Opportunities and Challenges for Adoption and Implementation of Industry-5.0 by Micro and Small Enterprises (MSEs) of Durg District of Chhattisgarh.

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Highlights

- Industry-5.0 is regarded to be the digital and physical integration of manufacturing, services and data processing in a view to create new opportunities in the manufacturer sector, services and to consumers.
- When Industry 4.0 is still gaining ground and has not yet reached maturity, Industry 5.0 is ready to take the stage.
- The industry-5.0 works on the principles of automation through use of artificial intelligence, big data analysis, and cobotic technology
- The Durg District of Chhattisgarh is reported as the industrial district, due to wide network of industries including MSEs.
- The adoption of Industry-5.0 by MSE sector of Durg district are associated with number of opportunities and Challenges.

Abstract

Industry-5.0 is regarded to be the digital and physical integration of manufacturing, services and data processing in a view to create new opportunities in the manufacturer, services and consumers. The Industry-5.0 lies on the principles of automation. It uses the eight different technologies viz artificial intelligence, big data analysis, cobotics, digital twin, block chain, internet of everything, edge computing, and 6g & beyond for bringing the industrial sector to automation. Across different industrial sector Micro and Small Enterprises (MSEs) plays a pivotal role in economic development, production and employment generation. In India, almost each states a good network of MSEs. Likewise Chhattisgarh has a vibrant network of MSEs. The Durg District of Chhattisgarh is reported as the industrial district, due to wide network of industries. After Raipur, Durg have highest number of MSEs in Chhattisgarh. The Industry-4.0 was adopted by 70% of MSEs in Durg Chhattisgarh, but still Industry-4.0 is gaining grounds and hasn't yet been matured. But in the current era India has made its digital infrastructure efficient. Thus the adoption of Industry-5.0 will be easy by MSEs than the Industry-4.0. With the development in information technology the Industry-5.0 is making its

edge. However the adoption of Industry-5.0 is associated with number of challenges and opportunities with reference to MSEs. In this paper we will discuss the opportunities and challenges for the adoption of Industry-5.0 by the MSEs of Durg, Chhattisgarh. The study uses secondary data to allocate the opportunities and challenges for the adoption of Industry-5.0. The results suggest that one of the major opportunities of Industry-5.0 by the MSEs of Durg, Chhattisgarh is the personalization and customization of the production through use of artificial intelligence, and robotics. In addition to the opportunities, the results suggest number of challenges for the adoption of industry-5.0 by MSE sector. The major Challenges which MSEs of Durg, Chhattisgarh faces for the adoption of Industry-5.0 were; higher investments, lack of infrastructure by MSEs, incompatibility for accepting automation,etc. The adoption and implementation of Industry-5.0 through automation, by the MSEs of Durg, Chhattisgarh will stimulate the production in less time.

Keywords: Industry-5.0, MSEs, Opportunities, Challenges, Durg, Chhattisgarh.

Introduction

India's economy is currently the fifth largest in the world (Helms, 2023). The nation has seen remarkable growth over the past few decades and has managed to keep up this growth rate. Numerous changes in the nation have resulted from this quick expansion, particularly those in the manufacturing sector. To transform India into a more advanced manufacturing powerhouse, the Indian government has been working hard. According to Maddikunta, (2022) time to time industrial revolution take place for the development of industries across the globe (Fig-1). The Industry-4.0 has been a boon for the manufacturing sector of India, and its gaining grounds and hasn't yet been matured (Leng, et.al., 2022). Now with the development in technology, robotics, automation, and artificial intelligence the industrial sector is gaining new dimensions(Xu, et.al., 2021). This advanced technology gave rise to Industry-5.0. Industry-5.0 is regarded to be the digital and physical integration of manufacturing, services and data processing in a view to create new opportunities in the manufacturer, services and consumers (Zhodage, 2023). Industry-5.0, will provide advance features for the development of the manufacturing sector in order to attain Sustainable Development Goals (SDG).

