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The STUDY OF Industry 4.0 AND ITS IMPACT ON SUPPLY CHAIN MANAGEMENT

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Abstract- *This research is based on a study of industry 4.0 concept and its impact on the supply chain management. The study involve various stages. Work is start with historical background of industrial revolution. Start with 1st industrial revolution to 4th industrial revolution.*

Various technologies are used in industry 4.0. The technologies are internet of things (IoT), big data, smart factory, cyber physical system. From all this technologies we study the working model, architecture of the above technologies. The further study involved the supply chain management concept and its levers like procurement, manufacturing, warehouse, logistics, and fulfillment these are study in detail.

After getting the data from each and every aspect further study is to find the impact of industry 4.0 on the supply chain management. And also benefits getting by the supply chain management due to industry 4.0.

The study is concluded with understanding rapid development in manufacturing and other industry because of the industry 4.0 technology revolution.

***Key words**:* Industry 4.0, IoT, Smart Factory, Supply Chain Management, Big Data etc.

1. INTRODUCTION

In 1784, the first industrial revolution is introduced is based on machine work and development of steam power plant. The second industrial revolution is initiated in 1870, started with assembly line production and used of electricity as well as mass production started. In 1969, is be began with PLC system. This revolution is taking place used of computers and robots for production. Finally in the year of 2013 we face the fourth industrial revolution which is based on technological advancement. Industry 4.0 is the newly developed concept in which all manufacturing processes are get change from traditional to advance technological based manufacturing system. The origin of industry 4.0 concept is in Germany in 2011. The concept is based on various technologies like internet of things, smart factory, big data, and cyber physical system. Industry 4.0 is basically focused on the internet which is the most important factor in the day to day life of human being. Industry 4.0 concept develop the virtual reality also this revolution is important in the view of current pandemic situation. IoT is used for connection all devices together and making one single system to human to human and human to machine interaction. Big data also work on high volume, high variety and high velocity data. Smart factory concept is based on manufacturing to adopt the change done by automation, technological changes. Cyber physical system (CPS) are integrations of computation, networking, and physical processes.

This Industry 4.0 concept are making impact on every management area. It also impact on the supply chine management. The concept of supply chain is found in German literature it is referred as delivery chain, logistics chain, supplying chain or value chain. Supply chain working of seven principles of management. Supply chain consist procurement, manufacturing, warehouse, logistics and fulfillment. Industry 4.0 is also making huge impact on all above lever of supply chine which are discusses in the further chapter.

Industry 4.0 concept also gives some benefits to supply chain management like achieving greater transparency and accuracy, decision making which leads cost saving, increase the interconnectedness and collaboration, improves the warehouse management, and grater agility. The corresponding concepts such as Automotive 4.0, Logistic 4.0 and Education 4.0 have based on Industry 4.0 which capture and analyze the real- time data.

The research structure are as follow firstly go through the background of industrial revolution followed that concept of industry 4.0. In the concept of industry 4.0 we discussed about key technologies are used in industry 4.0. After that study the supply chain management and its key lever of supply chain management. At the end study to goes to the impact of industry 4.0 supply chain management.

Objective-

- To understand the industry 4.0 concept and its historical background.
- To identify the key technology in Industry 4.0.
- To study the impact of Industry 4.0 on supply chain management.
- To identify the benefits gain by industry 4.0 concept.

Scope-

- This study gives the opportunity to learn the new thing like IoT, Cyber physical system, BIG data concept, and Smart factory from that we can developed new organization structure.
- Its main aim to find the impact of fourth industrial revolution i.e. industry 4.0 on supply chain management.
- The study seeks to find out facts and key technologies in industry 4.0 and what kind of software are require to develop the industry 4.0 in any organization.

2. SECTOR PROFILE

The study is the combination of Manufacturing sector as well as Information Technology sector (IT)

Information Technology (IT) sector-

According to the report of working organization on information technology the IT sector is one of the growing sector in the last decade. It transforming the world, increases the productivity, connecting the people, improve the standards of living, and make a new opportunities over the globe. IT sector is contributes to increase in GDP, employment rate and export.

The pace of technological advance is accelerating and ICT is increasingly becoming a ubiquitous and intrinsic part of people's behaviors and social networks as well as of business practices and government activities and service provision. In order to sustain India's lead in ITITES sector and to capture new opportunities in the electronics hardware industry, there is a need to address the gaps in the availability of skilled and technically trained human resources for meeting present and future requirements of the sector.

Cyber security and quality management are few key areas of concern in today's information age. To overcome such concerns in today's global IT scenario, an increasing number of ITBPO companies in India have gradually started to emphasize on quality to adopt global standards such as ISO 9001 (for Quality Management) and ISO 27000 (for Information Security). Today, centers based in India account for the largest number of quality certifications achieved by any single country.

Manufacturing sector-

Manufacturing industry are goes through a various changes with newer development over the period of time. Its start from independence in 1947, at that time we build industrial foundation. In 1965- 1980 period of license-permit raj. After that in 1990's phase of liberalization. And now past decade is move towards the automation with the help of IT sector.

According to a report by Mckinsey and Company, India's manufacturing sector could touch US$ 1 trillion by 2025. According to these reports there is potential for the sector to account for 25-30 per cent of the country's GDP and create up to 90 million domestic jobs, by 2025.

To give its ambitious 'Make In India' program the much needed atmosphere to succeed, the government is expected to come up with a separate set of labour laws governing the Micro, Small and Medium Enterprise (MSME) sector which forms the backbone of the manufacturing sector.

3. METHODOLOGY-

In the first stage of research is based on searching the various research paper related to the industry 4.0 using the key words like "Industry 4.0 historical view", "Cloud computing", "Internet of Things", "Big data analysis", "Cyber Physical System", "Supply Chain Management", "Procurement", "manufacturing", "logistics or transportation".

In next stage the contents of all the papers are studied and classified the study according to topics, keywords, and methodology. The research is goes through technological development, application of technology in industry 4.0, and further impact of industry 4.0 on supply chain levers.

Also for the research purpose used the platform like google scholar, IEEE, ProQuest, emerald for collecting the information of industry 4.0, supply chain management, and impact of industry 4.0 on supply chain management.

