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Industry 4.0 and its Effect on Indian Manufacturing Sector

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Abstract: *The 4.0 Industry is known in the present development and improvement of the process and every part of the life related with the interconnection, technology and network that provides security, overview of process and connection of almost everything based on the internet of things. This kind of associates and networks allow the industry to improve the processes, the things can follow guidelines throw internet of things and learn how to improve that processes making relations between the work or action realized with the ideal taking advantage of the big data analysis and give infinite possibilities to more efficient progresses. This paper review Industry 4.0 its role in Indian Manufacturing sector.*

Keywords: industrial revolutions, elements of industry 4.0, Indian manufacturing sector, challenges and opportunity

I. INTRODUCTION

Producing various objects is old as mankind. Basically, every product recognized by individuals or groups can be adapted with a basic industrialized process. During times, humans managed to manufacture objects for their own usage or for profitable purposes, into small workshops and using basic tools.

First Industrial Revolution (Industry 1.0)

A first major shift came during the First Industrial Revolution (Industry1.0) in the 18th century where, instead of items being produced by basic means, processes were invented and allowed items to be produced by machines.

Fig.01

Second Industrial Revolution (Industry 2.0)

Then afterward shift in manufacturing is the period between 1871 and 1914, known as the Second Industrial Revolution (Industry 2.0), as result of wide railroad and telegraph networks, which allowed for faster transfer of people and ideas.

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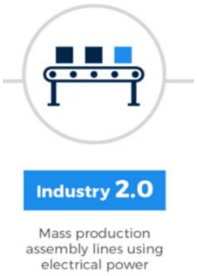

Fig.02

Third Industrial Revolution (Industry 3.0)

The Third Industrial Revolution (Industry 3.0), also known as the Digital Revolution, began in the ’70s in the 20th century through partial automation using memory-programmable controls and computers. Industry 3.0use of digital logic, MOS transistors, and integrated circuit chips, and their derived technologies, including computers, microprocessors, digital cellular phones, and the Internet

Fig.03

Fourth Industrial Revolution (Industry 4.0)

Nowadays everyone relates to The Fourth Industrial Revolution, known as Industry 4.0 - a combination between physical assets and advanced digital technologies -like Internet of Things (IoT), Artificial Intelligence (AI), robots, drones, autonomous vehicles, 3D printing, cloud computing and others, that are inter connected, having the possibility to communicate, analyze and act

Fig.04

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INDUSTRY 4.0

Definition. The concept of "Industry 4.0" was coined by German's group of mechanical engineers in the year 2011 to account for the broad combination and adaptation of ICT in manufacturing industries. The definition of industry 4.0 is uncertain, and no single definition has been predictably adopted. The Institute of Technology Assessment (ITA) defined industry 4.0 as a systemic change bringing about extensive changes in the way works are done. However, it is stressed that industry 4.0 is not just about the introduction of a new technology linked with an incremental adaptation of work systems as in the previous three industrial revolutions, but about an assemblage of innovative technologies and forms of application, with discrete degrees of technical maturity and systemic effects.

EMERGERGING TECHNOLOGY AS PER INDUSTRY 4.0

Since 2011, the world has entered a new era, widely known as Industry 4.0 or Fourth Industrial Revolutions because numerous emerging technologies were introduced, and their applications are visualized in the manufacturing domain.

The essential technologies:

- Internet of Things (IoT)
- Blockchain
- Collaborative Robotics (Cobots)
- High- Performance Computing (HPC)
- Artificial Intelligence
- Additive Manufacturing, Drone system
- Cyber-Physical System

All above these plays a crucial role in envisioning digital and smart manufacturing systems. It is estimated that by 2030 IoT annual revenue will be increased to $1058 Billion, Artificial Intelligence is growing to $300 Billion by 2025, Blockchain market increasing to 39.7 Billion by 2025, HPC to 49.4 Billion in 2025, Additive Manufacturing to 37.2 Billion by 2026.

Fig 05

Drone market touches the 501.4 billion, and similarly, CPS will reach to 12.7 Billion by 2026. All over the globe, a tremendous effort has been made to adopt these technologies and digitization on an early basis, and accordingly, the World Economic Forum released an Industry 4.0 preparedness report by ranking the countries based on the current structure of production and driver of production. Entire ratings were also sorted by leading, legacy, high-potential, and nascent countries. Abundant opportunities for India are seen because it is the only country from South Asia ranked in legacy countries with ranks of 30 and 31 in the structure and driver of production respectively.