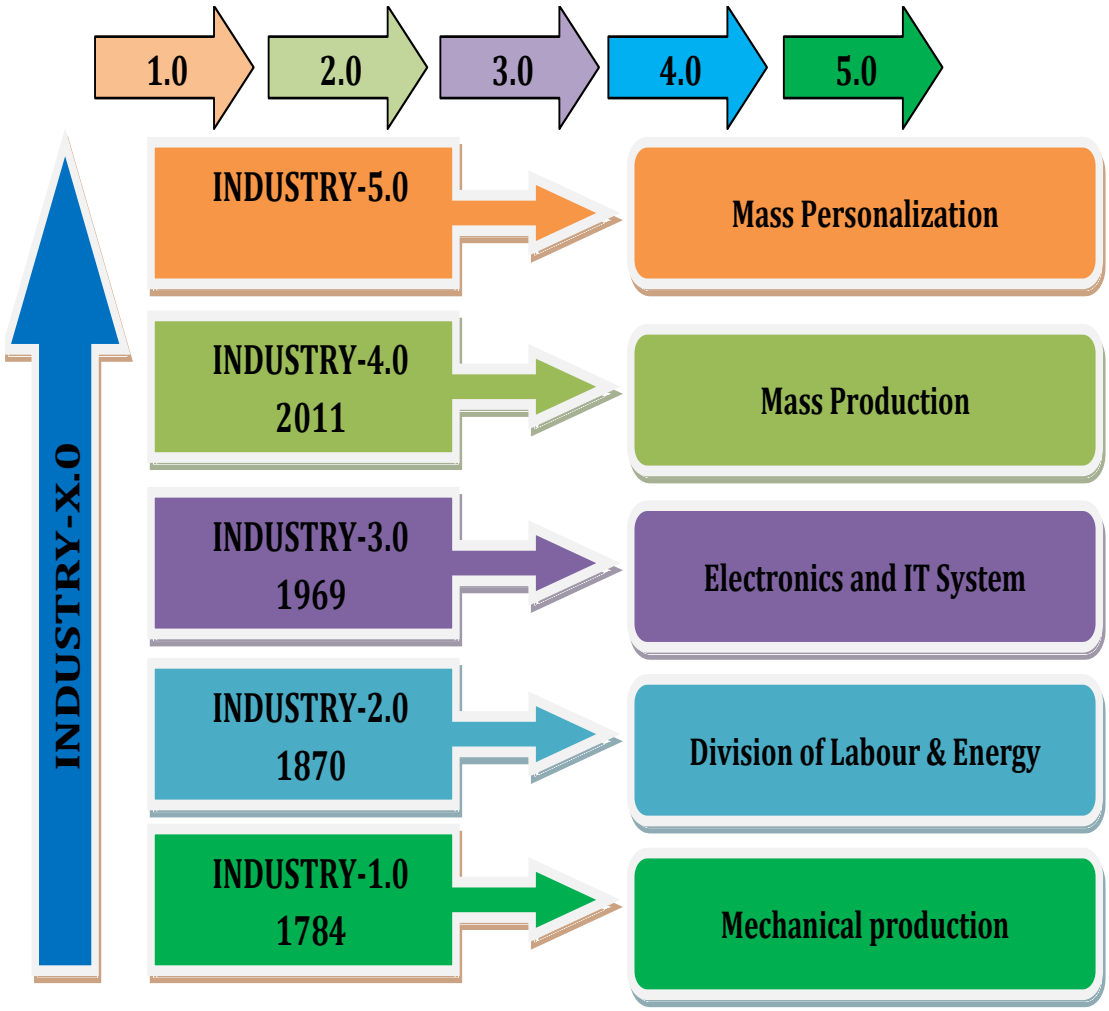

Fig-1. Illustration of Industrial Revolution

Michael Rada is credited with coining the term "Industry 5.0" (Maddikunta, 2022). Utilising collaborative robots to reduce risk is one of the fundamental components of Industry 5.0Naveen, 2023). These robots are capable of recognising, comprehending, and sensing the human operator as well as the objectives and expectations of the activities being carried out. The idea is that these robots will observe and learn how a person completes a task, then assist human operators in completing the work. Additionally, Industry 5.0 calls for the integration of artificial intelligence into daily life with the goal of boosting human potential. Industry 5.0 actively uses cutting-edge IT technology, the Internet of Things, robotics, artificial intelligence, and augmented reality for the advantage and convenience of human labour (Skobelev and Borovik, 2017).