3.1 Research flow

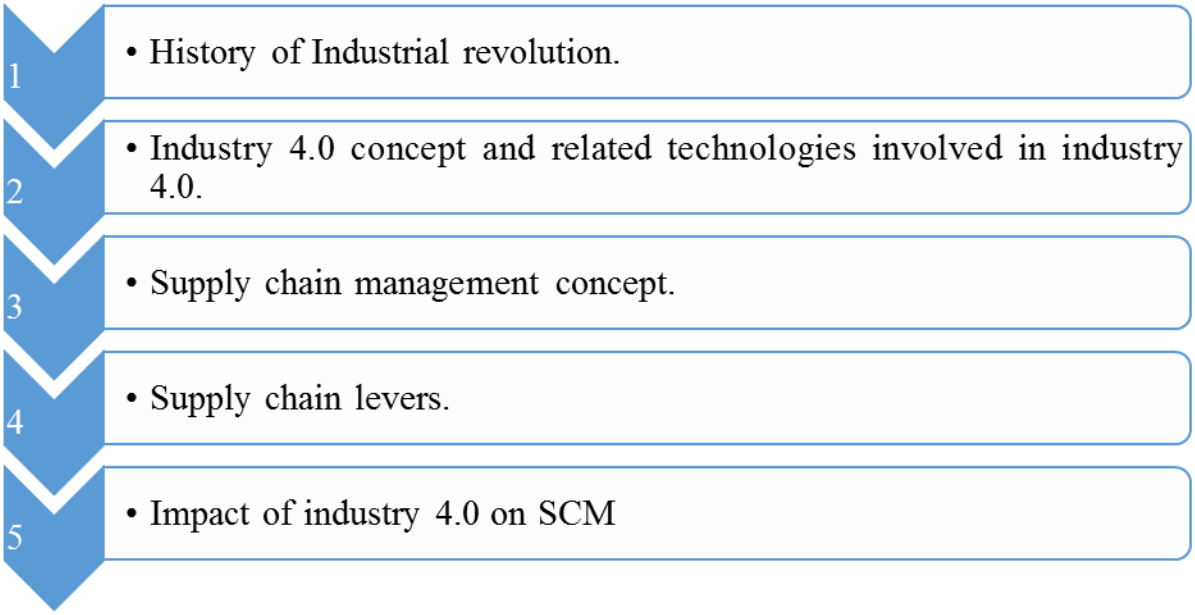

Fig- 1: Research flow

4. DATA COLLECTION

4.1 History of industrial revolution-

The main feature of industrial revolution is advancement in socio-economical, technological, and cultural changes. The technological changes includes used of new material like iron steel; the used of new energy sources such as steam engine, coal, fuel power, electricity, IC engine, and petroleum product; the used of new machines like power loom and spinning jenny; new concept of factory system which divides the work and workers according to specialization; development transportation and communication system, and automation in organization work.

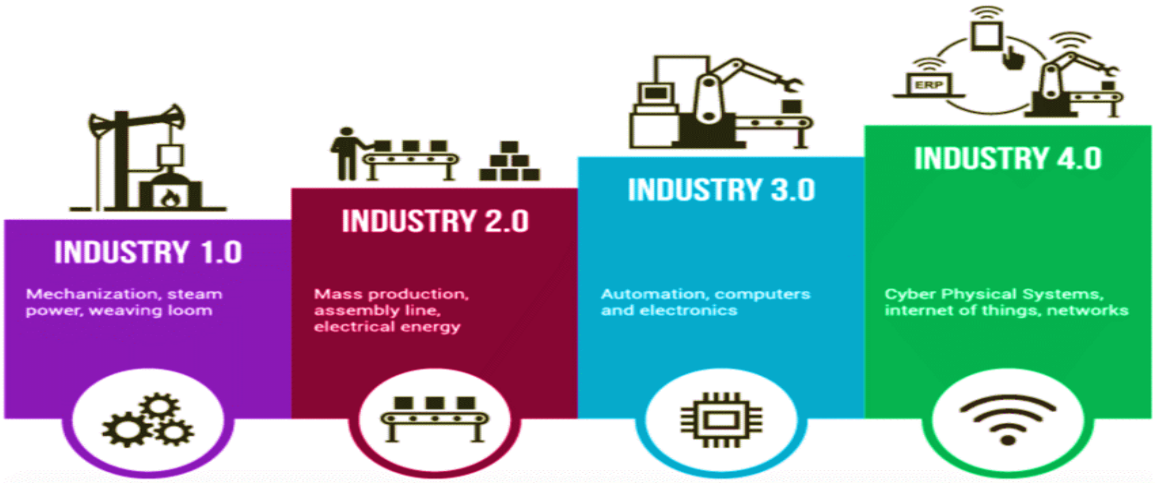

Fig-2: Industrial Revolution

Industry 1.0:

- First industrial revolution is happen in the period of late 18th century.
- This revolution transforming the hand production method to machine production.
- In industry 1.0 the increase the use of steam and water power.
- The 1st industrial revolution begin in Great Britain.
- In that era new chemical manufacturing and iron production processes are developed.
- An improved quality of life was a main driver of the change in 1st industrial revolution.
- The main driver of 1st industrial revolution is improved quality of life.
- Textile industry was dominate the industrial revolution in terms of capital investment and workers.
- This industrial revolution marks major point in history which involved almost every aspect of daily life activities.

Industry 2.0:

- Followed by the first industrial revolution after a century later the world go through the 2nd industrial revolution.
- Industry 2.0 started at the end of 19th century and known as "Technological Revolution".
- In this industrial revolution technological advancement done in huge number.
- This industrial revolution came up with new sources of energy like electricity, gas and oil.
- The result of this revolution was the creation of IC engine.
- In the second industrial revolution was the development for steel demand, Chemical synthesis and methods of communication such as the telegraph and the telephone.

Industry 3.0:

- Another century passes and we face the 3rd industrial revolution that is happen in second half of the 20th century.
- In 3rd industrial revolution we see another source of energy i.e. nuclear energy.
- The 3rd revolution rise of electronics, telecommunication and computers.
- From the technological advancement in 3rd industrial revolution open the doors of space expedition, research and biotechnology.
- Industry 3.0 gives the world rise to an era of high level of automation.
- The concept of sharing economy is also explain as a crucial element of the 3rd Industrial Revolution.

Industry 4.0:

- Industry 4.0 that it is a revolution happening right now.
- The 4th industrial revolution is based on the internet which we use day by day life.
- Industry 4.0 that develops virtual reality world, which allowing us to bend the laws of physics.
- The Industry 4.0 revolutions shapes the world and worldwide economies are based on them.
- The technologies develop in 4th industrial revolution like augmented reality (AR), artificial intelligent (AI), robotics, automation, 3d-printing etc.

4.2 Industry 4.0 concept-

Industry 4.0 is "*the technological combination of CPS into logistics and manufacturing with the use of internet of services and things in the industry process. They have implications for downstream services, value creation, work organization and business models."*

Industry 4.0 is ongoing transformation which changes the traditional way of manufacturing and industrial practice to the smart manufacturing and industrial practice by using latest smart technologies.

Principle of industry 4.0-

Interconnection- Connecting the human, machine, sensors, and various devices are connected by using Internet of Things (IoT).

Technical support- Get the technical support to identify and diagnosis the problem, easy decision making to human.

Decentralized decision- The ability of machine and devices to identify the problem, make decision and solve it by use of Cyber Physical System (CPS) technologies.

Information transparency- Ability to operate large amount of data storing and easily available to use to making appropriate decision.

Component of Industry 4.0 concept-

- Mobile devices.
- Internet of Things (IoT) platforms.
- Location detection technologies.
- Advanced human-machine interfaces.
- Authentication and fraud detection.
- 3D printing.
- Smart sensors.
- Big analytics and advanced processes.
- Multilevel customer interaction and customer profiling.
- Augmented reality/ wearables.
- Fog, Edge and on-demand availability of computer system resources.
- Data visualization and triggered "live" training.
- Cyber physical system.
- Big data.
- Cognitive computing.
- Robots.

