Status of Smart Manufacturing System Implementation in Indian SMEs: A Multi-Case Approach

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Abstract

Smart Manufacturing System (SMS) is facilitating new ways for humans and machines to work together, empowering businesses to achieve greater insights, reduce the risk of error and make better decisions. This revolution in the manufacturing sector is possible through digital transformation, up-gradation to new technological developments and effective use of data and thus making the manufacturing sector more intelligent and smart. In recent times, significant efforts have been undertaken by the Indian government to promote the implementation of SMS in the Indian manufacturing sector to leverage the benefits of this technological transformation. Thus, this paper presents the status quo of SMS implementation in Indian "Small and Medium Enterprises (SMEs)" and discusses the various initiatives undertaken by the Indian government and private players. In addition, five case studies are conducted which either is seeking or have already implemented SMS system in their working environment. The study also comprehends detail about challenges faced by SMEs in SMS implementation and finally elaborate the future scope of SMS based research.

Keywords
Implementation Challenges, Indian Manufacturing Sector, Multiple Case Study, Smart Manufacturing, SMEs.

1. Introduction

Manufacturing sector is constantly evolving and producing real value for the manufacturers in all shape and sizes. However, complexity in manufacturing, increased global competition, radically changing the demands of the customer and need of higher system security requires some pervasive application of network and some real-time monitoring. Smart Manufacturing System (SMS) potentially addresses these issues through highly automated system and advance enabling technologies (Shukla and Shankar, 2021). SMS is believed to be one of the promising technologies that are associated with artificial intelligence and real-time system making the manufacturing practice more efficient (Fedorov et al. 2015).

Smart manufacturing is often associated with Industry 4.0, the term introduced in an exposition held in Germany, with an intension to promote 4th phase of industrial revolution (Moyne and Iskandar, 2017). This revolution considers smart manufacturing as its central element and generally the term is interchangeably used by the most of the researcher (Kagermann et al. 2013). SMS is set to revolutionize the present manufacturing ecosystem by incorporating use of recent technological developments. Furthermore, this will create foundation for a new digital manufacturing era (Shukla and Shankar, In Press).

Smart Manufacturing leverages advance technologies which provide promising approaches to address specific issues. The most important ones are "Big Data Analytics (BDA, Cloud Computing (CC), Digital Twin (DT), Internet of Things (IoT), 3D Printing and Cyber-Physical System (CPS)". These technologies can be integrated as per the need of the industry instead of going for complete SM system implementation. This can foster great advantage to SMEs where financial capability is a constraint in SMS implementation. SMEs have potential to play a crucial role in boosting the Indian economy as they can contribute greatly to the country's socio-economic development (Shukla, 2018). This sector also contributes in generating employment opportunities thus fostering rural development (Abubakr et al. 2020).

This paper is organized in 7 sections, the next section comprises of details of smart manufacturing in India and its need. Whereas section 3 elaborates the SMEs contribution towards India's development, followed by initiatives taken by Indian government for successful SMS implementation in section 4. The section 5 and 6 consists of five case studies of Indian SMEs and potential challenges faced by SMEs in SMS implementation. The section 7 represents the concluding remarks of the paper.

2. Need of Smart Manufacturing in India

Smart Manufacturing is important in India for having a strong economy growth. At present in 2020, the manufacturing sector in India contributes 17.4% in "Gross Domestic Product (GDP)" (Dhawan and Sengupta, 2020). Promoting the growth and increasing the contribution of manufacturing sector is the utmost priority of Indian government today. For this, the government has taken initiatives to increase the share of manufacturing sector by 25% by the year of 2022; one of such initiative is "Make in India" (https://tinyurl.com/2p279vne). This initiative aims to make India a global manufacturing hub by focusing on infrastructure development, jobs creation, skill development, and simple processes fostering innovation in the manufacturing sector. In Indian context, implementation of SMS is more complex since it being semi-organized and possesses orthodox thinking. However, Indian firms are now coming ahead to adopt newer technologies to reaps its benefit. Further, Indian organization might get supportive aid from "Smart Manufacturing Systems Characterization (SMSC)" as of USA which is enabler of SMS in USA. However, we all know there is huge gap in culture of Indian and USA manufacturing organization. Although India needs to withstand increasing global competition especially in manufacturing sector and it also contribute to major economy of the country. Implementation of SMS can possibly help this country to uplift its productivity and bring transparency into the manufacturing system. Manufacturing is the backbone of any country's economic growth. One cannot deny that India is far behind to catch the full-fledge technology bus unlike China and South Korea. China's manufacturing sector contributes to 26.8% to its GDP (https://tinyurl.com/7vra24pt) and South Korea around 25.32% (https://tinyurl.com/r7j65dy8) in 2019.

