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Smart factory of Industry 4.0

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Abstract: With the rapid development of electric and electronic technology, information technology and advanced manufacturing technology, the production mode of manufacturing enterprises is being transferred from digital to intelligent.

Industry 4.0 is a combination of Cyber-Physical Systems linked in the supply chain and manufacturing processes with usage of the Internet of Things and Industrial developments. A definition for Industry 4.0 is that it is an (r)evolution towards digitalization.[1]

The term Industry 4.0 stands for the fourth industrial revolution. It is understood better as a latest level of control and organization over the value chain of the product lifecycle, it is focused on individual customer requirements. The cycle starts from the product idea. Then order placement in made and product goes through the development and manufacturing. Then it makes it way to product delivery for the end customer where the cycle moves to the end phase, recycling. The availability of relevant information in real time by connecting all activities of the value chain forms the basis for the fourth industrial revolution.

The connection of systems, things and people creates self-organizing, dynamic, real-time optimized value-added connections across companies. They are further optimised in accordance with different criteria like availability, costs and consumption of resources.

Industry 4.0 is a reevaluated technique for manufacturing that makes use of the newest and latest technological creations, especially in incorporating operational and information technology.

keywords: Industry 4.0, smart factory, sensors, actuators, information channels, IoT, RFID tags, Business intelligence

I. INTRODUCTION

Based on the Literature Review, it is discovered some gaps from the articles. They are as follows:

i. There is a need for the adoption of Industry 4.0 in various manufacturing and IT industries to study the impact of the improvement on the outcome of a company.

ii. Need for more conceptual methodology in research is required to easily interpret the concept and help to work more efficiently.

iii. Horizontal value chain helps Industry 4.0 to enormously merge step by step to give colossal suggestions in the industrial process.[2]

iv. Industry 4.0 is found to have a presence in manufacturing industries the most with automation.

v. Most industries like in construction, agro and food require a strong framework to meet the challenging demands in their activities.

vi. One of the most critical issues is that there is no generalised model for Industry 4.0 implementation for most of the industries. Hence there are no clear tool usages in various phases of the Industry 4.0 implementation.

2.0 ROADMAP OF INDUSTRY 4.0

Industry 4.0 combined with Internet of Things and Service, Cyber Physical Systems, Cloud Computing and Big Data have the potential to enhance industry performance, make new products and spark ingenious business models. It makes manufacturing devices to independently self-optimize.

The figure below shows the roadmap and development path of Industry 4.0. There are 4 different stages. They are:

2.1 **Digital Beginner**:

Industrial companies are beginners on the path of industrial 4.0. At this level the initial digitization results are attained in all divisions as well as in discrete products and service portfolios. Compliance are not guaranteed in this stage and digital hazards are not documented.

2.2 **Vertical Integrator**:

It is the second maturity stage of companies in Industry 4.0. Companies use integrated software also known as embedded systems and it allows internet based transmission of the product with the manufacturing mediums. The network existence provides market arrival by explicit online sites and product inventory.[3]

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2.3 **Horizontal Collaborator**:

It is the third maturity stage that integrates the value chain with customers and stakeholders. It integrates customers, suppliers and subcontractors along the production line. It is better coordinated with logistics service providers and hence creates proficiency with increase in quality, enhance the time for handling the process or shrink operating costs. Compliance is maintained throughout all the functions of the business and digital hazards are administered with improved methods.

2.4 **Digital Expert**:

It is connected to its operative and executive processes worldwide and will virtualise these processes. The crucial executive procedures are globally improved according to the costs and control specification. The expansion of internet solutions for industries needs a large investment. One can follow many ways to achieve the title of digital champion. It should be based on its configuration of the existing product and service as well as on the operative and executive processes and capacity.

3.0 FACTORS FOR TRANSITION FROM CONVENTIONAL FACTORY TO SMART FACTORY

The merging of the virtual and the physical worlds through cyber-physical systems and the resulting fusion of technical processes and business processes are leading the way to a new industrial age best defined by the "smart factory" concept. The deployment of cyber-physical systems in production systems gives birth to the "smart factory." Smart factory products, resources and processes are characterized by cyber-physical systems; providing significant real-time quality, time, resource, and cost advantages in comparison with classic production systems.