4.3 Key Technologies in Industry 4.0-

1. **Internet of Things (IoT)-**

The Internet of Things (IoT) refers to a system of interrelated, internet-connected objects that are able to collect and transfer data over a wireless network without human intervention. The personal or business possibilities are endless. A 'thing' can refer to a connected medical device, a biochip transponder (think livestock), a solar panel, a connected automobile with sensors that alert the driver to a myriad of possible issues (fuel, tire pressure, needed maintenance, and more) or any object, outfitted with sensors, that has the ability to gather and transfer data over a network. IoT is the approach of converging data obtained from different kinds of things to any virtual platform on existing internet infrastructure .First time concept of IoT used for coke machine which send information about drink and whether the drink were cold.

Architecture

There is huge no of things are connected through IoT for the handle such a huge no IoT develop six layer of architecture.

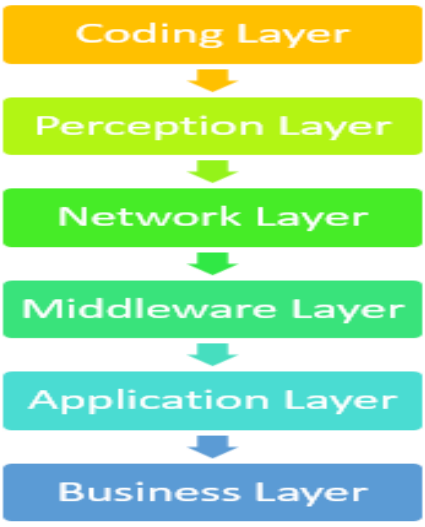

Fig- 3: Architecture of IoT

Six level architecture-

Coding Layer- It is the foundation of IoT .it provides identification to object of interest.in this each object assigned a unique identity which make it easy to discern the object.

Perception Layer- In this layer gives physical meaning to each object. With the help sensors, which sense the temperature, humidity speed and location etc of object. After collecting all information it will convert into digital signals and passed onto network layer.

Network Layer- The main aim of this layer is to transmit the useful information to the middleware layer virtual medium like Wi-Fi, Bluetooth, WiMAX, ZigBee, gsm, 3G eith special protocols like IPv4, IPv6.

Middleware Layer- This layer processes the all information received from all sensors devices and save it with help of technology like cloud computing for complete access to database to store all necessary information in it.

Application Layer- This layer realizes the applications of IoT for all kinds of industry, based on the processed data. The IoT related applications could be smart homes, smart transportation, smart planet etc.

Business Layer- Everything are manages by this layer and applications its services of IoT.

Technology Related to IoT:-

A. Radio frequency Identification (RFID):-

It is a transceiver microchip similar to an adhesive sticker which could be both active and passive type. Active tags have battery attached to them and therefore it can continuously emit signals whereas passive activated by external rays when they triggered on it.

There are four Types of RFID-

a) Low frequency -135 KHz or less
b) High frequency -13.56 MHz
c) Ultra-High frequency -862 MHz -928 MHz
d) Microwave -2.4GHz

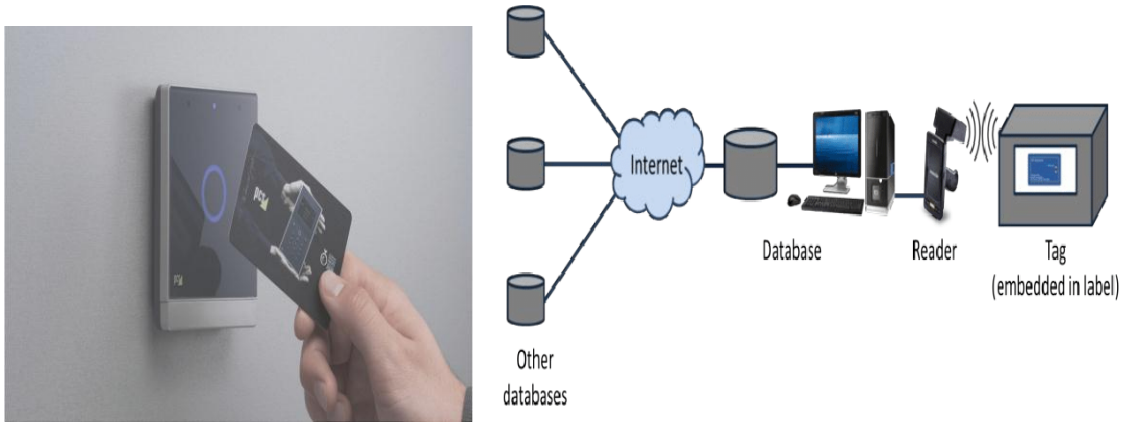

Fig- 4: RFID Tag and RFID connection

B. Wireless sensor Network (WSN)-

It refer to group of spatially dispersed and dedicated sensors for monitoring and recording the physical condition of the environment and it organizing the collected data at a central location .

Types of Wireless Sensor Network-

a) Terrestrial WSN
b) Underground WSN
c) Underwater WSN
d) Multimedia WSN
e) Mobile .

C. Cloud Computing-

It uses the internet and control remote server to maintain data and application. It allows consumer, business, education institute etc. to use application without installing costly software in their computer. Instead of installing a suite of software for each computer, only an application has to be installed. This application would allow all the employees to log into a web based service which hosts all the programs the user would need for his or her job. In cloud computing system, there is a significant workload shift. Local computers no longer have to do all the heavy lifting when it comes to running applications. The network of computers that makes up the cloud handles them instead.

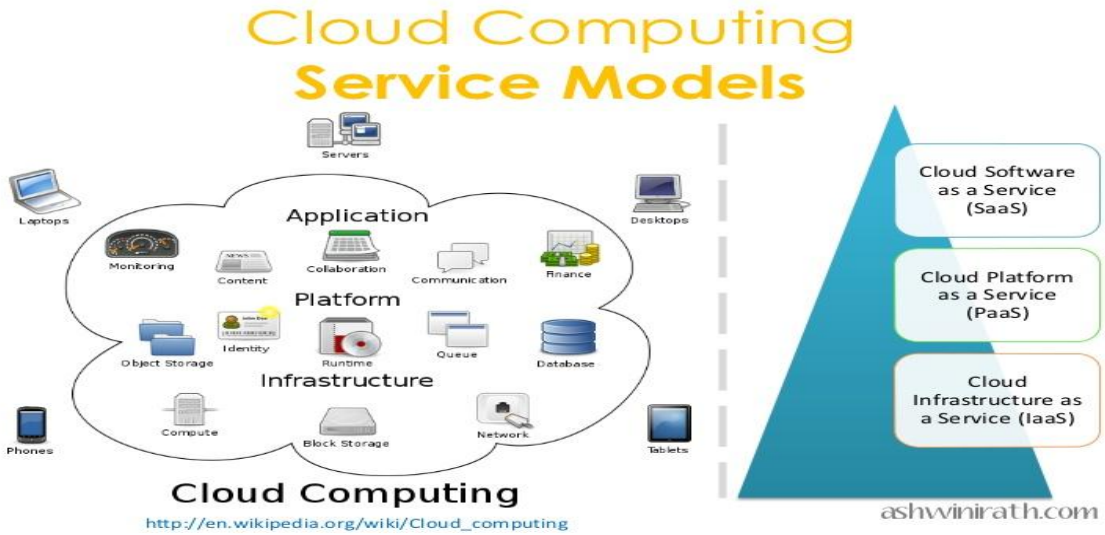

Fig-5: Cloud computing service model

D. Network technology :-

Network technology is any technology by which two or more computer systems are connected and communicate information between them. This can be as simple as a dial-up modem connection between two PCs, or as complex as the Internet itself. Whether it's a wired local area connection at work, a home Wi-Fi connection, an undersea cable connecting devices beneath the ocean, or satellite signals all around the globe, all of these are network technology. From a more human standpoint, though, network technology is any technology by which people communicate with one another, and reach out to each other. Our computer networks only exist because of our human need to network with one another. Humanity is at the heart of all of our communication. For wide range transmission network we commonly use 3G, 4G etc.