The concept of SMS is very new in the world of manufacturing which endorse a biggest challenge for small scale industries in developed and developing countries to accept this challenge. India being a developing nation needs an environment for smart manufacturing to push its manufacturing sector for greater productivity and efficiency. In this work, an effort is made to present the needs, current scenario and future challenges for SMS implementation in Indian SMEs. Indian economy is very much dependent on its manufacturing sector after agriculture and government of India believes this sector as one of the most promising area for its economic development. Here, we discuss few important aspects which push the need of SMS implementation in Indian manufacturing sector.

2.1 Slow growth in GDP contribution

Manufacturing's contribution is almost stagnant to 16% in recent years (Iyer 2018), therefore it is very necessary to uplift and focus on the development of Indian manufacturing sector. China and countries with "unparalleled" economic growth mainly in this sector and mainly focused on introduction of new technologies, infrastructure and investment in R&D. Indian Government also needs to incorporate constant efforts in manufacturing by bringing new technologies by technology transfer, global collaboration and indigenously development.

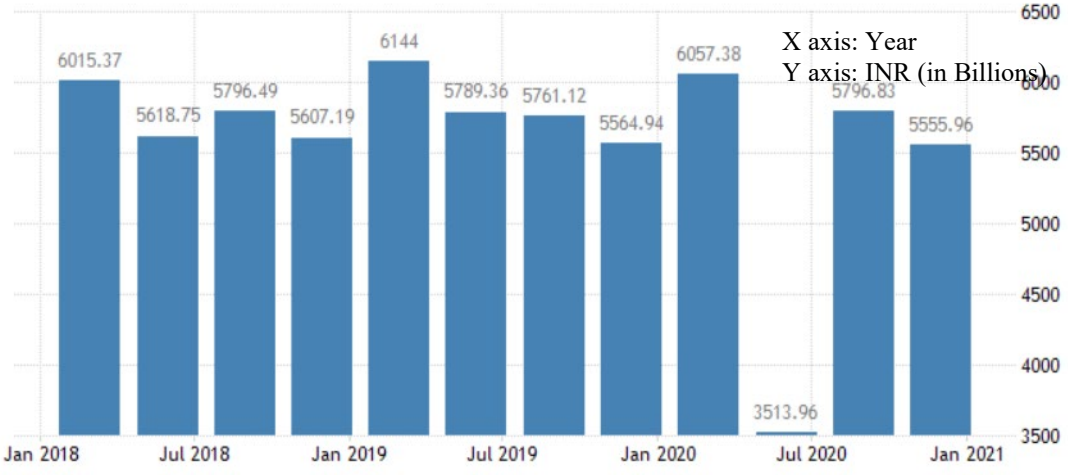

Figure 1. Manufacturing sector growth rate from 2018 to 2021 (fourth quarter report) (Source: "Central Statistics Organization, India")

2.2 Steady growth rate in manufacturing sector

Another reason for implementation of such smart technology is the steady growth rate of manufacturing sector to the contribution of Indian GDP. Figure 1 shows the quarterly contribution of GDP by manufacturing sector which is near about constant. However, sudden decrease in April to June 2020 is observed due to country wide lockdown. Further, after relaxation in lockdown rules and opening of industries resulted in the normal growth. Moreover, if we look at wider horizon, the growth seems to steady and this sector needs technological booster in terms of SMS and proper policy planning by government.

2.3 High employment generation

India is a country with large population of engineers and factory workers; India's intellectual property and workforce is spread globally. Utilizing this power of India can be well put into manufacturing sector as manufacturing sectors brings more employment opportunity as compared to other sectors. According to, Labor Bureau's Quarterly Employment Report in selected sectors (as on 1st October, 2017), the manufacturing sector added an estimated 89,000 jobs in the 2nd quarter of 2017-18, which is highest among any sector in India (refer Table 1).

