Role of Industry 4.0 for Sustainable Manufacturing in India's Largest Automobile maker, The Maruti Suzuki India Limited- Conceptual study

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Abstract. The mass manufacturing is one of the reasons for availability of costly products at reasonable price to common man. This is possible because of automation. The concept of Industry 4.0 has revolutionized the industrial sector in general and manufacturing sector in particular. The integration of Industry 4.0 to manufacturing led to the coining of term Intelligent Manufacturing systems. Various innovative approaches as Internet of Things (IoT), Big Data Analytics, Cloud Computing, Information and communications etc. are being integrated with traditional manufacturing systems to generate a high quality output. In this paper role of Industry 4.0 in revolutionizing car mass production by India's Leading Car manufacturing Industry Maruti Suzuki India Limited has been analyzed. The role of various IT enabled services into concept of Industry 4.0 has been elaborated. Also it has been found that Industry 4.0 concept has led to emergence of Maruti Suzuki as No. 1 car Maker Company. The company has used Enterprise Resource Planning, Artificial Intelligence enabled employee/Human Resource interface, Robots in production shops, E-Nagare, Just in Time (JIT), Chat Bot, Data Lake etc. This paper tries to understand how Maruti Suzuki is way ahead in adapting Industry 4.0 to retain market share of more than 50%. Finally the current challenges and future research areas has been identified and discussed.

Keywords: Industry 4.0, Robots, E-Nagare, JIT, Smart manufacturing, Automation, Computer

Introduction

The Industrial revolution was the turning point in the history of mankind. Whenever, mankind witnessed them, their way of living, perspective about technology gets totally reformed.

From food gatherer to hunter to food producer to sailor, the role gets diversified. The industrial revolution quashes the myths about using certain prohibited theories. Certain innovative and ground breaking technological inventions were the signature of these industrial revolutions.

There were four industrial revolutions that have happened or rather classified as industrial revolutions.

The first Industrial Revolution: The first industrial revolution ranged from period between the end of the 17th century to the beginning of the

18th Century. The characteristic of the first industrial revolution was mechanization of manufacturing processes, agriculture and other backbone sectors of an economy.

Steam engine was invented. It forayed into every aspect of manufacturing, transportation, agriculture etc. industry. Even the large scale mining of coal was attributed to the invention of railways using the steam engine.

The Second Industrial Revolution: The invention of newer sources of energy as Electricity, gas, and oil led to the invention of internal combustion engine. The most important aspect of this industrial revolution was invention of telephone.

The Third Industrial Revolution: It started during late 19th century to first decade of 20th century. The most important inventions were nuclear energy, PLC's and computer.

The third called for the automation of processes with integration of electronics and machines.

The Fourth Industrial revolution: Industry 4.0 was framed by German government in collaboration with industry and academia in 2011. It was aimed to develop advanced production systems that will contribute towards country's prosperity. Such systems are Sustainable production systems.

The concept of sustainable manufacturing has been defined, using four point agenda [1].

1. Focus on Man, Machine, and Method approach
2. Focus on Product lifecycles
3. Value creation at company level and associated vendor units level.
4. Global manufacturing impacts on environment, society, economy.

The sustainable manufacturing is that manufacturing which will regulate itself and adapt itself to newer technologies and methods so as to be more nature, environment and economy friendly [17]. The concept of value engineering, human engineering, intelligent manufacturing, robotics, Computer Integrated manufacturing are all connected to sustainable manufacturing.

It is the result of sustainable manufacturing being achieved with concept of Industry 4.0, that stringer vehicle emission norms are being imposed and is motivating car manufacturers worldwide to develop environment friendly vehicles.

Industry 4.0 supports sustainable manufacturing or advanced manufacturing or Smart Manufacturing , where manufacturing systems are flexible to adapt themselves for multiple products on same line [2]. The concept of Industry 4.0 in manufacturing has led to introduction of intelligent manufacturing [3] [4].

Intelligent manufacturing is an upcoming sub area of manufacturing which integrates shop floor with the IT (Information Technology).

