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The concept of 4.0: An overview

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Abstract
Industry 4.0 and Smart factory are the most commonly used terms in case of next generation production systems. In the era of industrial digitalization, the enterprises are investing more on their tools and solutions which allows their employees, machines, processes and even their products to be integrated into a single integrated network for date collection, data analyse, evalution of company development and even performance improvement. To remain competent in their competitive global market an industry has to utilise these technological advancement to the fullest extent inorder to solve the current the market challenges and serve their customers in new ways which their never imagined before. Industry 4.0 is a new strategic initiative introduced by german government and its goal is to transform an ordinary manufacturing industry to a digitally advanced and integrated one. An Industry 4.0 production system is thus flexible and enables them to produce customized products inorder to satisfy the needs of each customers. The aim of this paper is to present understandable view over the concept of Industry 4.0, its drivers, current challenges faced by the companies.

Keywords: Industry 4.0, digital manufacturing, internet of things (IOT), cyber physical system (CPS)

1. Introduction
Now-a-days an industry's production is driven by the global competition. The need for fast adaptation of production to the ever changing market demands, inorder to full fill these demands an industry has to improve its current manufacturing technology. Industry 4.0 is a promising strategical approach based on integration of business and its manufacturing process, as well as integration of Company's customers and suppliers. Technical aspects of these demands are addressed by applying the generic concepts of Cyber physical system (CPS) and industrial Internet of things (IOT) to the industrial production systems. The industry 4.0 works based on the connections of CPS Building blocks in which the blocks are embedded with decentralized control and advanced connectivity and exchanging real-time data with the goal to identify, locate, track, monitor and optimize the production systems. All these data which are collected from the machines, processes and the products are stored using a cloud storage. Industry 4.0 is an initiative approach and became an inspiration for other initiatives, which is originated in Germany and will be addressed in detail in the upcoming topics.
In short, Industry 4.0 tend towards full automation of industry by exchanging data in manufacturing technologies and processes which includes Cyber physical system (CPS), Industrial Internet of things (IIOT), cloud computing, cognitive computing and artificial intelligence.

2. Definitions of industry 4.0
Kangermann, Wahlster & Johannes (2013) [3] defines "Industry 4.0 utilizing the power of communications technology and innovative inventions to boost the development of the manufacturing industry".
Qin, Lin & Grosvenor (2016) [5] states that "Industry 4.0 encourages manufacturing efficiency by collecting data smartly, making correct decisions and executing decisions without any doubts. By using the most advanced technologies, the procedures of collecting and interpreting data will be easier. The inter operating ability acts as a connecting bridge to provide a reliable manufacturing environment in industry 4.0. This overall consciousness gives industry 4.0 the most important aspect of Artificial intelligence functions".

Schumacher, Erol & Sihn (2016) [4] mentions "Industry 4.0 is surreounded by a huge network of advanced technologies across the value-chain. Service. Automation, Artificial Intelligence Robotics, Internet of Thing (IOT) and Addictive manufacturing are bringing in a brand new era of manufacturing processes. The boundaries between the real world and virtual reality is getting blurrier and causing a phenomenon known as Cyber Physical Production Systems (CPPS)".

Wang *et al.* (2016) states "Industry 4.0 makes full use of emerging technologies and rapid development of machines and tools to cope with global challenges inorder to improve industry levels. The main concept of industry 4.0 is to utilise the advanced information technology to deploy IOT services. Production can run faster and smoothly with minimun downtime by integrating engineering knowledge. Therefore, the product built will be of better quality, production systems are more efficient, easier to maintain and achieve cost savings".

Murgalska & Magdalena (2017) [6] tells that " the modern and more sophisticated machines and tools with advanced softwares are networked sensors can be used to plan, predict, adjust and control the societal outcome and business models to create another plase of value chain organisation and it can be managed throughout the whole cycle of a product. Thus, industry 4.0 is an advantage to stay competitive in any industry. To create a more dynamic flow of production, optimization of value chain has to e autonomously controlled".

According the above seen definitons, most of the authors mentioned the meaning of Industry 4.0 consists of key topics related to Cyber Physical System (CPS), Internet of Things (IOT) and others. Besides that some authors stated that Industry 4.0 is a cost factor and profitable with recently developed high-tech information and intelligent services.

3. Evolution of Industry from Industrial Revolution 1.0 to 4.0

3.1 First Industrial Revolution

The first industrial revolution happened between the late 1700's and early 1800's. During this period, the manufacturing evolved from focusing on shifting of manual work done by labours to adaptation of animals to perform the labour work. Then the invention of steam power and mechanisation of production. Before the threads are produced in simple spinning wheels with the help of human hands, after the advancement the mechanised version produced eight times the volume.

3.2 Second industrial revolution

In the early part of 20th century, the world entered into second industrial revolution with the introduction of steel and use of electricity in production. The introduction of electricity enabled manufacturers to increase the efficiency and helped to make the machineries in factories more mobile. It was during this phase, the mass production concepts like assemble line were introduced by Henry Ford as a way to boost productivity with lower cost.