Table 1. Estimated change in employment in few selected sectors (in lakhs)

S. No	Sector	01/07/16 over 01/04/16	01/10/16 over 01/07/16	1/01/17 over 01/10/17	01/07/17 over 01/01/17	01/07/17 over 01/04/17	01/10/17 over 01/07/17
1	Accommodation & Restaurant	0.01	-0.08	0.00	0.03	0.05	0.02
2	Construction	-0.23	-0.01	-0.01	0.02	0.10	-0.22
3	Education	0.51	-0.02	0.18	0.02	0.99	0.21
4	Health	0.33	0.00	0.02	0.31	0.31	0.11
5	IT/BPO	-0.16	0.26	0.12	0.13	0.02	0.01
6	Manufacturing	-0.12	0.24	0.83	1.02	-0.87	0.89
7	Trade	0.26	-0.07	0.07	0.29	0.07	0.14
8	Transport	0.17	0.00	0.01	0.03	-0.03	0.20
	Total	**0.77**	**0.32**	**1.22**	**1.85**	**0.64**	**1.36**

(Source: "Quarterly Report on Employment Scenario in Selected Sector (As on 01 Oct 2017)")

Being one of the highest growths in employment government and researchers are bound to focus on manufacturing and transform it into Smart Manufacturing. Implementation of such technology is such a vital thing to do in India that it can open many doors of opportunities not only in terms of economic growth but also improve international relations. Technologies are standing on the verge of being use but accepting or adopting is getting difficult by the management to do. But hopes can never go down by quoting the examples the evolution of software technology in this country although people and experts were skeptical about it (Patibandla and Petersen, 2002).

2.4 Fall in Network Readiness Index

One of the main or rather most important elements to consider when it comes to adoption of any technology is how well the country is prepared with its ICT infrastructure. This is measured by "Network Readiness Index"; this calculates the capacity if the country to support ICTs for increased competitiveness and well-being. This index is prepared based on 53 individual indicators which are distributed into different pillars. India has slipped down to 137 (with a score of 58 out of 100) from rank 91 from 2015 to 2018 (as on page 55 of World *Economic Forum's Global Innovation index 2017-18*). One can say a serious need of ICT will improve its leverage in this country, because this urge will make the government left with no option and just to focus on it. Need can make their way by making our manufacturing system "Smart" which is possible only though the support of proper ICT infrastructure.

2.5 High Global Innovation Index

According to *"Global Innovation Index (GII) 2020"* report by Dutta et al. (2020), India stands in third position when it comes to Innovation achievers among 130 economies around the globe. The report categorized countries into four bracket i.e. "High Income Group, Upper Middle Income Group, Lower Middle Income Group and Low Middle Group." Apart from being in Lower-Middle bracket India still manages to make place amongst high innovative countries beating Upper-Middle Income bracketed countries like Thailand, Montenegro and Bulgaria. In addition,

India has been ranked as the 48th most competitive economies over the countries accounted and where Switzerland, Netherlands and Sweden are the top rankers. India's rank has taken a jump of nine places from 2018 which is quite remarkable growth. The editors of this report, believing in the potential of India said *"India is consistently an overachiever relative to its level of development, although it is making progress in its rankings year on year. Given its size, India has the potential to make a true difference to the global innovation landscape in the years to come."* (As on page no. 35 of *Key Findings of the GII, 2020*). Having such potential towards innovation and open arms welcoming new technologies this country must work on how to make this possible. Further, based on the innovation, the countries are divided on the basis of "expectation for level of development" where India stands in the category of "above" expectation for level of development. This shows that India has potential to leverage the SMS in manufacturing sector and thus making big contribution towards the economic growth of the country.

3. Significance of SMEs in Indian Manufacturing Sector

According to, "The Micro, Small and Medium Enterprise (MSME) Act 2006" notified in September 2006 ("as on chapter III of Classification of Enterprises, Advisory Committee and Memorandum of MSME") provide the classification of enterprises based on their investment size and nature of activity undertaken. Further, this act was updated in June 2020 and classifies the various enterprises as presented in Table 2.