E. NANO TECHNOLOGY :-

Nanotechnology is a field of research and innovation concerned with building 'things' - generally, materials and devices - on the scale of atoms and molecules. A nanometer is one-billionth of a meter: ten times the diameter of a hydrogen atom. The diameter of a human hair is, on average, 80,000 nanometers. With the help of this technology it is possible to connect small things at Nano level which helps to decrease the system consumption and hence size of component become small.

F. MICRO ELECTRO MECHANICAL SYSTEM :-

It is miniaturized mechanical and electro mechanical elements .That are made using the techniques of microfabrication. While the functional elements of MEMS are miniaturized structures, sensors, actuators, and microelectronics, the most notable (and perhaps most interesting) elements are the micro sensors and micro actuators. Micro sensors and micro actuators are appropriately categorized as "transducers", which are defined as devices that convert energy from one form to another. In the case of micro sensors, the device typically converts a measured mechanical signal into an electrical signal.

2. Big data-

Definitions-

"Big data is high volume, high variety and high velocity information assets that demand cost-effective, innovative forms of information processing for enhanced insight and decision making".

-Gartner IT Glossary. N.d.

Similarly *"Big data is a term that describes large volume of high velocity, complex and variable data that require advanced techniques and technologies to enable the capture, storage, distribution, management, and analysis of the information."*

-Tech America Foundation.

The concept of big data are mainly depend on three V's which are describe below-

1. Volume-

Volume tells to the magnitude of data. Big data size are in the number of multiple of terabytes and petabytes. To understand is one terabyte is the data to store in 1500 CDs and one petabyte is equal to 1024 terabyte.

2. Variety-

Volume refers to the structure heterogeneity in a database. Technological advancement in organization which allows use various types of data like structure, un- structure and un- structure data. Structure data is tabular data in the spreadsheet; text, audio, video are semi- structure; and Markup language (XML) are the example of semi- structure.

3. Velocity-

Velocity is the rate of speed which data is generated and its speed of analyze it and taking action on that.

Traditional data management does not handle the huge data generated by organization to overcome this big data concept came in picture which handle real time analysis.

Big data analytics-

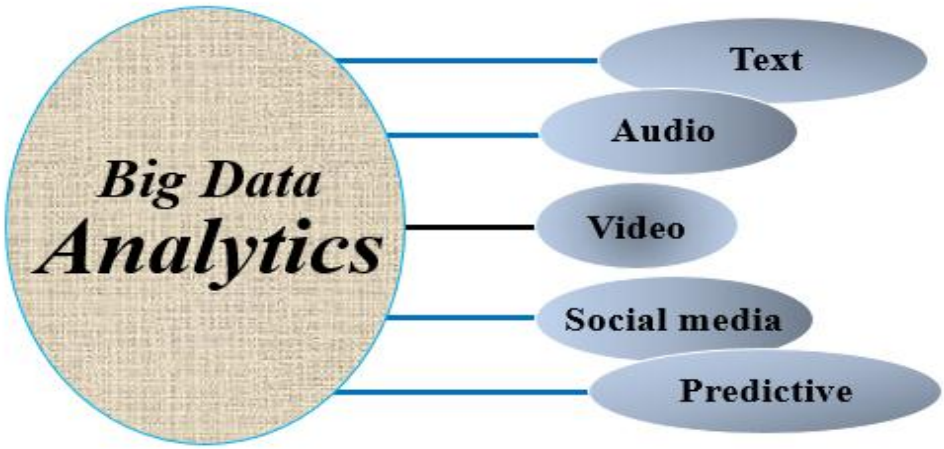

Fig-6: Big data analytics

- Text analytics-

Text analytics is basically work on the textual data for extracting the information.
Data like email, feeds, blogs, corporate documents, news, survey report, call center data is the example of textual data which are in unstructured format.
For the extraction of this unstructured data, Information Extraction (IE) technique is used to extracting in the form of structure data.
Also use the techniques like Entity Recognition (ER) and Relative Extraction (RE).
Question Answer (QA) techniques used for the answer of the question asked by customer. Apple's Siri is one of the example of QA technique.

- Audio analytics-

Audio name itself says that it extracting data from the unstructured audio files.
Audio analytics extract data from human speech, phone calls, audio files are the data source for extraction of data.
Mainly call centers are used the audio analytics for efficient analysis of thousands of hours call recording.
The audio analytics are mainly used two techniques for data extraction i.e. transcript- based approach.
Transcript- based techniques also known as large- vocabulary continues speech recognition (LVCSR), which used two phase i.e. indexing and searching.
Phonetic-based approach is work with sounds and phonemes.

- Video analytics-

This type of video analytics which is used for monitoring, analyzing and extracting the useful data from video file.
To processing the real time and pre-recorded video the use of close circuit television (CCTV) cameras and video share website are two main contribution in video analytics.
The main challenge of video analytics is problem of storage. The size of the video file is so large than compare to other analytics.
The application of video analytics as the purpose of security and surveillance system, also is used to identify the buyer's behavior of customer in retail store.

- Social media analytics-

Social media analytics as a name say that it analyze the structure and un-structure data from social media platform.
Social media platform includes Facebook, LinkedIn, blogs, twitter, Tumblr, dig, reddit, Instagram, YouTube, Wikipedia and so many mobile applications.

The main object of social media analytics is the purpose of marketing.
Social media are categorized in two parts-

1. Content-based analytics- it deals with feedback, product review, images and video.
2. Structure based analytics- Synthesizing the structural attributes in social networking.

- Predictive analytics-

In predictive analytics is done by used of various technique comparing the historical data and current data and capture the relationship in the data.
Technique used predictive analytics are moving average, linear regression and correlation which are based on statistical data.

3. Smart factory-

Definition-

"*A smart factory is a manufacturing solution that provides such flexible and adoptive production process that will solve problems arising on a production facility with dynamic and rapidly changing boundary conditions in the world of increasing competition*".
The smart factory gives the special solution could be in automation, combination of various software, hardware and machines. And in the other hand it could be seen in a perspective of collaboration between different industrial and non-industrial partners where the smartness comes from forming a dynamic organization. Smart factory mainly consist three aspect namely as follows interconnection, collaboration and execution. From the below figure shows the architecture of the smart factory which are divided in four different level namely physical resource layer, network layer, data application layer, terminal layer. The main moto of that to convert the modern factory into the smart factory.