Industry 5.0 acknowledges that by making any production, it takes into account the limits of our planet and placing employee health first, industry may satisfy societal purposes beyond employment and development, and become a sustainable source of development. Industry 5.0 adds to the technological update needed by business in order to be a reliable system for people looking for a fulfilling and healthy profession. In order to generate income beyond employment and development while respecting the limits of the earth, it places a priority on worker wellbeing and makes use of new technologies. It empowers employees and satisfies their evolving training and skill needs. It increases industry competition and draws top talent. While implementing Industry-5.0 it should fulfill three objectives; 1.) an economy that works

for people, 2.) it should work for to attain sustainable developmental goals (SDG), and 3.)," its should be compatible with the digital age. Therefore, Industry-5.0 is based on values such as human-centricity, environmental stewardship, and social benefit rather than technology. This reorientation is based on the idea that technology may be used to promote values and that ethical goals can be integrated into technical innovation rather than the other way around (Muller, 2020).

Industry-5.0 is the advanced step to the industry-4.0, in the era of industrial revolution (Paschek, et.al., 2019). By allowing a more productive production process with reduced waste and energy consumption through automation, digitalization, and artificial intelligence, Industry 5.0 will have a significant influence on manufacturing (Haleem and Javeed, 2019). Additionally, it will provide new employment opportunities for high-skilled positions such as data analysts, system integrators, cyber-security specialists, etc., all of which call for advanced degrees to be executed at a proficient level. Industry 4.0, which is at the mass customization stage, uses robots to do monotonous jobs, whereas industry 5.0 seeks to achieve mass personalization using artificial intelligence and robotics. Higher autonomy for collaborative robots is projected to revolutionize the manufacturing process in Industry 5.0 (Nahavandi, 2019). Industry 5.0 is a hypothetical industrial revolution that will enable robots to carry out monotonous activities (Jabrane and Bousmah,2021), increasing creativity and innovation in products. It should make the best possible use of human creativity and intelligence.

Since, Across India a wide network of Micro and Small Enterprises (MSEs) has been playing a vital role in national production, employment and exports (Kumar and Nanda, 2023). MSEs also contribute to the Economic development of the country. From past few years India have evidenced the potential growth in MSEs. Likewise Chhattisgarh have seen a pace in the development in the network and diversity of MSEs. It has been reported that the adoption of Industry-4.0 by the MSEs of Chhattisgarh have increased the production and economic growth of the state. Now the advanced in technology have given rise to the Industry-5.0. Durg, Chhattisgarh have adopted the technologies required for the implementation of Industry-5.0. There is a lot of potential in the adoption and implementation Industry-5.0 for MSEs sector of Durg Chhattisgarh. With these potential there exist also a number of challenges in the adoption and implementation of Industry-5.0 for MSEs sector of Durg Chhattisgarh. Keeping in view this scenario, the present study was undertaken to understand the potential and challenges in the adoption and implementation of Industry-5.0 for MSEs sector of Durg Chhattisgarh. The main objectives of the present study are;

1. To determine the status of Micro and Small Enterprise (MSEs) in District Durg of Chhattisgarh.
2. To identify the potential while adopting and implementing the principles of Industry-5.0 for Micro and Small Enterprise (MSEs) of Durg Chhattisgarh.
3. To identify the major Challenges while adopting and implementing the principles of Industry-5.0 for Micro and Small Enterprise (MSEs) of Durg Chhattisgarh

Research Methodology

The present work aims to access the key drivers and Barriers for Industry-5.0 in small and micro scale industries in Durg, Chhattisgarh. The study is descriptive in nature. Randomly one district i.e., Durg was selected to observe the potential drivers and barriers for Industry-5.0 for micro and small scale industries. This research work was carried out by using a qualitative approach since this method is used to fulfill the research goals, and it is more fitting to understand how and why things happen (Cooper and Schindler, 2011). The study includes secondary data for the analysis. The secondary data was collected from websites, blogs, magazines and newspapers in India. The analysis was focused on a broad variety of data sources, including books, government records, journal articles, policy reports and conference papers. Journal article searches were made in the Library Catalogue and reference lists of retrieved articles and textbooks, and electronic literature databases, such as google scholar, Science Direct, Emerald, and Scopus. Finally the utmost important factors as drivers and factors as barriers were noted and represented in the result section of this research article.