Industry 4.0 concept integrates manufacturing and computer. It advocates mass and precise manufacturing. It combines all information on all the physical and manufacturing processes and thereby assisting manufacturing supply chains, or the inventories, marketing and sales department etc. [5]

Industry 4.0 is a widely accepted concept in most of the industries including manufacturing industry. It calls for computerization of processes. Most of mass manufacturing industries as automobile, aerospace, sheet metal, plastic molding are automated and calls for very hard materials as tool and die inserts, plastic molds, machining tools etc.

The Industry 4.0 has revolutionized every industry. Now there is no clear demarcation among various sectors, be it manufacturing, electronics, Bio Technology, Chemical, Computer as all the sectors are working in cohesion. Even newer branches as Mechatronics, Bio-mechanics, Electro-chemistry, are emerging.

Computer has entered almost every field. Even diseases are successfully treated with help of computers by devising various medical applications.

Similarly manufacturing industry has progressed in leaps and bounds because of usage of Computer and numerically controlled machines (CNC Machines).

The result is automation and lesser dependence on labor. The quality of product has been improved. The overall efficiency of production process will improve [6]. The Concept of mass production is now lot more achievable. Machines are controlled by programmers and not by semi-skilled labor.

Even such AI based IMS can be used for optimization of resources to get optimal output from machines, thereby reducing any wastage and increasing the overall process efficiency [7].

The intelligent manufacturing concept can be adopted using the intelligent manufacturing system (IMS) [8]

IMS is a hypothetical manufacturing system, which can become reality in next 3-5 years. It is semi-reality right now. The bigger automated manufacturing industries as Car industry, Food processing industry, Textile industry, Chemical Industry etc. are already on their way to become fully automated or IMS units.

In this IMS approach, the highly skilled IOT and AI experts will be handling large information databases over internet. The various interdependent industries can share their requirements, learning's, etc. to save time and simultaneously reducing time in physical/ Manual data flow[9][10].

The Government of India introduced the National Manufacturing Policy of 2017, which further advocated the Make in India initiative in order to make our country as a leading manufacturing hub [11].

However to make Industry 4.0 concept successful, the Government, the manufacturing industry and the academia need to work together in cohesion, simultaneously sharing the learning and their outcomes. Also to produce Industry 4.0 skilled employees, the education institutes need to revise their curriculum in accordance with representatives from the industry.

1 Case Study: Industry 4.0 Car Designing and Manufacturing

The Indian automotive sector is one of the most progressive sectors of Indian economy. It always adjusts itself as per the latest technologies. It is one of the fastest growing sectors and one of the largest job generators in the economy.

In Automotive sector, Industry 4.0 has already entered with full bang. In India, Topmost automobile company, Maruti Suzuki has implemented ERP, or the Enterprise Resource Planning, way back in early 2000's. It has also implemented various softwares related to online connectivity with dealers, service centers and various component suppliers way back in early 2000's.
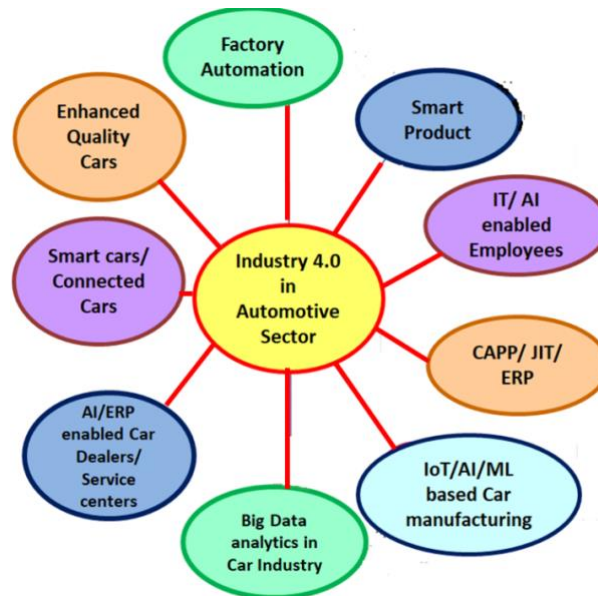

Figure 1: Industry 4.0 in Automotive Sector

The above figure 1 is showing the various components of Industry 4.0 in perspective of automotive sector. The industry 4.0 calls for factory automation, which means most of the factory operations, should

be automated. It will result in smart manufacturing, thus producing smart product.