Table 2. The limit of investment for plant and machinery/equipment for manufacturing/service enterprise, revised classification applicable w.e.f. 1st July 2020

Classification	Micro	Small	Medium
"Manufacturing Enterprises and Enterprises rendering Services"	"Investment in Plant and Machinery or Equipment: Not more than Rs.1 crore and Annual Turnover; not more than Rs. 5 crores"	"Investment in Plant and Machinery or Equipment: Not more than Rs.10 crore and Annual Turnover; not more than Rs. 50 crores"	"Investment in Plant and Machinery or Equipment: Not more than Rs.50 crore and Annual Turnover; not more than Rs. 250 crores"

(Source: https://msme.gov.in/know-about-msme)

Each country has separate definition for SMEs. European countries generally categorize SMEs based on number of employee (i.e. workforce size). In Indian context, SMEs can be considered as basic concept while MSME is its broader term. The ministry of MSME India has setup few objectives for MSME. These include increasing employment and contribution to GDP, encouraging innovation and improvement in administration activities. One can say Micro enterprises can be skeptical to introduce SMS into working due to the limit of investment. So, going for just SMEs can make this integration possible without such limitation. Although a need for change in the limitation is raised by the stake holders time to time. SMEs are emerging with high potential and dynamic sector for the growth Indian economy as compared to other enterprises. SMEs not only provide large employment with less capital cost as compared to "Multi National Enterprises (MNEs)" and also provide growth opportunities to rural regions also. This helps a country to eliminate regional imbalances, also fair and equitable distribution of national wealth. This sector contributes to socio-economic status the country through integration of different culture into one organization. These enterprises have proven their sustainability with highs and lows of Indian economy time to time.

3.1 SMEs contribution in economic development

SMEs produce 45% of total industrial outputs and are often considered as the backbone for the evolution of manufacturing sector development (https://tinyurl.com/49394tna). The contribution of SMEs is significant towards country's economy. Few of the characteristics of SMEs are as follows:

- Generating employment to larger masses
- Capacity to produce and fulfill customize product demand
- Being competitive in domestic and global markets
- Capability to adopt new technologies
- Generating new entrepreneurs
- Low capital investments requirements
- Use of domestic resources
- Location wise mobility
- Low intensive imports

- Technology-oriented industries
- Training to provide knowledge and developing skills of rural workers

Srinivasan & Kadu, (2018) analyzed well the importance of SMEs to transform the industries from industry 2.0 from industry 4.0. The author in the article with a deep study concluded that with the growth of this sector requires a significant push towards introduction and adoption of new technology is necessary to industrial upliftment. Thus, targeting this sector for bringing SMS into practice in India is a viable option for the upliftment of Indian manufacturing sector. However, there exist several roadblocks for the transformation of SMEs. Some of them are elaborated in next subsection.

3.2 Challenges faced by SMEs

- Many SMEs are reluctant to grow, resulting in reduced productivity. (To avoid regulatory and taxation related hurdles).
- Those who choose to grow, have a different set of problems to deal with (SMEs' exposure to bank credit was drastically falling due to the high interest rates).
- Another issue originates due to repayment timelines. (MNEs get an interest-free repayment timeline of 120 days; SMEs get only 60 days to pay back their interest-loaded bank loans) (https://tinyurl.com/49394tna).
- These companies are not market leaders in their segments; they are unable to hold a bargaining power in the price battle. They struggle to maintain quality while coping with reducing profit margins.
- Supply chain inefficiencies.
- Global and local competition.
- Insufficient skilled manpower.

4. Initiatives taken by Indian Government for SMS and Industrial Revolution

Industrial sectors are taking SMEs as one of the most promising enterprise for the economic growth. So, the government is focusing on bringing new and smart technologies to withstand global market and increase its contribution to GDP from 15.3 % to 25% by the year of 2022 (https://tinyurl.com/2p279vne). For this Indian government launches two main projects "Make in India" and "Smart Advanced Manufacturing and Rapid Transformation Hub (SAMARTH) Udhyog" to boost SMS implementation in manufacturing sector.

4.1 Make in India

In a global economy landscape, India is showing its presence through its technology transformation and Digitization. Indian Government on September 25, 2014, launched a "Make in India" initiatives (http://www.makeinindia.com/home) to boost manufacturing sectors. The motto behind this initiative is to encourage the multinational as well as domestic manufacturers to make Indian economy as one of the self-dependent strong economy. This national programme designed to encourage local manufacturers for innovations, enhance skill development, and facilitate investment to produce products within the country. In addition, Department of Industrial Policy and Promotion are promising to make the contribution of Indian manufacturing sector to 25% of GDP by the year of 2022. This initiative is built on four pillars:

1. *New Processes:* For example, creating possibilities for "Foreign Direct Investment (FDI)" and focusing on improving the "Ease of Doing Business" index, as India jumped 23 places and holds 77th rank among 190 economies. (https://www.makeinindia.com/eodb).
2. *New Infrastructure:* The government intends to have world class infrastructure and to develop industrial corridors keeping in forefront the "Intellectual Property Rights (IPR)" registration.
3. *New Sectors:* This initiative targeted 25 sectors to promote and allows open business access to work.
4. *New Mindsets:* Government came out with the concept of "Zero defect, zero effect" where seeking the possibility of having "zero defects" and having "zero effect" on the adverse conditions.