Architecture-

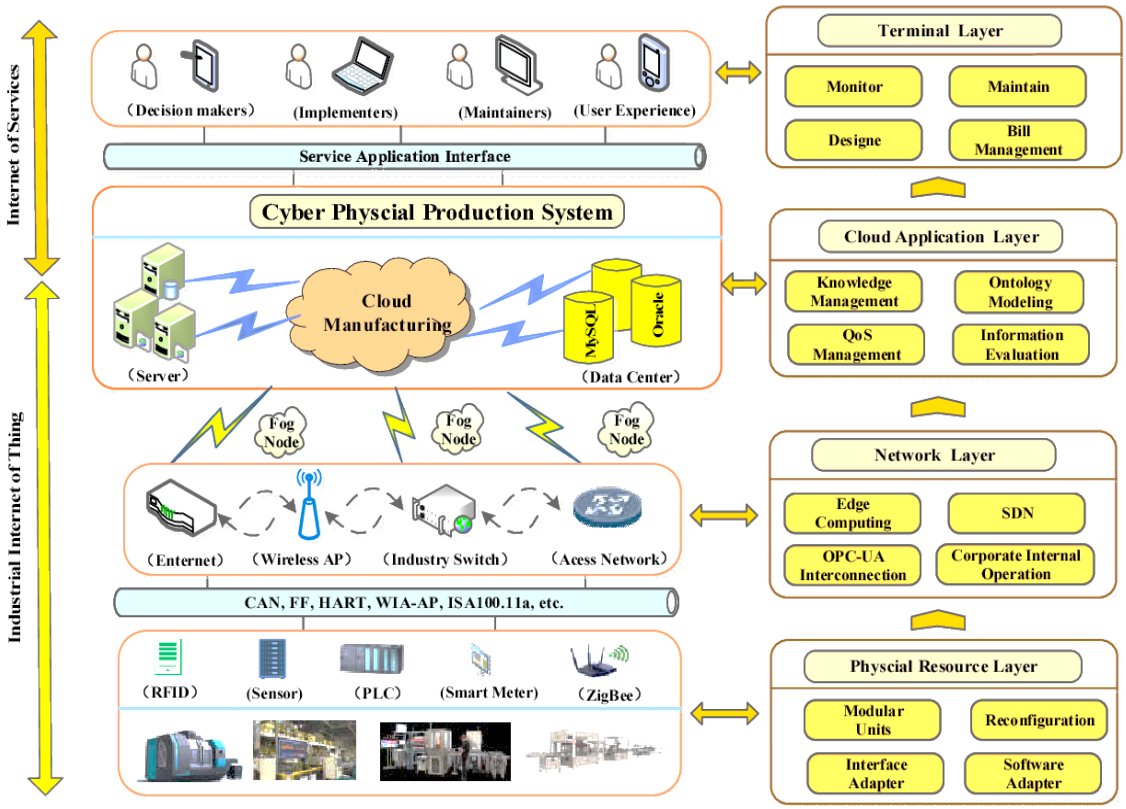

Fig-7: Architecture of smart factory

A. Physical resource layer-

In this layer contains all manufacturing equipment which are involve in the entire life cycle of the manufacturing. Now a days manufacturing of the product are in small batches and high varieties. Therefore we need to reconfiguration of system dynamically. This changes done by the smart factory in the real time and increase the productivity and generate the production line of different product range. The used of wireless sensor network are employed in smart factory for data monitoring, acquisition and logging.

The most common type of sensor-

Radio Frequency Identification (RFID), which enables the real time manufacturing system for mass production.
ZigBee and Bluetooth, both are used for meet the requirement of industrial automation.
Programmable Logical controller (PLC), are used for maintain adequate control on the manufacturing system, like assembly line and robotic control.

B. Network layer-

Network in the industry are in various network technologies like field bus and sensor network. Because of that network layer are perform important role in smart factory. Due to the improvements of cloud computing technology, real-time and reliable network techniques are required for data transmission, information sharing between intelligent equipment, and manufacturing cloud platform. Network layer are connect all machine to each other also connect different manufacturing department and other organization applications.

Technologies in network layer-

- OPC UA- based interaction in multi-agent system which consists of task driven intelligent equipment, where agent is characterized by autonomy, heterogeneity and decentralization. OPC UA are transmit the original communication to the service orientation architecture.
- Software defined industrial network, which is used for integrate internal and external resource in smart factory.
- Device to device communication, refers to the communication where in devices directly exchange information with neighbors under the control of communication system.
- EDGE computing gives an open platform for most features such as networking, computing, storage, and application.

C. Cloud application layer or middleware layer-

In the smart factory interconnection are in huge number by factory devices. It is generated by the shop floor machines and technologies involved in IoTs which brings back new challenges for IIoT application. This layer offers the application support to simplify the raw data for easily storage and access it further used whenever is required. This middleware network having various components which are used to convert the raw data.
Components of converting raw data-

- Resource management, is collect the raw data from the industry through smart devices and intelligent networks.
- Event management, are used to store the raw data for the further used.
- Data management, in this component raw data is collected, storage and aggregate according to time period. This can be reduced the storage cost and minimize the volume of data.
- Recovery management, is used for detect the problem of system failure and database crash.

D. Application layer or Terminal layer-

Application layer provides security and easy access of different data storage services. The application layer provides a platform to extract the useful data which are used for the further improvement in existing process. The data is collected by various industrial application are delivered by various platform.
Various platform for data extraction-
Product lifecycle management (PLM),
Enterprise Resource Planning (ERP),
Supply chain management (SCM),
Manufacturing Execution System (MES),
Quality Management System (QMS),

Warehouse Management System (WMS).

4. Cyber Physical system-

"Cyber-Physical Systems (CPS) are integrations of computation, networking, and physical processes. Embedded computers and networks monitor and control the physical processes, with feedback loops where physical processes affect computations and vice versa."