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Fig 06

ADDITIVE MANUFACTURING

3D printing or additive manufacturing is the procedure of making three-dimensional solid objects from a digital file. The formation of a 3D printed object is completed using additive processes. Additive Manufacturing and smart materials have obtained significant consideration from industries and academicians because of their applications in the defense, space, and toy sectors. The utility of advanced materials, innovative surfaces, open-source design, intelligent factories, electronics devices, and additive manufacturing has been designated as part of manufacturing innovations

Fig. 07

ADVANCED ROBOTICS & COBOTS

Advanced robotics has been involved in high-level automation with minimal human interventions, supported by AI techniques, especially data analytics and machine learning, to achieve workplace navigation and exercise complex activities. Robots optimize the manufacturing performance related to cost, quality, accuracy, productivity, and reliability. In recent developments, the application of drones has been recognized as one of the disruptive technologies for the upcoming future of the delivery system. For full automation, the manufacturing systems are being shifted to the usage of collaborative robots (Cobots).

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Fig. 08

Application

Accepts high-level mission-oriented commands, for example, navigating to a workplace, and performing complex tasks in a semi-structured environment with minimal human intervention.
Role in arc welding, spot welding, and fully automatic robotic welding systems.
Perform moving, storing, and retrieving products.
Mechanizing the production line to improve efficiency.
Human-machine interaction is the next big trend in robotics as Cobots.

DRONES TECHNOLOGY

In recent years, drone technology has gained attention from researchers, academia, and industry that is also known as Unmanned Aerial Vehicles (UAV). It also noted that the drone industry is one of the fastest-growing because of its wide range of applications, from the factory floor to warehouse management, online delivery, and defense services including navigation devices and weapons. In India, the use of drones is increasing, and accordingly, the Government of India released Drones Rule 2021 for various activities related to it like Preliminary, Classification, Certification, Registration, Operations, Remote Pilot Licenses, and Training, Drone services are estimated to be worth $127 billion globally, $13 billion of which is based on drone-powered transportation.

Fig. 09

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Benefits

- Faster than delivering with traditional vehicles
- Road infrastructure cannot limit its application
- Faces less complex obstacle avoidance scenarios.
- Significantly reducing the cost and time during last-mile deliveries and responding quickly to emergencies.
- Least expensive to maintain than traditional delivery vehicles and can lower labor costs by performing tasks autonomously.
- Maintain shop floor management and operation flow
- Efficiently operationalized automated warehouse system.

CYBER-PHYSICAL SYSTEM

Cyber is linked to computation, communication, and control. The integration of traditional manufacturing systems with the internet and cloud computing has been proposed as a cyber-physical production system (CPPS). The adoption of advanced technologies like IoT devices, sensors, and big data, blockchain, and cloud services have the potential to boom CPS-based manufacturing. Furthermore, the digital twin (DT) has been identified as a vital technology in achieving the cyber-physical system. Digital Twin reveals a replica of the physical system, whereas CPS is the use of a computer with any physical system. It has been considered a connecting technology between the virtual and physical world in the manufacturing system. To support the CPS, virtual reality and augmented reality also play a crucial role where Virtual Reality provides the opportunity to visualize the data and Augmented reality gives an interactive experience with the real world by controlling the system.

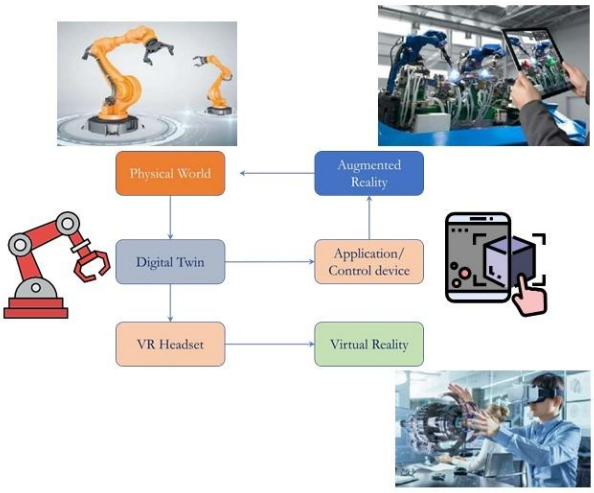

Fig. 10

Benefits of Augmented Reality

- Production
- Faster and smarter
- Expert support
- In training
- Product assembly
- Machine maintenance
- Quality assurance

ARTIFICIAL INTELLIGENCE

The AI technique has played a notable role in achieving the intelligence- based advanced manufacturing system with the decision support system. In artificial intelligence, machine learning, and deep learning are viewed as the two