This dream can be accomplished by the implementation of Smart Manufacturing in our factories as this technology responds well and leads to a quick business transformation, maintaining the economy and leads to fulfillment of demand customization with no time (Davis et al, 2012). The author also believes that an IT-enabled smart factories and supply networks works for national interest and a strategic approach can open the rooms for such implementation. Therefore, various projects are undertaken and proposed by the government to foster Smart Manufacturing in India.

4.2 Aatmanirbhar Bharat

The year of 2020 has been a devastating year due to pandemic accompanied by nation-wide lockdown. This situation eventually affected country's economy in large scale mainly due to industries and business shutdowns. Therefore, Indian Government (on 12th May 2020) came out with a "Self-reliant" movement called Aatmanirbhar Bharat Abhiyaan. This campaign started with the vision of new India raised a clarion call to the nation giving a boost to the country's economy. The objective of Aatmanirbhar Bharat is to promote indigenous products and ensure that these should match their imported counterparts thus, making India a stronger player in the global market.

The Aatmanirbhar Bharat Abhiyaan is an important mission for country's economy revival and progress. The government added various other sectors along with this initiative scheme to prosper and provide easy investment facilities. Sectors like telecommunication, pharma, medical devices, automobile, and auto components etc. are promoted where there is way to increase domestic manufacturing. This initiative was much needed at this time of pandemic as India has huge potential to achieve self-reliance but it requires proper implementation of this initiative on ground by Indian government and proper allocation of funds to both multinationals companies as well as to SMEs.

4.3 SAMARTH

SAMARTH Udhyog Bharat 4.0 is an industrial growth initiative by "Department of Ministry of Heavy Industry and Public Enterprises of Government of India". This initiative is India's response to revolution like Smart Manufacturing and Industry 4.0. SAMARTH is basically created for programme contents with the experts to bring awareness about Industry 4.0.

Vision of SAMARATH: "To facilitate and create eco system for propagation of Industry 4.0 set of technologies in every Indian manufacturing by 2025, be it MNC, large, medium or small-scale Ultimately, Industry 4.0 is set to take root across the manufacturing ecosystem. But only by understanding and harnessing the technologies driving Industry 4.0, will manufacturers stay on the cutting edge of this new digital era". (https://www.samarthudyog-i40.in/about-samarth-udyog)

Mission of SAMARATH: The mission of the SAMARTH Udhyog Bharat 4.0 is divided into six piers. They are as follows:

1. Awareness and demystification about the technology
2. Experience and demo centers
3. Training and skill development
4. Industry and academia
5. Engineering research and applicable for Industry 4.0 technologies
6. International cooperation

Apart from this, five centers are open under this programme uniquely design for spreading awareness about advance technology and Industry 4.0. These five centers are known as "Common Engineering Facility Centre (CEFC)" especially stressed that these centers would have resource sharing so that resource utilization is maximized and common platform for Industry 4.0. The five CEFC centers are:

1. "Kirloskar Center for Learning in Industry 4.0 Lab Pune"
2. "IITD-AIA Foundation for Smart Manufacturing"
3. "Industry 4.0 Indian IISc Factory R&D Platform"
4. "Smart Manufacturing Demo and Development Cell at CMTI"
5. "Industry 4.0 projects at DHI CoE in Advanced Manufacturing Technology, IIT Kharagpur"

The evolution of Smart Manufacturing is still under the microscope and need more research and development. India to have an economic growth needs this SMS in its conventional manufacturing system.

4.4 CII Smart Manufacturing Platform

CII also known as "Confederation of Indian Industry" and is formed that consist people for industry, academia, and government to try and collaborate to work for continuous growth of Indian industries. This confederation is non-government and non-profit works to make Indian industries more sustainable, more advance, and more competitive

in global market. This alliance was founded in 1895, includes around 9000 members both public and private including SMEs and MNEs and around 3000 industrial membership from 265 regional and national industries.