Results and Discussion

Micro and Small Scale Enterprise (MSEs) encompass wide scope covering activities like manufacturing, servicing, Financing, construction, infrastructure etc. In view of Government of India's ever increasing Importance given to the small scale industries in the national economy more & more small scale Industries are to be set up in the years to come. By contributing its increasing share to the National production, employment & exports, small scale industries also contribute to the Economic development of the country. Chhattisgarh is a newly formed state and is rich in mineral and natural resources, which had attracted the industrialists across the country. The state has a good network of the industries including MSEs. Across all the districts Durg has been regarded as the Mini India due to its industrial development. Durg has a very rich network and diversity of micro and small scale industries (Table-1). District wise status of MSEs have been reported I Table-1. It has been reported that Durg, Chhatisgarh have highest number of MSEs, after Raipur in Chhattisgarh.

Almost 70% of these industries are following the principles of Industry 4.0 for smart manufacturing. It has been found that the smart manufacturing system focus on the product design, process of manufacturing, packaging of product, product analytics, product stock, supply chain, product customization, machine to machine (M2M) production, deliver system, cloud computing, robotic inclusion, artificial intelligence, production efficiency and accuracy etc in order to meet the demand of the consumer in a sustainable way. The Industry-4.0 is gaining grounds in MSE sector of Durg, Chhattisgarh. With the development of artificial Intelligence, big data analysis and robotics Industry-5.0 have made its presence across the globe. The western countries have been extensively adopting the principles of Industry-5.0, But in India it has been at its initial phase. From past few years we have been observing a speedy development in the digital infrastructure of India and Chhattisgarh. Durg Bhilai is known as the IT city of Chhattisgarh. Thus for the implementation and adoption of Industry-5.0 have a good scope and future in Durg Chhattisgarh.

Table-1. Detail of Micro and Small Enterprises (MSEs) Chhattisgarh

S.No	District	**Total Reg**	**Micro**	**Small**	**%age** Share of **Micro** to Total Reg	**%age** Share of **Small** to Total Reg
01	Balod	1804	1355	381	**75.11%**	**21.11%**
02	Baloda Bazar	3994	2427	1422	**60.76%**	**35.60%**
03	Balarampur	1434	1141	251	**79.56%**	**17.50%**
04	Baster	1495	966	377	**64.61%**	**25.21%**
05	Bhemtara	2451	1564	713	**63.81%**	**29.09%**
06	Bijapur	258	214	38	**82.94%**	**14.72%**
07	Bilaspur	5572	3765	1357	**67.56%**	**24.35%**
08	Dantewada	401	285	82	**71.07%**	**20.44%**
09	Dhamtari	2325	1473	699	**63.35%**	**30.06%**
10	**Durg**	**10474**	**6611**	**3122**	**63.11%**	**29.80%**
11	Gariyaband	1124	806	274	**71.70%**	**24.37%**
12	Gorilla-Pendra	296	220	64	**74.32%**	**21.62%**
13	Janjgir-Champa	5968	4447	1179	**74.51%**	**19.75%**
14	Jashpur	2282	1930	305	**84.57%**	**13.34%**
15	Kabeerdham	3498	2867	504	**81.96%**	**14.40%**
16	Kanker	1279	903	299	**70.60%**	**23.37%**
17	Kondagaon	752	529	104	**70.34%**	**13.82%**
18	Korba	3268	2519	530	**77.08%**	**16.21%**
19	Koriya	1121	907	177	**80.90%**	**15.78%**
20	Mahasumand	3484	2407	901	**69.08%**	**25.86%**
21	Mungeli	1308	1040	197	**79.51%**	**15.06%**
22	Narayanpur	198	160	20	**80.80%**	**10.10%**
23	Raigarh	4661	3034	1193	**65.09%**	**25.59%**
24	Raipur	17701	9456	6226	**53.42%**	**35.17%**
25	Rajnandgaon	4619	3131	1092	**67.78%**	**23.64%**
26	Sarguja	3540	2812	566	**79.43%**	**15.98%**
27	Sukma	279	245	23	**87.81%**	**8.24%**
28	Surajpur	1419	1148	195	**80.90%**	**13.74%**
	Total	**87005**	**58362**	**22291**	**67.07%**	**25.62%**