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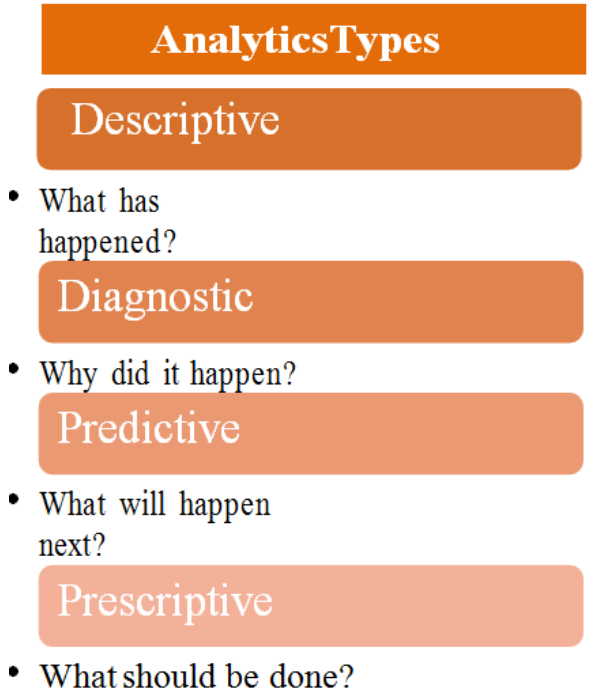
leading contributors with the support of numerous algorithms and techniques, for example, versions of Neural Networks (NN) and evolutionary algorithms. Artificial intelligence helps Indian Manufacturing System by providing quick and efficient results in getting the decision proactively while progressing various manufacturing and logistics activities.



INTERNET OF THINGS (IOT)

The Internet of Things (IoT) is defined as the internet in devices employing wired and wireless sensor networks (WSN), embedded systems, Radio Frequency Identification (RFID), and Near Field Communication (NFC). The scenario of the manufacturing sector has been transformed with the application of IoT gadgets that assist in promoting Machine to Machine (M2M) communication, constant communication between elements, data generation on the cloud, collaborative robots (Cobots), and object tracking while manufacturing, warehousing, and transportation. Furthermore, in recent years, blockchain technology has gained researchers' attention, especially with IoT devices for real-time monitoring of finance, logistics, cybersecurity, and various others.

WHERE WE ARE

"For India to become a USD-5-trillioneconomy, our manufacturing sector has to sustainably grow in double digits." - NITI Aayog.

India is the second-most populous country globally, with more than 1.35 billion peoples reported in 2020. It is also the fastest-growing major economy in the last decade with an annual average gross domestic product (GDP) growth rate of 6-8% and contributed $3.05 trillion to the world's total GDP in 2021. Although, the COVID-19 pandemic has ominously affected the economy and human lives that decreases the GDP up to -7.3 in 2020 and it is projected to be 9.5% and 8.5% in 2021 and 2022, respectively. However, India's global GDP and international trade contributions are comparatively low, contrary to its population and size. Further, the country lacks numerous societal, economic, and environmental issues associated to the developed world.

The industrial sector is one of the quintessential components to balance employment generation, economic growth, and environmental sustainability. Due to that, it is acknowledged as the backbone of the country's economy as it offers a substantial contribution to GDP and job creation. Globalization further impacts it by the driving forces of

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outsourcing and distributed manufacturing with technological advancements. However, the decreasing share in GDP and shrinking employment from the manufacturing sector has become concerning predicaments.

Micro, small, and medium enterprises (MSMEs) are the important players in the manufacturing sector because of their plentiful production output, export, and employment creation. However, in India, MSMEs are not well prepared with emerging technologies, and they do not follow up the quality and the environmental standards. However, in India, MSMEs are not well equipped with emergent technologies, and they do not follow up the quality and the environmental standards.