CII's has launched a smart manufacturing platform that is designed for industries seeking for technological change and make an Industry 4.0 enabled India. This vision requires skilling of workforce and collective wisdom of all the industrial experts forming the alliance. Further, this confederation helps in consulting, auditing, research institute, technology provider and various international collaborations to bring industrial excellence in Indian industries. Furthermore, training program, case-studies, studies and publication, state level intervention center and demonstration facilities, advisory services, business opportunities are also the beneficiaries of this platform.

4.5 Private and Consortium Initiatives

4.5.1 Siemens/IBM/Red Hat launch Hybrid Cloud Initiative

This initiative started with the ambitions to provide a flexible, open and highly secure solution for manufacturing organizations. Siemens, IBM, and Red Hat have joined hands to launch a Hybrid Cloud Initiative. With a single manufacturing site generation over 2,200 terabytes of data with most going unanalyzed, the three organizations aim to increase real time value from operational data. The main intension of this initiative is that the Siemens Digital Industries Software can be applied to IBM's open hybrid cloud approach and set up on Red Hat's OpenShift. By doing so, these three organizations aim to increase the deployment flexibility of "MindSphere" which is Siemens' Industrial Internet of Things (IIOT) leading service solution. This is platform has been created for customer to run MindSphere on-premises thus unlock the speed and agility in factory and plant operations and seamless support, updates and connectivity through cloud technology.

4.5.2 Wipro 3D

Wipro limited is a global corporation delivering information technology solution, innovation strategy and business consulting services. It has started center for 3D printing called Wipro 3D. This initiative solely focus on metal additive manufacturing which is providing services and solutions to aerospace, defense, space, industrial and tooling, healthcare, automotive and nuclear sectors. Wipro 3D also provides consultation regarding adaption of additive manufacturing technology, additive engineering services, deployment, research and development, operations, and solution of this technique into an individual's organization. The main feature of this center is that it provides a customize solution through as per the organization's requirement seeking for the solution. Believing in the power of future of additive manufacturing, Wipro 3D is working at its way and working successfully. It is trying everything like to train, consult and provide solution to change conventional manufacturing practices with this advance technology.

5. Case Study

In this paper, five industrial case studies have been comprehended to present a realistic approach on SMS implementation in Indian SMEs. The case study is conducted through a semi-structured interview with the employees at various levels of the case companies and the study is confined to "National Capital Region (NCR)" of India. NCR constitute of few district of Haryana, Rajasthan, Uttar Pradesh and whole of Delhi. Out of five cases presented, two companies have successfully implemented SMS and the other three are in the planning stage to implement the same. The detailed of the cases is discussed below:

5.1 Case A

Company A is also an auto ancillary company situated in Noida, Uttar Pradesh and established in the year 2009. It is manufacturer and trader of efficient range of thermoforming and packaging trays. Apart from this, company manufactures blister tray, fiber reinforced plastics, rubber rings and rubber profiles which are fireproof and recyclable. This company has implemented SMS in its production system to give utmost attention towards maximum satisfaction of the clients. The company also offers its client that if any new item is not developed in 96 hours, the delivery will be free for the same. This company also caters the needs of the clients by well-developed and smart system facilities. These facilities installed with advance machine and tools that have a production capacity of 10 tons per months, thus meeting client's demand on time.

After ditching conventional system over SMS, the company now connects to its machinery for monitoring the complete production process at the plant. This was achieved by setting sensors into factory machine which can further

be utilized to collect the data for monitoring the condition and cycle time of machines. The real-time monitoring and advance data analytics can alert workers for any type of bottleneck situation. Moreover, this can help to predict any kind of machine failures making operators enable to schedule maintenance activity well before time of failure and thus making machine more durable with longer operating and running time. The experts of the industry claims that using data analysis in above described way resulted into more than 20% output increase in specific areas, thus providing on-time delivery and better customer satisfaction. Lastly, implementing SMS can give a greater insight to industry processes thus enabling it to reduce machine breakdown and optimize production processes. This company has craved its good reputation in Indian market and willing to globalize by adding more smart systems into their production.

5.2 Case B

Company B is located in Delhi and was established in 1993. It is a pioneer in the Indian snacks' food market and its range of corn ring snacks became India's most successful packaged food. This company is in the business of manufacturing, selling and marketing of packaged snacked food and has been successful for 27 years. The company maintains healthy practices while producing baked snacks and is yet tasteful. It became most popular among kids as preferred choice by the mothers. Today, this company has won over the client across West, Central and North India. Being a public company listed on the "Bombay Stock Exchange (BSE)" limited and "National Stock Exchange (NSE) of India Limited. The company has two manufacturing unit one in Noida and Gaziabaad both near Delhi head office. The company installed "Radio Frequency Identification (RFID)" technology to handle (track and manage) large amount of food packaging. RFID technology uses low-power radio waves communicate and identify information stored on a RFID tag attached to the object, such as in food packets.