**Source: Department of Commerce and Industries, Govt of CG.*

Key Technologies of Industry-5.0

With the integration of cognitive skills and innovation, a number of supporting technical developments, including Artificial Intelligence, Big Data Analysis, Cobotics, Digital Twin, Block Chain, Internet of Every Thing, Edge Computing, and 6g & Beyond , may help companies enhance productivity and offer customized goods more swiftly. Industry 5.0 is an improved manufacturing model with an emphasis on the interaction between robots and humans thanks to these supporting technologies. Smart machines are built to collaborate with people, making human talents more productive and straightforward to automate for both individuals and small organisations than ever before. In this section, enabling technologies for Industry 5.0 are briefly discussed. The important enabling technologies in relation to Industry 5.0 are highlighted in Fig. 2.

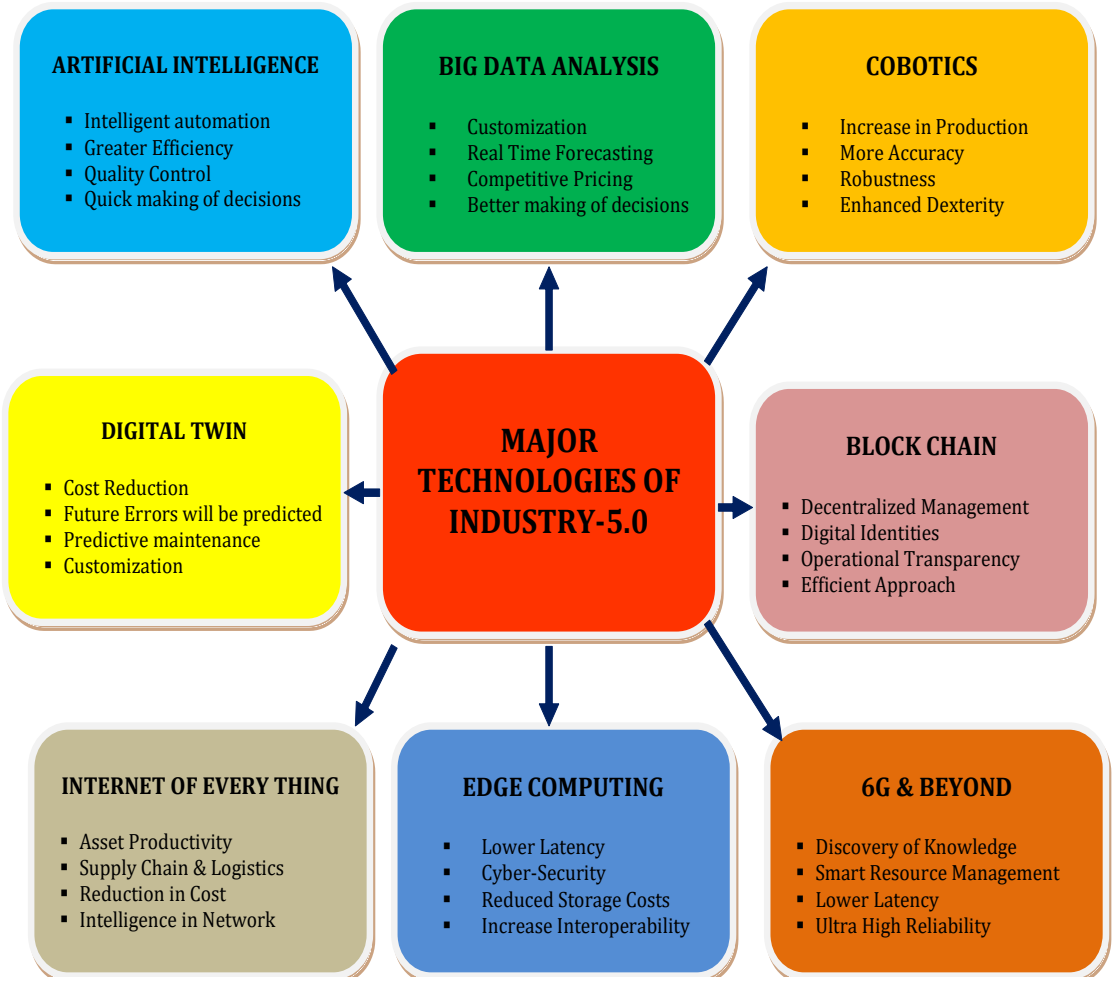

Fig-2: Key Enabling Technologies of Industry-5.0

Opportunities and Challenges of Industry-5.0 in MSE Sector of Durg Chhattisgarh.

Industry-5.0 is a play card for the increase in the production in the current era of time. With development in the information technology day by day new applications and ground is being made in the production process, the industry-4.0 was revolving round the digitization for increasing the work efficiency. Still the Industry-4.0 is being making grounds of success and has still to do lot of things. Now the introduction of automation in the industrial sector through artificial intelligence, big data analysis and cobiotics, Industry-5.0 has made its stage. Industry-5.0 is at its existing stage. The developed countries have adopted the principles of

Industry-5.0. But, still the developing nations are thinking for its adoption. The adoption and implememtaion of Industry-5.0 is associated with the opportunities and challenges. In this section we will discuss about the opportunities and challenges which MSEs of Durg Chhattisgarh will face while adopting the principles of Industry-5.0.

1. Opportunities of Industry-5.0 in MSE Sector of Durg Chhattisgarh.