The employees in different departments can be connected through ERP (enterprise resource planning). They can share and discuss their learnings and interpretations.

These softwares as CAPP (Computer aided process planning) can be used to schedule the production, planning and control activities. The factory schedules can be automatically generated using CAPP softwares. The big data analytics can be used to track market data and understanding the needs of customers. Also the car dealerships are connected to main factory through Dealer management software. The different softwares as E-Nagare help to track supply chain defects, Inventories management, any disruption in the production line, Assembly blockage. These all help in continuous decreasing of down time or the inefficient time of the automotive industry. Further it has the following benefits:-

• More number of car variants being produced on same assembly line.
• Less Production time.
• More product and process innovation.
• Less time in rolling of different car models.
• Simultaneous up gradation of safety features w.r.t international markets
• Better fuel efficiency

2   Industry 4.0 : In Maruti Suzuki

GOI has identified several industrial sectors to implement Industry 4.0. Automotive sector is one of the most important sectors. It is one of the prominent job generating sectors.

In this paper Maruti Suzuki will be analyzed. Maruti Suzuki is always the market leader in Indian Automobile sector. It has always adapted to the cutting edge technologies to compete with global automotive manufacturers. The philosophy is to adapt and learn the latest techniques to remain way ahead of competitors without any compromise on quality and safety. It is successfully implementing concept of Industry 4.0 with some prominent steps taken in various areas. Some of the steps taken in directions of implementation of Industry 4.0 will be discussed in the following sections.

2.1 Robotic process Automation

The Maruti Suzuki is currently employing Robots in automation of repeated routine daily tasks almost in divisions as Research and Development, Production, Finance, HR etc.

Figure 2: Robots for welding of car panels

As shown in figure 2, the robots are being used for welding of inner and outer body panels. The Robotic Process automation has resulted in increasing efficiency of overall production shops and also the dangerous and repetitive jobs which can prove monotonous for human beings are being assigned to robots. For example doing spot welding of outer and inner body panels.

2.2 AI-Enabled Chabot for HR Support

The text dependent ChatBot has been started to interact with employees to answer queries related to functioning of human resource department. This will soon be upgraded to voice based by incorporating Natural Language Processing. This will help employees to raise their HR concerns.

The Amazon has used concept of Alexa, which can interact with human beings just like fellow human being. In western countries, it is being used as fellow companion by the lonely people.

2.3 Enabling Industry 4.0 Adoption With IoT

The integration of IoT based methodologies have been done in different manufacturing arenas as press and die shops, machine shops, painting shops etc.

It ultimately helped in increasing the productivity, improved quality, mass manufacturing, reduced defects etc. Also the rejection rates of such shops have drastically been reduced. The employees now can coordinate better due to reduction in monotonous tasks which can be assigned to robots.

2.4 Data-Driven Decisions: Big Data Analytics

A newer concept of Data Lake concept is being applied across the company. It is basically a large data reservoir in which data is being fed from across different sectors of company as

manufacturing shops, production shop floor, Dealers, Interactions with customer, social media, etc. The data from all possible sources are interconnected. The usage of this interconnected is analysis to create a wide roadmap to forecast demand and supply, improve quality, increase in efficiency, employee satisfaction etc. These insights can then be used for the improvement of car performance on ground. **Maruti Suzuki India** manages seven process shops and five assembly lines by employing around 1,700 robots,

2.5 Robots in Maruti Suzuki plant

Maruti Suzuki India Ltd deployed about 5000 robots at its Manesar and Gurugram plants [12], which makes one robot for almost every four workers. They have replaced manual welding guns. The guns were being operated by man. The guns were heavy and difficult to operate. So now robotic welding has replaced manual welding.
They are also employed to conduct quality checks on the engine of a car using the high-speed Vision system. The result is TACT time has reduced from about 24 seconds in 2005 to half value of 12 seconds in 2017. In its inception in 1981, the earlier factory has negligible automation and was fully dependent on its manual force. While in current scenario, over 15 lakhs of 16 car models having about 1200 variants are being produced in a year, due to high degree of automation [13]. As a result Maruti Suzuki is India automobile leader. Almost every second passenger vehicle sold in India is from the stable of MSI.