Earlier the company used to manually track inventory which can be difficult, as the company produces different kind of products and store a lot of items in factories itself for specific procedures. For specific items, the products' expiration dates are needed to be tracked closely, as the stock out can lead to conducting long inventory checks. Over last 12 years the company has prospered at a "Compounded Annual Growth Rate (CAGR)" of 21.9%, and sales turnover increasing around 485cr INR (approx.) from 80.2cr INR (approx.) in financial year 2018-2019. The company now wants to extend its reach to global markets and is very optimistic and open to new technologies and innovation for robust and efficient manufacturing.

5.3 Case C

Company C is a medium enterprise located in Delhi, established in year 2011 and manufacturer of premium mattress, and serving perfect sleep solutions to their esteemed customer. This company has revolutionized the mattresses industry in India with its commendable services. With its current employee strength of 800, the company produces around 700 mattresses every day. This is a 100% home-grown company and matching the class and style with most of the leading mattresses company. The company produces well-crafted, well-engineered mattresses backed by science, technology and innovation, and has extended its hands orthopedic products. To provide custom made products to their customer in various fabrics, design, comfort and size, company is seeking for advance technologies. Company also wants to extend its commitment to social, ethical, and environmental responsibilities. Therefore, SMS implementation can fulfill the goals of the company. The first goal is to develop the smart production line. In the smart production line, the machines are upgraded to cyber-physical systems and can intelligently interact with their environment. The company is focused on automatic process and product quality control. The second goal is to develop a consistent machine to machine communication to link the production chain as a basis for the smart customized fabric. To do this, an existing strategy from other industrial branches is picked and concretized for the company with an implementation recommendation.

5.4 Case D

Company D is an electric vehicle manufacturing of Gurugram District of Haryana and established in 2011 overshadowed many Chinese companies. The company manufactures electric scooters, electric school van, electric loader, and electric rickshaw (e-rickshaw) amongst which e-rickshaws is its core competency product. With high quality, durability and certified e-rickshaw has made a specific place in the market, breaking Chinese monopoly in this field. This company is however a small-scale company, which has made a unique place in the market through its pioneering efforts in electric vehicles. Having dealer networks all over India, the company guarantees superior quality, latest design feature and top management inputs in sales and services. Presently, it is producing more than 700 vehicles and vision to produce around 2000 vehicles in a month. Company needs a concrete SM system implementation

strategy with an intension to make a household name in electric battery-operated vehicle and removing the dependency on foreign companies for the same. SMS implementation can help in making autonomous and smart electric vehicles. For automakers, this technological transformation can be an effective approach of handling huge amount of data for their vehicle-related command and decision. Furthermore, embedding "cloud-based storage and communication platform (CSCP)" can be an effective way to overcome the challenges faced by these automakers.

5.5 Case E

Company E is an auto ancillary company started in the year 2013 in Gurugram district of Haryana. The company was started with a meager investment of around ₹13 lakhs for a manufacturing unit with an area of 500 sq. yard. This company manufactures truck/trailer body parts, automotive parts, framework accessories, electronic components, OHE fittings, special bolts and nuts, sheet metal stamping and parts fabrication. Apart from this, company offers customized solutions to the clients' technical problem. Though being a small enterprise, the company is progressing steadily. About 90 percent of their products are exported in countries like USA, Germany, and New Zealand. During last 6 years, the company has achieved sales turnover around of USD 1.5 million and aspire to touch sales figure of USD 2.5 million. Therefore, the company is planning to undergo technological transformation to setup modern unit with the company's own tool room, forge shop, machine shop and a well-equipped laboratory.

By 2022, company is planning to implement SMS in 50% of their auto-parts manufacturing unit. The company wants to use 3D Printing i.e. Additive Manufacturing (AM) for rapid manufacturing of spare parts with minimum scrap waste. This technology facilitates the automakers to produce low costs tools and saves from future losses in production when investing in high-cost tooling. Through this, the company can vision mass customization of products with quick turnaround. The AM platform closely analyzes the design and can collect data that is further stored and manufactured in a virtual warehouse. The 3D printing application requires evaluation in engineering and investment difficulties to produce the components as required specification and can achieved through data analytic. Moreover, the company can also facilitate supply chain optimization through its virtual inventory. The company will produce virtual parts warehouse consisting of 2500 components for a heavy equipment manufacturer. Furthermore, this can be a good solution for value chain of the companies maintaining high maintenance and infrequently ordered auto parts.