3.3 Third industrial revolution

Starting in the late 1950's, a third industrial revolution slowly began to emerge, as manufacturers began to incorporate more electronic- partial automation using memory programmable controls and eventually computer technology into their industries. During this period, manufacturers started experiencing a shift that put less emphasis on analog and mechanical technology and more on digital technology and automated softwares. Since these introduction, we are now able to automate an entire production process without human assistance.

3.4 Fourth industrial revolution

In the past few decades, industry 4.0 takes the emphasis on digital technology which takes the production to a whole new level with the help of inter-connection among the machines, employees, process and products through Internet of things, access to real time data and introduction to Cyber physical system. Industry 4.0 offers a more comprehensive, interlinked and holistic approach to manufacturing. It connects physical with digital and allows for better collaboration and access across departments, partners, vendors, product and people. Industry 4.0 empowers business owners to better control and understand every aspect of their operation and allows them to leverage instant data to boost productivity, improves processes and drives growth.

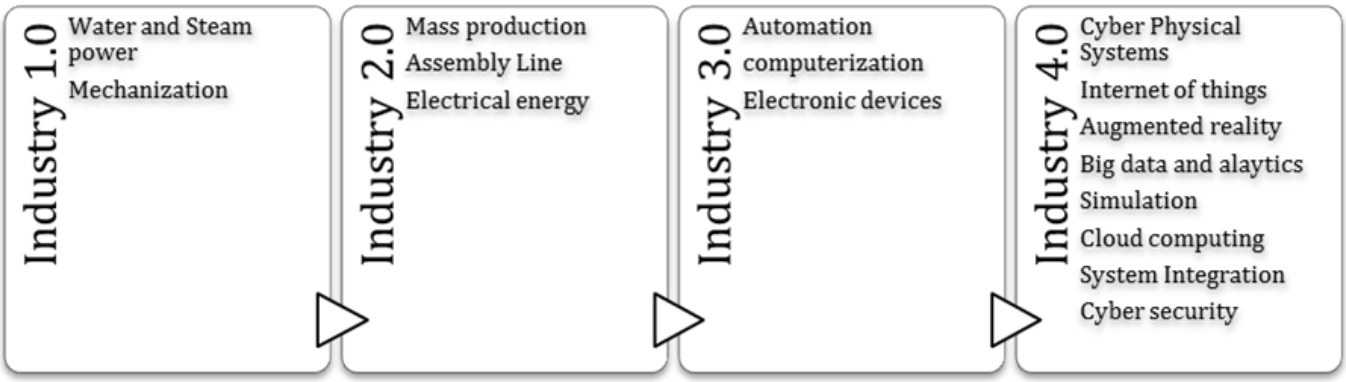

Fig 1: History of Industrial Revolution

4. Components of industry 4.0: Industry 4.0 cab be classified into three components.

- Horizontal integration
- Vertical integration
- Engineering integration

4.1 Horizontal integration: It brings the concept of new type worldwide value chain networks i.e, one corporation has to cooperate and compete with other corporations that have similar characteristics to create an efficient production system.

4.2 Vertical integration: It is to achieve the hierarchical subsystems at the production line in order to produce an easy to configure an Hugh flexible production line. From this integration, the highly intelligent machines create an automated controlled systems that is able to be automatically reconfigured according to the various types of products. The large amount of data collected and processed enables the manufacturing system to be transparent.

4.3 Engineering integration: It is otherwise called ad End-to-End integration as this deals with the whole value chain from beginning to the end to assist in the customization of products. It works in a chain of activities throughout the product-centric value creation process which involves aspects such as customer requirement expressions, development of product design, recycling, production engineering, production services, planning and maintenance. Through this integration every product can be reused to the same product model. In the end the product will be easily customisable.

5. Characteristics of industry 4.0

As seen earlier Industry 4.0 is the future of global manufacturing and digitalized products and factories are the outcome of this revolution. There are 8 characteristics for industry as shown in Figure 2

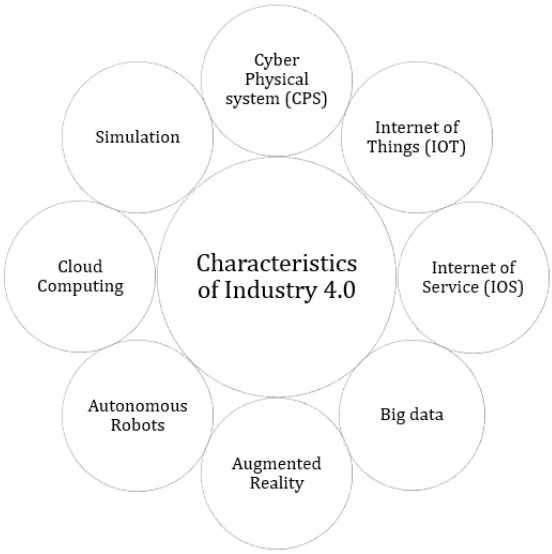

Fig 2: Characteristics of Industry 4.0

5.1 Cyber-physical system (CPS)

Industry 4.0 totally relies on this Cyber-Physical System where the advances and speed of development in communication and calculation form in CPS gives life to Industry 4.0. In CPS each production system has sensors installed in the entire physical systems inorder to connect the physical things with virtual models. CPS is the foundation to create Internet of Things (IOT), which can be combined to become Internet of Services (IOS). Hence, businesses will find it easier to establish global networks which joins the warehousing systems, machinery and production facilities of CPS in future.