Industry-5.0 has made its stage by opening new dimensions in the manufacturing sector. The principles of Inudstry-5.0 have given new hands of customization, automation, and personalization to the MSE sector of industries. The major opportunities which MSEs of Durg Chhattisgarh will have while adopting and implementing principles of Industry-5.0 are given under;

i. Through the use of next-generation technologies, increased automation will have a favourable influence on employment in MSE sector of Durg, Chhattisgarh.
ii. Highly automated production techniques provide MSE sector of Durg, Chhattisgarh more customized options.
iii. In order to maximize human productivity, Industry 5.0 expands the options for creative individuals to come and work in MSE sector of Durg, Chhattisgarh.
iv. Industry 5.0 will assist the customer digitally in managing frequent follow-up assignments and machines are adaptable according to employee wants to generate a high-level choice in MSE sector of Durg, Chhattisgarh.
v. Industry 5.0 generates higher-value employment in MSE sector of Durg, Chhattisgarh than it did previously.
vi. In industry 5.0, the operator within the production cell gets more engaged in the planning method than in the more or less automated manufacturing method.
vii. Industry-5.0 permits more individualized and custom items and allows for the freedom of design to operate in MSE sector of Durg, Chhattisgarh.
viii. More personalized products and services increase customer satisfaction, loyalty, and attract new customers, which results in increased profit and market share for the MSE sector of Durg, Chhattisgarh.
ix. Increased safety of the employees at the work floor because COBOTs can take on hazardous and dangerous works in MSE sector of Durg, Chhattisgarh.
x. Industry 5.0 enables the automation of manufacturing methods better by feeding the real-time information from the MSE sector of Durg, Chhattisgarh.
xi. If sufficient finance and infrastructure are available, Industry-5.0 offers start-ups and entrepreneurs in creative and inventive fields in MSE sector of Durg, Chhattisgarh
xii. The topic of human-machine interaction is given more weight in Industry 5.0 and has a broader platform for research and development in this area.
xiii. With the aid of industry 5.0, quality services may be delivered in remote places, particularly in the healthcare sector where robots can perform procedures.