2.6 E-Nagare System

The Maruti Suzuki India also uses concept of E-Nagare, to implement the Just in Time concept of inventory or to ensure zero inventory.
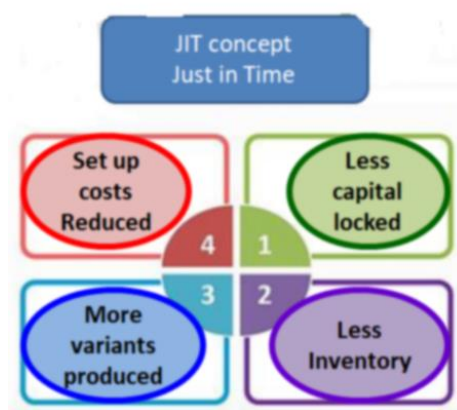

Figure 3: Just in Time Inventory concept

The important benefit of JIT concept is reduction in locked capital and simultaneously more car variants can be produced. Also stored inventory will gradually reduce. The E-Nagare was applied to further improve on the inventories [14]. In the E-Nagare system, the vendor associated with parts supply at Maruti Suzuki Plant, gets information at 4 o'clock in morning, what needs to be supplied. The vendors are connected to supply chain and other concerned departments through extranet and gets concerned information. Total readings were divided into training and testing data sets.

3   Potential Benefits of Industry 4.0

The concept of Industry 4.0 has already modernized manufacturing sector in India, then how can automotive sector be left behind? This concept has integrated manufacturing with IT/ITeS and Artificial Intelligence. The introduction of AI/ML/Robots in manufacturing sector have reduced human errors and enhanced the quality of product.

The concerned parties associated with automotive industry, as vendors, labors, skilled workers, customers, management professionals are all connected with each other through ITeS. This results in passing of customer feedback to concerned area without any delay. Even the car Dealers which actually sell the cars, can now be able to pass on the customer suggestions/feedback to the sales/service department of Maruti Suzuki. Furthermore, Industry 4.0 will enable multi directional flow of information simultaneously as from manufacturer to product, but between producers, products and, most importantly, customers. Also the manufacturing operations as engine shop, die shop, paint shop, weld shop etc. are operated with help of computers and robots. This resulted in fast and efficient running of these shops. Even the accidents are reduced. The dangerous and dull/monotonous works are often assigned to robots. It is clear that Industry 4.0 generates tremendous job opportunities, as well as the quality of the product has been increased manifold. As a result more and more ITI's (Industrial Training Institutes) are opening up and skilled employees are in great demand.

4   Conclusion and future scope

There is no doubt about the implementation have already been started in Indian Automobile Industry [16]. The leading Indian automobile maker Maruti Suzuki is using 5000+ robots in its weld shops and other production shops.

Even AI based platforms are being used for solving any HR queries of employees. E-Nagare helped in maintaining almost negligible inventory, and thus implementing the JIT (Just in Time) Inventory concept. It has already implemented ERP, E-Nagare, various customer feedback softwares, which enable them to connect directly with the customers.

The car industry is growing very fast and technology is also getting old very fast. This all call for a constant up gradation of technology usage and incorporating excellence at each step. The future calls for smart and AI driven cars. The already started smart manufacturing in automotive industry is a big leap towards Industry 4.0. In future, when driver less cars are being conceptualized and fuel efficient cars are being high in demand, the concept of integration of Industry 4.0 in each and every area of automotive sector as Car designing, Car manufacturing, Car assembling, Quality check, Car selling, Car Servicing, Customer feedback etc. will have a profound effect.

The focus areas in an automobile/ manufacturing industry can be efficiency, disruption and technology. To apply any AI/ML technology, it is first of all necessary to analyze and gain an understanding of an industry first, the technological needs and requirements of the industry. The case study of Amazon is very apt example, whose supply chain & warehouse management has been integrated with the AI & ML, and results in overall enhancement of operations [15][16][18].The main benefit of Industry 4.0 concept is reduction in manual errors, accidents, as well as simultaneously increase in quality of product.

The future cars will be designed so as to give comfort to rider, without even driving the cars. Most of cars will be connected to each other through a common server. They will then generate their own path tracing the position of nearby cars. Such high concept may look like fancy today, but they may be reality in next 10 years.

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