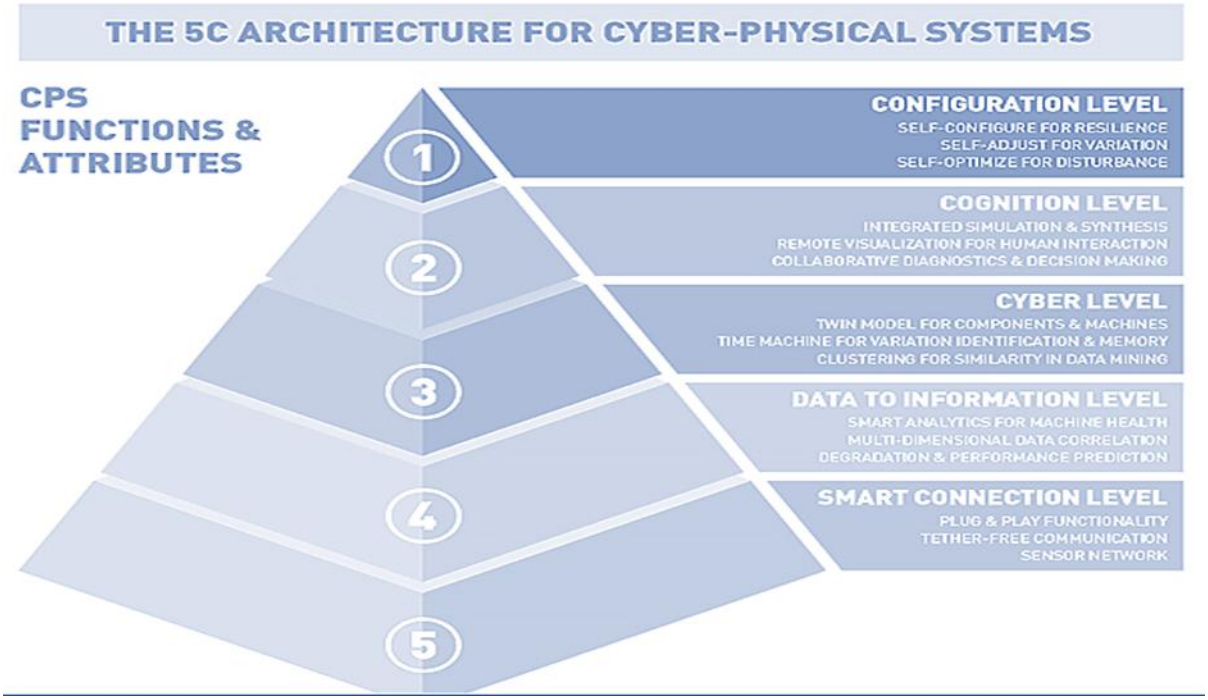

Fig-8: Architecture for Cyber-Physical System (5C)

Data scientists have defined a five-level architecture for the tasks involved in CPSs that work in manufacturing. The visualization of the architecture is pyramid-shaped to represent the way data passing to higher levels gets reduced in size while the value of the information rises. The levels break out this way:

A. Connection: In the connection level, the data generated by connected machines, tools and products is gathered so it can be pushed up through the next levels.

B. Conversion: This level converts data to information using algorithms that are based on the application. For example, consider raw vibration data from a machine tool in a production line. The raw data carries no knowledge about the health or status of the machine. But health assessment algorithms can extract pertinent features and use them to get knowledge about the status of the machine.

C. Cyber: The cyber level receives processed information from the level below and uses it to create additional value. This level acts as the hub for information and performs complex analytics. For example, the cyber level might run sophisticated fleet-based analytical methods. These compare similar assets in a fleet or group (such as specific kinds of manufacturing machines in a single facility). It might run deep-learning algorithms to identify patterns in a large set of fleet data. Recommender systems, special algorithms that seek to predict the "rating" or "preference" for an item, might recommend the best way to use each individual asset.

It might seem as though the cyber and conversion levels do similar tasks. The major difference between the two is the scope of input information and the target of the algorithms. The conversion level is more focused on individual assets

while the cyber level uses data from the entire system to infer additional knowledge. It is possible to perform conversion level analytics locally, at individual sensor nodes, say. But cyber-level methods take place on a central computation hub such as the cloud.

D. Cognition: The cognition level may be able to convert machine signals to health information and compare this information with other instances of it. In cognition level, the machine itself should take advantage of online monitoring to diagnose its own potential failures and become aware of its potential degradation in advance of any obvious signs of trouble. Based on adaptive learning from historical health evaluations, the system then can use specific prediction algorithms to foresee a potential failure and estimate the time to reach certain kinds of failures.

E. Configuration: A machine able to track its own health can detect failures early on and send health monitoring information to the operation level. This maintenance information can serve as feedback to business management systems. Operators and factory managers, in turn, can use it to make informed decisions. At the same time, the machine itself can adjust its working load or manufacturing schedule to reduce down time caused by machine malfunctions. The overall goal of these measures is to produce a system that is resilient—able to defend itself from difficulties by changing its own behaviors and preventing cascading failures that would otherwise disrupt operations.

5 Supply chain management-

The concept of supply chain is found in German literature it is referred as delivery chain, logistics chain, supplying chain or value chain.

Definition of Supply chain-
Chopra and Meindl (2007, p.3) believes that "*a supply chain consists of all parties involved, directly or indirectly, in fulfilling a customer request. Within each organization, such as a manufacturer, the supply chain includes all functions involved in receiving and filling a customer request. These functions include, but are not limited to, new product development, marketing, operations, distribution, finance, and customer service*".
Mentzer et al. (2001, p. 4) describes a supply chain as "*a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer*".

Definition of supply chain management-
"Supply Chain Management" can be defined as "*the management of the value chain consisting of all members associated with moving goods & services from the raw-material stage to the finished goods stage ready for consumption by the end customer. The ultimate goal of all members in the supply chain is to satisfy the demand of the end customer*".

Principle of supply chain management-

1. Segment customers based on the service needs of distinct groups and adapt the supply chain to serve these segments profitably.
2. Customize the logistics network to the service requirements and profitability of customer segments.
3. Listen to market signals and align demand planning accordingly across the supply chain, ensuring consistent forecasts and optimal resource allocation.
4. Differentiate product closer to the customer and speed conversation across the supply chain.
5. Manage sources of supply strategically to reduce the total cost of owning materials and services.
6. Develop a supply chain-wide technology strategy that supports multiple levels of decision making and gives clear view of the flow of products, services, and information.
7. Adopt channel-spanning performance measures to gauge collective success in reaching the end-user effectively and efficiently.

Levers of supply chain-

- Procurement,
- Manufacturing,
- Warehousing,
- Transportation or Logistics,

- Fulfillment.

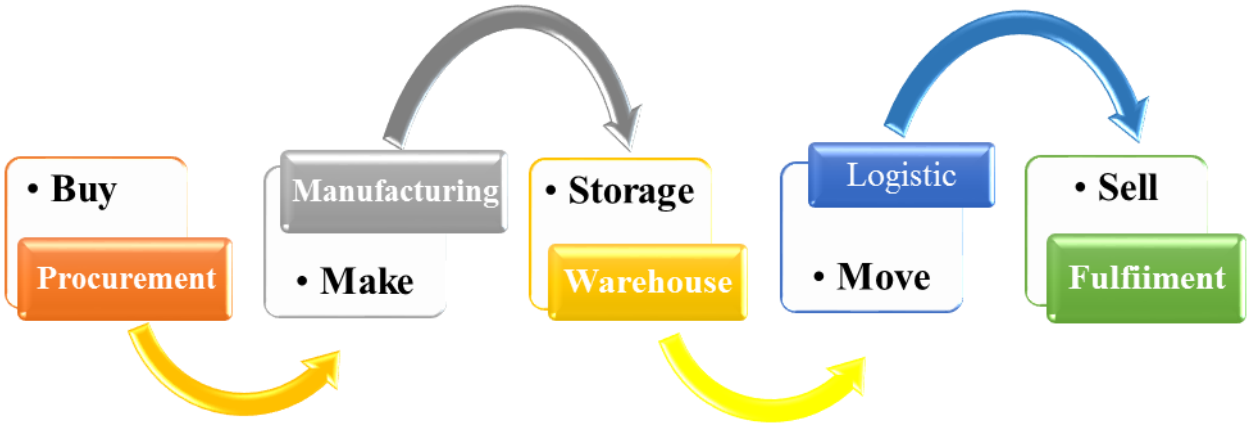

Fig-9: Supply chain Levers

Procurement-

Procurement is the process of buying the goods and services for the purpose of business. Procurement process is used to ensure the buyer receives goods, services, or works at the best possible price when aspects such as quality, quantity, time, and location are compared. Procurement consider all the factor of purchasing like delivery, material handling, pricing and marginal benefits.