6. Challenges of Implementing SMS

SMS is going to play a vital role in the upliftment of Indian manufacturing sectors by implementing better technological solution in this competitive industrial age. In India, SMEs are the backbone for the growth of the country's economy and are intending to integrate their existing system with SMS. But the implementation of SMS in SMEs often comes with many challenges. Some of them are summarized as below:

1. *Integration:* Manufacturing industry in India is strong advocate of "if it is not broken, do not fix it" idiom. Existing system and machines are used for many years without taking efforts to integrate advance system. This happens to Indian SMEs because integrating or replacing machine can cost them huge amount which is very hard to bear by smaller companies.
2. *Connectivity:* Implementation of wireless connectivity with IoT is preferred over conventional wired form in industries for an advance infrastructure. But this change may lead to the concern of network security. To overcome this issue is another complexity which comes in the way of SMS implementation.
3. *Capital Investment or Financing:* SMS implementation comes with the issue of capital investment. It is quite difficult to convince management on releasing funds regarding new technologies. Therefore, it is important to quantify benefits related to new system implementation to compare the operational improvements in existing system.
4. *Lack of Skill:* The main issue after getting funded by management is that who will take the responsibility of SMS implementation? The solution to this issue lies in training and skill development of employees. These skilled and train workforces can help industries with the place to design, develop, implement, and maintain the SMS. The training and skill development expectation for this system implementation is quite high. Employees should be enabled to deal with system architects with a detailed knowledge of manufacturing environment, data analytics and implementation strategies.
5. *Cyber-security:* The security of network is a big challenge when the systems are becoming more technologically advanced. Smart Manufacturing technology is a data-based technology which processes, analyses and transmits information through one channel to another. Generally, the internet-based systems are more prone to cyber-attacks which can lead to huge production loss by machine-down time, lack of trust

between partners and customers. Hence, a concrete management plan and mitigation techniques is much needed to eliminate this attacks.

7. Conclusion

The manufacturing sector is globally witnessing a new period of radical change and transformation. Several advance economies are focusing on the implementation of SMS to withstand the competitiveness of the market. Further, SMEs across India accounted for nearly 30% of India's GDP and 48% of export in the financial year 2019-20 (PTI, 2018). Indian government is much focused on their SMEs as these units also drives employment, exports, and provides inclusive growth opportunities. Implementation of SMS in SMEs will act as a catalyst in improving the manufacturing prosperity of these enterprises and of the nation. Companies can strategies the implementation of this industrial automation using a suitable framework and with clear system architecture. Instead of going for a high-cost sophisticated transformation, SMEs can deploy simple and affordable customized automation support system. As transformation is not about cost; it is also about how much improvement it brings in manufacturing practice. The cases discussed in this paper is a clear evidence to prove that small or single technology transformation provided a major help in their production output. Furthermore, the government is also showing clear interest in providing platforms or SMS and Industry 4.0 implementation, especially in SMEs to move the steady growth of manufacturing sectors. With some successful initiatives like SAMARTH, Aatmanirbhar Bharat and Make in India, the Indian government is providing financial support and ease of doing businesses to SMEs. Apart from the Indian government, the private firms are also coming forward to joins hands in bringing the SMS implementation in Indian industries.

It is observed through this study that SMEs are going under the required amount of transformation as financial constraints restrict them from complete transformation. Case company A an auto ancillary company by installing real-time monitoring in their machinery benefited around 20% output increases in their production. Similarly, Case company E a food-producing, and packaging company integrated an RFID system for tracking and monitoring food packaging. By this single integration, the company benefited from the increase in sales turnover 485cr INR (approx.) from 80.2cr INR (approx.) by minimizing food waste. The other three case companies also believed in the potential of SMS and rather than waiting for complete transformation companies planned to implement this system in specific areas. SMEs in India are highly organizing themselves in terms of improving their technology infrastructure and skill management. However, many challenges are in the way of these technologies evolving completely in the Indian Scenario. But with the confluence of the wisdom of researchers, academicians, “public private partnerships (PPPs)” and government members; the complete existence of the SMS in Indian manufacturing can become reality.

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