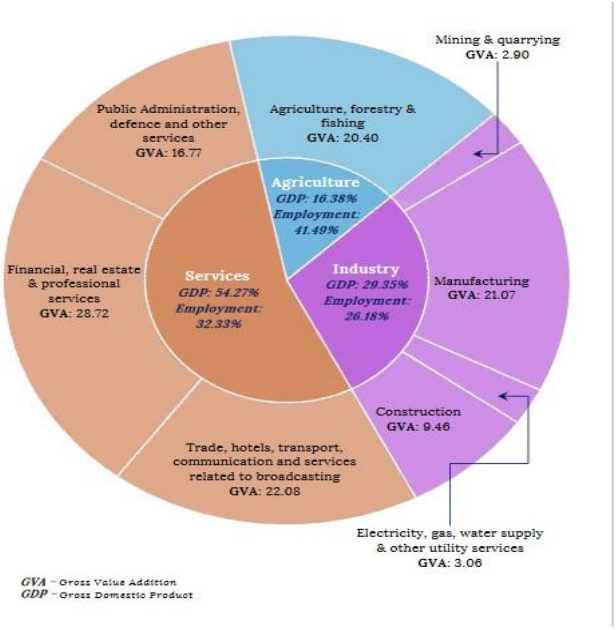

Fig. 11

Similarly, another regarding factor is environmental degradation, and in a 2018 report, India has been positioned at 168th rank out of 180 countries in the environmental performance index (EPI). Even Indian products fail to match the international requirement standards due to low-quality products produced from old technologies or Jugaad innovations in practices that lead to inferior quality products, import-export deficit, and encourage cheaper imports.

Therefore, India was placed in 68th place in 2019 on the global competitiveness index (GCI) out of 141 countries. In a nutshell, India needs to introduce an emergent technology-equipped manufacturing system by envisioning the practical implications in the industrial sector that concur with several triple- bottom-line sustainability concerns. Moreover, India has an ample opportunity because it is the only country from South Asia ranked in legacy countries with ranks 30 and31 in production structure and driver of production, respectively, in a report released by the World Economic Forum on Industry 4.0 preparedness. Therefore, we are confident that the evolution of systems would be a breakthrough for meeting the objective and vision of Make- in-India and the Indian Century - 21st Century.

Rank	GCI	GMO	GMRI	Net Export	GMCI	CIPI	GDP
1	Singapore – 84.8	China – 28.7%	China	China	China -100	Germany	US – 19.5
2	US – 83.7	US – 16.8%	India	Germany	US – 99.5	China	China -12.2
3	Hong Kong – 83.1	Japan – 7.5%	US	Ireland	Germany – 93.9	South Korea	Japan – 4.8
4	Netherland – 82.4	Germany– 5.3%	Canada	Russia	Japan – 80.4	US	Germany – 3.7
5	Switzerland – 82.3	India – 3.1 %	Czech Republic	South Korea	South Korea – 76.7	Japan	UK – 2.7
India	68th – 61.4	5th	2nd	198th	11th - 67.2	42nd	6th – 2.6

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GCI – Global Competitiveness Index (Score)
GMO – Global Manufacturing Output (Percentage)
GMRI – Global Manufacturing Risk Index (Rank)
GMCI – Global Manufacturing Competitiveness Index (Score)
CIPI - Competitive Industrial Performance index (Rank)
GDP – Gross Domestic Product Nominal (in Trillion USD)

PROSPECT AND SCOPE OF IMS

To achieve the sustainable goals of United Nation Development Program (UNDP), the target of 'Make in India', and Inclusive growth of the economy, emerging trends of the current marketing strategy, and changing customer behaviors and requirements, tremendous opportunities are envisioned for the Inclusive Manufacturing System. A few of the reasons are mentioned herewith:

IMS implementation provides a centralized platform to Micro, Small, and Medium Enterprises (MSMEs) for their collaboration with resource composition. Based on historical data and customer demand, personalized and customized orders can be fulfilled. Various environmental, economic, and societal issues can be fixed with the implementation of associated policies and standards, and it helps in retaining the sustainability aspects.

Continued monitoring and selection of the best players from the market through the system, improving product quality and efficient services that lead to substantial growth in cross-border business and contribution of the manufacturing sector.

Novel innovations, potential opportunities, job creation, improving lifestyle, and inclusive growth can be witnessed with the expansion of the manufacturing sector.

Finally, such concepts can play a big role and become the backbone of Atmanirbhar Bharat (Self-reliant India), giving the ideas of 'vocal for local', 'local for global', 'make for world' and 'brain drain to brain gain'.

II. CONCLUSION

The present study identified transformations in the view of previous researchers on the significant technologies of industry 4.0.These differences were due to the different scopes of the case studies undertaken by the researchers. This is because industry 4.0 technologies are being adopted among countries or industries at different paces. Most investigations focused their case studies on countries like China, USA, Germany, India, UK, South Africa, Korea, Russia, Philippines, and Malaysia. Thisinterpretations for the differences because these countries have different capabilities in terms of resources, knowledge, and finances to implement industry 4.0 technologies. This implies that the rate of industry 4.0 adaptation has been growingamong countries and industries over the years. The race among countries and companies towards industry 4.0 will further escalation the rate of adaptation of these technologies.

However, the more the industry 4.0 implementations, the more the skills required to support its growth will be needed. In essence of IMS Industry 4.0 play a vital role in the overall and inclusive growth of India.

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