5.2 Internet of things (IOT)

Industry 4.0 brings a new way for the present Internet of Things (IOT) and the manufacturing systems. The mission of Industry 4.0 can be achieved only through the combination of IOT and Internet of Services (IOS) in production process. IOT enables a advanced connectivity in systems, services, physical objects and also enables object-to-object communication and data sharing.

5.3 Internet of services (IOS)

In automotive industries, this Internet of Services plays as an very important role as the activities are triggered through data transfers in the information technology to make their daily mobility easier and safer. IOS acts as a service vendor to provide services through the internet according to the types of digitalized services. These services are availabe around the business on demand as the result the suppliers can provide and aggregate these services on additional value.

5.4 Big data and Analytics

Big data analytics is very helpful for predictive manufacturing and is an important direction for industrial technology development. This result in huge amount of information produced and obtained daily where the current processing and analyses are unable to cope using traditional methods. Many other applications would be able to gain additonal values when existing techniques become more mature to handle big data. According to Forrester “Bog data can be divided into four dimensions which ar volume, variety, value and velocity”.

5.5 Augmented Reality (AR)

Under Industry 4.0, Augmented Reality (AR) has become one of the most promising one as all the technological companies should invest in it because it helps the companies by doing their maintenance works in less time with reduction of potential errors. It can predict with high accuracy and allows the frequency of maintenance to be kept at low numbers by utilising predictive maintenance to rpevent any unplanned reactive maintenance. Thus this will reduce costs associated with doing too much preventive maintenance.

5.6 Autonomous Robots

Today’s Robots are highly flexible and are easier to operate in multitudes of field. In the upcoming future, robots will

interact with eachother and collaborate actively with humans under the supervision of handlers. These robots will be more sophisticated and cheaper to achieve better production when compared with the current ones.

5.7 Cloud Computing

Industry 4.0 is stimulating the utilization of advanced technologies, smart production systems and integration of machines. In order to save all those huge data, a company requires a huge amount of space to store them. There comes the Cloud computing, it allows the user to access and store their data with small amount of money. When the company uses fully automated machines, its data will continue to be stored into cloud storage system, allowing production systems to be more data-driven. Now-a-days cloud computing has becoming a consideration by many companies on the time of building their data systems.

5.8 Simulation

Simulation modelling is a way of running a real or virtual process or System to find out the output of the modelled system or process. Simulations are done by using real-time data to represent the real-world which includes all aspects such as humans, machines, products, etc., the operators feed all those Datas and adjust the programme in order to achieve the optimum machine setting and production format. This in return will reduce the machine setup times and improves working quality.

6. Challenges of industry 4.0

Industry 4.0 is a way new and unique concept from any of the earlier industrial revolutions. As the manufacturers attempts to implement any of these concepts in their production system they tend to face challenges and obstacles in the first place. So, here are just some of many challenges they face in successful implementation of concepts of Industry 4.0

- Lack of unified leadership that makes cross-unit coordination difficult within the company.
- Data ownership concerns when choosing third-party vendors for hosting and operationalizing company data.
- Lack of courage to launch the radical digitalization plan.
- Lack of in-house talent to support the development and deployment of Industry 4.0 initiatives.
- Difficulties with integrating data from various sources to enable initial connectivity.
- Lack of knowledge about technologies, vendors and IT outsourcing partners that could help execute the core initiative.

7. Benefits on implementing industry 4.0

The company tend to face many challenges while implementing Industry 4.0, as a result on successful implementation it enjoys certain progress in the production and as well as in their administration systems. The following are some of the benefits

- Enhanced productivity through optimisation and automation.
- Real-time data for real-time supply chains in a real-time economy.
- Greater business continuity through advanced maintenance and monitoring possibilities.
- Higher quality products as a result of real-time monitoring, IoT-enabled quality improvement.
- Better working conditions and superior sustainability.
- Personalisation opportunities that will earn the trust and loyalty the modern consumer.
- Improvement in matching of Demand and Supply of products.
- Reduction in machine down time.

8. Conclusion

In a nutshell, Industry 4.0 is the future of global manufacturing which aggregates the existing ideas to a new value chain. It describes a future scenario of industrial production that is characterized by the aspects of new level of controlling, organizing and transforming the entire value chain which resulting in higher production, flexibility and superior quality. Hence, these can predict production performance degradation and autonomously manage and optimize product service needs and consumption of resources which lead to optimization and reduced costs. It is hoped that with proper guidance and technical skills, many manufacturing companies will implement Industry 4.0 in their business.

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