as a Service), PaaS (Platform as a Service), and IaaS (Infrastructure as a Service), which are consumed across the globe. These services are in the form of digital which does not require any physical transportation, thus making consumers buy services almost immediately and start using them.

Fourth Industrial Revolution's negative impact on International Trade:

Along with its critical benefits, 4IR also brings some disadvantages to international trade which can be a big challenge. According to Mohamed, et. al (2022), there needs to be a balance between human and 4IR technological resources in international trade. World Bank report has predicted that two-thirds of the workforce in developing countries will lose their jobs over the next two decades due to digitalization, automation, and reshoring (Kozul-Wright, 2016). Some of the skills will become obsolete and do not require any workforce to perform them. This will create an unemployment challenge, which will further result in poverty.

4IR will also impact the comparative advantage some countries have due to its well-developed physical infrastructure for global trade. Countries that developed ports, railways, terminals, and customs clearance facilities for international trade purposes, will lose their significance in the longer term, due to the digitalization of cross-border flows, apart from telecommunication and energy infrastructure (Agrawal, 2019).

Due to 4IR technological advancement, the governments of some countries may be unable to establish long-term policies to regulate it, which will pose a risk to the country's economy and impact its competitiveness. This will further decrease their international trade and increase the risk of poverty among its people. Additionally,

another negative side of 4IR technologies is information security at the national and international levels. Due to the global accessibility of data in the cloud and information sharing across the world, there is a high risk of data/information theft which could impact international trade.

The optimization of production and logistics processes allowed by 4IR technologies has a major impact on the environmental management, which allows energy savings and waste reductions to cut costs for firms. This helps preservation of natural resources and biodiversity. Constant monitoring of production efficiency and intelligent quality control offer great opportunities in terms of production efficiency, waste reduction, and improved reliability. However, these improvements could easily be offset by the fact that 4IR requires the collection and storing of massive quantities of data in data centers, which significantly contributes to global warming.

V. Conclusion

The digital transformation as a result of the fourth Industrial Revolution is going to leave long-lasting effects on our living and working environment. 4IR not only created the full range of opportunities for the industrial sector to expand its leading global position but also new digital business models, which will expand the existing product and service portfolio to ensure future growth in global sales. This digital age will perceive international trade by its reliability, punctuality, security, and elimination of losses caused by errors and fraud, along with a robust online payment system to facilitate global transactions.

In light of the above research study, it can be fairly concluded that the Fourth Industrial Revolution created a significant impact on the global economy by increasing the volume of global trade. Some of the key factors were a reduction in transportation costs, better tracking of goods in transit, global communication systems, and improved production efficiencies. 4IR will continue to influence global trade through the next generation of digital technologies which are not commercialized up to a sizable scale but will come in the near future. A few examples are the Internet of Things, artificial intelligence, 3D printing, augmented reality, blockchain, nanomaterials, and synthetic biology, which are at the stage of advanced research, with their experimental use about to be tested in practice. These innovations are expected to significantly impact the growth of world trade volume, also leading to a decline in its costs and information asymmetry, besides shortening the time needed for transaction completion and the delivery of goods and services.

Future Research

Although a significant outcome in international trade can be observed which was created by 4IR, however, the industry 4IR is not at its peak. There are many undergoing technologies which yet to be commercialized and the impact of those technologies on global trade. Moreover, 4IR created a multi-year transformation process for most global businesses, resulting in significant changes to their value chains.

From some studies, the term Industry 5.0 or 5IR has been introduced to the research areas that are considered as the next industrial revolution, but it is a more systematic transformation that includes impact on civil society, governance and structures, and human identity in addition to solely economic/ manufacturing ramifications.

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