Procurement life cycle framework-

- Identification of need and requirement,
- External micro level market analysis,
- Cost analysis,
- Suppliers identification,
- Non- disclosure agreement,
- Supplier communication,
- Negotiation and contracting,
- Logistic management,
- Supplier management and liaison.

Manufacturing-

Manufacturing is the processes of transforming the raw material into the finish good by using the labor, material, tools, and machines. Manufacturing processes is start from product design and ends with ready product. Manufacturing sector are closely depends on the engineering and designing.

Warehouse-

Warehouse is basically storing facility of finish goods, Raw material that will sold or used later. Warehouse gives quick supply of demand whenever is required. Warehouse also important to price stabilization by storing the goods in warehouse as per market price fluctuation. Some products are produced throughout the year but their demand is seasonal. Warehousing is important in such cases.

Functions perform by warehouse-

- Storing of finish goods and raw material,
- Protecting the goods,
- Risk taking,

- Financing,
- Processing,
- Transportation,
- Grading and branding.

Logistics-
Logistic is basically transportation and storage of good from point of manufacturing or warehousing to the point of consumption with efficient way. Modes of transportation surface (road, rail), water (sea, inland), air, pipeline, ropeway, multimodal. Route optimization is one of the most considerable factor when we talk about logistics. The main moto of logistics is timely delivery and customer satisfaction in efficient manner.

Fulfillment-
Fulfillment is the process of receiving, preparing, and distributing the orders. Fulfillment is the last phase of the supply chain management. Retailer and distributor are the major sources of the fulfillment which is actually sell the product to the customer. The sellers are actually involved in customer satisfaction and need identification. Strong sales network is good for every organization. Manufacturing and selling required strong communication to get the information regarding to existing product and identify the customer choice and according to that changes in product are done.

6 Impact of industry 4.0 on supply chain management-

The fourth industrial revolution came up with automation, robotics, Internet of Things (IoT), big data, machine learning, artificial intelligent, as well as analytics and cloud computing system which changes the way of doing business. There is also an impact on supply chain industry is also undergoing a transformation, adopting digitization, automation, and centralized business intelligence systems. The introduction of cyber-physical systems and the Internet of Things (IoT) is changing the pace of the transformation in supply chain management (SCM). There is development in supply chain is visible in every level-manufacturing, procurement, logistics, warehousing, and fulfillment has made companies with integrated digital supply chain functions far more efficient than their predecessors.
While transitioning to a digitized, automated and fully interconnected supply chain requires significant efforts and long-term investments, the pay-offs are huge. Bringing supply chains online can help enterprises reach the next level of operational effectiveness and realize significant cost reductions. Digital supply chain can lower operational costs by more than 30 percent, reduce lost sales opportunities by more than 60 percent, and even reduce inventory requirements by more than 70 percent, all while making companies faster, more agile, granular, accurate, and efficient.

Let's understand the impact of industry 4.0 on each component of supply chain management-

Planning and Execution-
Planning and execution stage in supply chain management (SCM) focus on end-to-end process and keeping a balance between supply and demand. Now because of industry 4.0 these decision are more data driven and the integration of automated end-to-end data aggregation solutions will be a game changer in deciding the more practical approach. The integration and digitization of supply chain operations eliminates the pits in organization and make easy to decision makers to respond in real time. Whether it is a shortage of raw materials, adapting to a changes in market dynamics or customer preferences, identifying the root cause of inefficiency in routine operations, gathering market requirement to plan for the future, a digital supply chain are stay on top of it all with minimal need for human mediation.

To achieve the effective supply chain we need to developed effective ERP system and integrated monitoring and tracking solutions can handle daily operations of the organization as well as strategic initiatives which will give the intelligent and future ready solution.

Procurement-
Procurement are affected by the demand of the customer, plant manufacturing and holding capacity and supplier management, contract management, supply analytics, strategic sourcing which is commonly known as supplier landscape. By using the industry 4.0 concept all demand data are track live using IoT. Live demand data are get from the Point of sale, Inventory data from the store, data from holding facility, data information from in transit raw material which are procure from

suppliers which all are integrated are help in streamline the procurement facility. By use of this type of integration manufacturer is no longer necessary of safety stock or buffer stock.

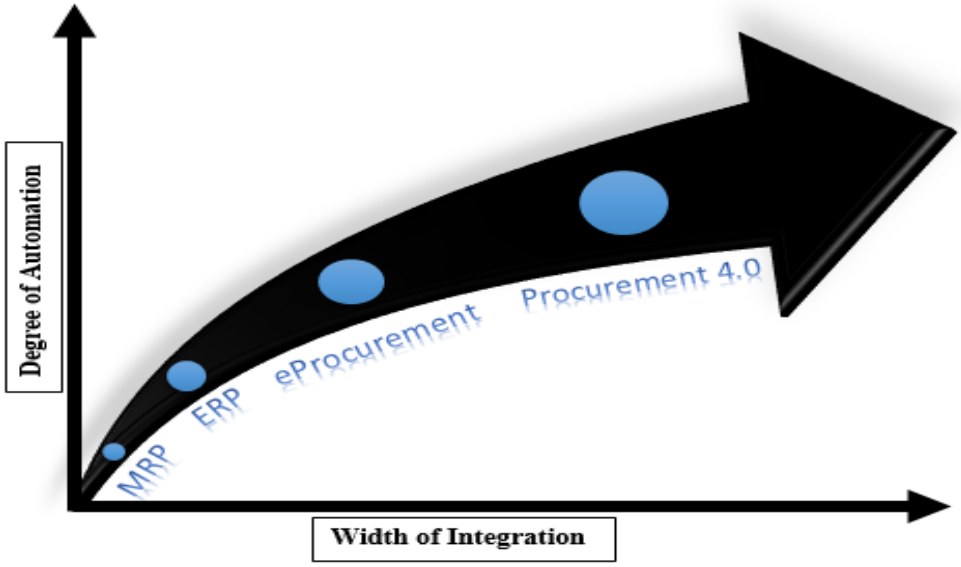

Fig-10: The evolution of procurement

After1970s, Application of IT in business organization are developed where the demand is capture using simple electronic system known as MRP ("material Requirement Planning"). It was only connected the internal department of organization like production, material requirement and procurement. This system is somehow restricted. Next ERP system ("Enterprise Resource Planning") are came in IT which are used in procurement having strong cross company integration. The use of this system is provide one common system which runs all major function across company from sales, finance, production to procurement. From MRP to ERP evolution, the next development stage is eProcurement. The technological advancement such as e-Business, Internet and supply chain management revolutionary used of technology. Which gives easily integration to the suppliers.

At the end we face the Procurement 4.0. It's a next step of revolution of procurement system which is more in automation than earlier eProcurement system. EProcurement is not fully automated is gives only the collaboration with suppliers and Manufacture to maintain the perfect demand, it needs the support of manual work to maintain it. Industry 4.0 works on automation and also emphasis smart IT system. Smart idea is to develop the fully automated system for entire procurement processes. This smart system is automatically recognize demand of the material required and generate the automatic order and send to the supplier without and human interference. The industry 4.0 gives the free flow of information to any point of the organization. It gives higher degree of exchangeability of data itself, a higher degree of automation of the information exchange and possibly even the integrated use of the data under the concept of "big data analytics". At the end Procurement 4.0 is concern about high degree of digitization and ultimate automation and make highly integrated procurement system which build the suppliers relationship.