2. Challenges for MSE sector of Durg Chhattisgarh in adopting Industry-5.0.

The automation, personalization and customization of the products from MSE sector of Durg Chhattisgarh have to face number of problems. With respect to the problems faced by the adoption of Indstry-4.0 also Industry-5.0 has to face number of challenges. With respect to

the common challenges like skill, technology, time and money, the specific challenges which MSE sector of Durg Chhattisgarh in adopting Industry-5.0 will face are given as under;

i. Industry-5.0 deepens the polarization of the labour market, as middle-skill employment is declining and the workforce is divided into two groups: highly skilled and qualified workers who earn high wages, and unskilled workers who earn low wages. This could narrow the gap between competent and unskilled people in society.
ii. Due to increasingly automated industrial methods, it is extremely difficult to teach the staff to accept cutting-edge technology and to adapt their behaviour while interacting with others in MSE sector of Durg Chhattisgarh.
iii. Collaborative robotics is a form of technology that, along with human coworkers, continues to pose a serious risk in MSE sector of Durg Chhattisgarh.
iv. Higher autonomy and sociality skills are essential for self-organized systems in smart manufacturing systems. Due to the current systems' lack of autonomy, such as integrated decision making, the transition from the current setting to industry 5.0 is challenging.
v. It is challenging to adapt various data repositories in MSE sector of Durg Chhattisgarh and to obtain data of high quality and integrity.
vi. Due to its increasing connection and adoption of common communications protocols, industry 5.0 poses a greater danger to cyber security in MSE sector of Durg Chhattisgarh
vii. Industry 5.0 is challenging for business, especially in MSE sector of Durg Chhattisgarh, to adopt since it requires enormous expenditure to properly execute all of its pillars.
viii. For instance, industry 5.0 has enormous promise for the healthcare sector, but it also demands a high level of accuracy and precision. This area of study is still in its infancy and calls for substantial infrastructural expenditures in MSE sector of Durg Chhattisgarh.
ix. For start-ups and business owners, it might be difficult because industry 5.0 involves significant infrastructure expenditures and the use of cutting-edge technologies in MSE sector of Durg Chhattisgarh.
x. Drawing regulatory frameworks in industry 5.0 is difficult because of the use of automation in MSE sector of Durg Chhattisgarh.
xi. The current company strategy and business models must be adjusted and customized to match the requirements of industry 5.0 due to greater degrees of automation in the industries. Business strategy will place a greater emphasis on customer-centric operations as a result of mass personalization. Customer subjectivity shifts throughout time, making it challenging to often alter corporate tactics and business structures of MSE sector of Durg Chhattisgarh.
xii. The business strategy of Industry-5.0 due to various client preferences requires a higher level of dynamism to maintain competition in MSE sector of Durg Chhattisgarh.

Conclusion

The present study aims to assess the opportunities and challenges in adopting and implementing Industry-5.0 by Micro and Small Enterprises of Durg, Chhattisgarh.The Industry 4.0 has been a major force framing the social, economic and technological environment after 2011in MSE sector of Durg Chhattisgarh. The Industry-4.0 is gaining more and more grounds and is yet to be matured. With the development in the information technology of Industry-5.0 is making the stage. The Industry-5.0 works on the principles of

automation, customization and personalization through use of artificial intelligence, big data analysis and cobiotics. Durg district of Chhattisgarh is reported to be the industrially developed district. This district has a wide network of MSEs almost after Raipur district the highest number of MSEs is reported to be in District. The adoption of Industry-5.0 by will provide opportunities of personalization, customization of the production through use of artificial intelligence, and robotics. In addition to the opportunities, the results suggest number of challenges for the adoption of industry-5.0 by MSE sector. The major Challenges which MSEs of Durg, Chhattisgarh faces for the adoption of Industry-5.0 were; higher investments, lack of infrastructure by MSEs, incompatibility for accepting automation,etc. Further analytical research is required to identify the type based MSE challenges while adopting Industry-5.0.

Conflict Of Interest

The author would like to undertake that the above mentioned manuscript has not been published elsewhere, accepted for publication elsewhere or under editorial review for publication elsewhere. The authors declare that they do not have any conflict of interest with the submission of this manuscript.

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