Manufacturing-

Manufacturing is one of the important factor of the supply chain and it consume more time as well as cost and also need human efforts to manufacture the final product. But now using the technological advantage getting by Industry 4.0 this problem is reduce. Industry 4.0 gives some of the advantages as follow-

- Increased compatibility-

Previously outsourcing is done by the manufacturing company only in the region of low wages worker are available to remain it competitive. Now they invest in technology rather than investing in wages to compete once again. The result of this technological advancement getting by industry 4.0 all manufacturer are choose the location as per the technological development and customer base and demand analysis.

- Increase productivity-

Automation, machine learning algorithms, robotics and analytics are reduced the human efforts to do the same work with low tine and high accuracy in the finish product. The use of human workers only to monitoring and maintaining the system.

- Increase the profit as well as revenue-

Industry 4.0 is not only the system of increase the efficiency of the manufacturing unit but it also help in the preventive and predictive maintenance and update whenever is required. The result of this reduce the capital investment required for manufacturing units and increase the profitability and revenue of the company.

- Manufacturing process optimization-

With more connectivity, shared data and better analytics, closer collaboration along the entire supply chain becomes possible, which could lead to increased efficiency, optimization and innovation in the long run across the manufacturing industry. Machine-to-machine communications and integrated systems will drive greater collaboration among producers, suppliers and other stakeholders along the value chain.

- Record keeping and tracing is getting simple-

The use of cloud computing and big data the storing of machine data are getting very easily and make it compatible to all. It help to analysis of any type of data of any machine at any location is possible. This record keeping enabled by digital systems will speed traceability, while limiting liabilities, warranty costs and recalls.

Despite these advantages, the shift is still in the early stage. But it clear that Industry 4.0 and its technological advancement soon become adopted by all manufacturer in worldwide.

Example-
Audi is one of the example of industry 4.0. Audi is working on the production fit by use of smart factory. Creating large number of big data and intelligent connection which can facilitate data driven and highly flexible as well as efficient manufacturing. Audi no longer to use the traditional way assembly line but they used radically new disruptive concept of modular assembly.
Audi used sensor based moving robots to carry the car body, doors and assembly by used of robots. Another they developed glasses which we used for assembly procedure, so who used the glasses they didn't get any confusion regarding assembly of product. Also used of 3D printing m/c to manufacturing the some parts.

Logistics-
Logistics and transportation having more impact because of digitization in supply chain management and industry 4.0. Tracking of shipment is getting easily for the supply chain managers. Supply chain managers having advantages of optimizing routes, fleets, and field asset utilization are done in real time. The advantages of automation in logistics is reduced the human efforts. Automated logistics management systems improve responsiveness to changes that affect throughput, ETA, unnecessary overheads like fuel costs, and the ability to hit narrowing windows of delivery, especially for last-mile logistics.
Logistics 4.0 concept are related to the innovation and application which are used in logistics system are added by cyber physical system. It contains smart product and smart services are driven by technology and this approach is used to define "Smart Logistics". Smart logistics is a system of enhancing the flexibility, adopting with change in market, and make the company be close to the customers and its needs. This is increase the customer relationship and service are optimize the production and reduce the cost of over production and storage. Logistics 4.0 are depends on some technological applications:

- Warehouse management,
- Resource planning,
- Intelligent transportation system,
- Transportation management,
- Information security.

Warehousing-
In the era of industry 4.0 warehouses are work on autonomous based. It includes the automatically handle the major task performed in the warehouse like space management, order tracking and picking, inventory tracking and management, ordering etc,. The use of technological advancement it simplify and reduced the labor work which is boost the efficiency and reduce the operational overheads. When coupled with end-to-end supply chain visibility solutions for inbound or outbound logistics, smart warehouses can anticipate the inflow of goods and space requirements, requisition assets like personnel or

pallets, and update enterprise inventory holding and throughput levels in real time. For tracking the inventory and management the inventory system there is used of new technologies like augmented reality (AR) can help to increase the efficiency.

Example-
The DHL is one of the example of smart warehouse management. DHL is use AR (Augmented Reality) and IoT (Internet of Things) for picking, sorting and tagging the products in the warehouse. All are done with the help of Vuzix smart glasses, their workers harnessed the goodness of AR to work hands-free in warehouses. It result that picking cost reduced 55 to 65% and 20% of shipping cost. Augmented Reality helped DHL improve efficiency in picking process by 25%. They also increased productivity accuracy, cut on-boarding and training costs by 50%. Combination of AR and IoT empowers warehouse workers with contextually relevant and real-time data. They provide precise real-time data that's directly fed from central systems. These further enable machine-to-machine communication, reducing manual data-feed requisites.

Fulfillment-
Industry 4.0 concept change the view of products in key ways. Like the smart, connected System produce huge no of data that can be harnessed to drive improvements across a range of metrics including price and performance. And the ability to connect to other machines creates, contributes to, and benefits from a broader ecosystem of activity and intelligence. Successfully managing data can result in richer, relationship-based sales models and help create new products to sell.

Industry 4.0 technologies are change the view of sales relationship by several ways as follow:

- Longer sales cycle.
- Broder sets of stakeholders.
- New opportunity developed in after sales market.
- Greater involvement and support from a network of vendors and providers.
- New pricing model.
- New product and services.

Customer benefits through Industry 4.0 by using selling concept-

- Better Diagnostics- One of the major problem to resolve the product failure at customer end and the services call system makes it very costly. On the other hand, technology gives the access to handle the problem remotely and in some cases device itself fixed the small problem.
- Smart product are more customer centric- the most of the business are constantly working on the innovation to give customer satisfaction.
- Better longevity- Most product having so many part, and one of them are fail to work the product stop working. To overcome this problem industry 4.0 allow businesses to not just see how their entire product is performing but how every component is performing.
- Lowe price- every failure of product are generate the cost and because of that generating high price on performing product. To overcome this reduce the failure. This is done by using the technology.

5. CONCLUSION

The aim of the research to identify the impact of Industry 4.0 on supply chain management. In this research we study the different technologies to implementing the industry 4.0 in manufacturing sector. Industry 4.0 is still in development stage. The implementation of industry 4.0 has showing the connection between human, machines and object to formed self-actualizing real time system, and also crate cross company value chain which impact on the entire supply chain.

Industry 4.0 also add some benefits in supply chain. It gives the greater transparency and accuracy between the all suppliers, manufactures, logistics, warehouse, and fulfillment are overcome unnecessary cost. Advance machine learning help to predict the demand of different products at high accuracy. High interconnection and collaboration between all the supply chain levers which taking supply chain on next level. Digitization increase the warehouse capabilities like sensor track the flow of goods and feed the relevant information in real time. It also improves the agility by using integrate data from procurement to consumer end in 'supply chain cloud' it insures that all stockholders having the way to take decision by considering all the factors.

6. APPENDICES

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