The smart factory is designed according to sustainable and service-oriented business practices. These insist upon adaptability, flexibility, self-adaptability and learning characteristics, fault tolerance, and risk management.

The high levels of automation come as standard in the smart factory (Figure1) , this being made possible by a flexible network of cyber-physical system-based production systems which, to a large extent, automatically oversee production processes.

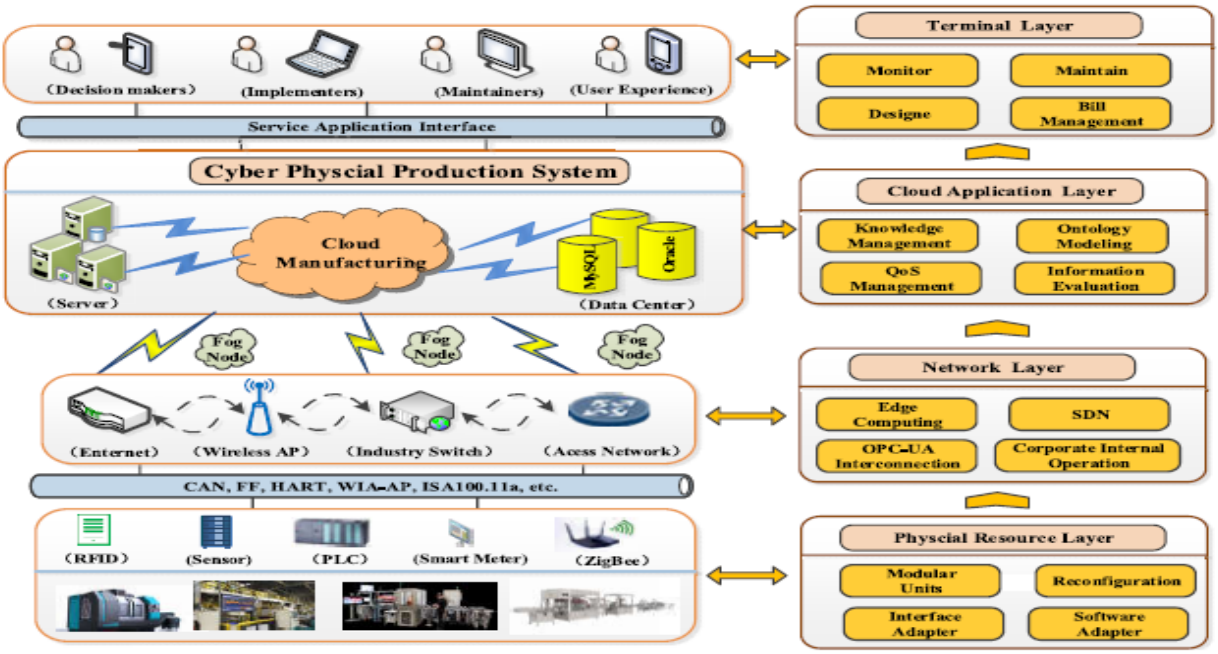

Figure:1 System architecture of smart factory

Production advantages are not limited solely to one-off production conditions, but can also be optimized according to a global network of adaptive and self-organizing production units belonging to more than one operator.

This represents a production revolution in terms of both innovation and cost and time savings and the creation of a "bottom-up" production value creation model[4] whose networking capacity creates new and more market opportunities. With sensor based technology connected to cloud and mobile devices, it would enable mobile call or message notifications. This can lead to emergency call to mobile personnel. We can design mobile friendly dashboards for summary, alerts and reports, where detailed reports can be seen on web pages. At the factory level, installed hardware consists of sensors, actuators, controllers, user and communication interfaces. The sensors and

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actuators, whose function is to measure physical attributes and carry out predefined tasks. This can have applications like preventive maintenance, break down management, load balancing, abnormal functioning alerts, etc.

Smart factories, with their interfaces to smart mobility, smart logistics, and smart grids concepts, are an integral component of tomorrow's intelligent infrastructures.

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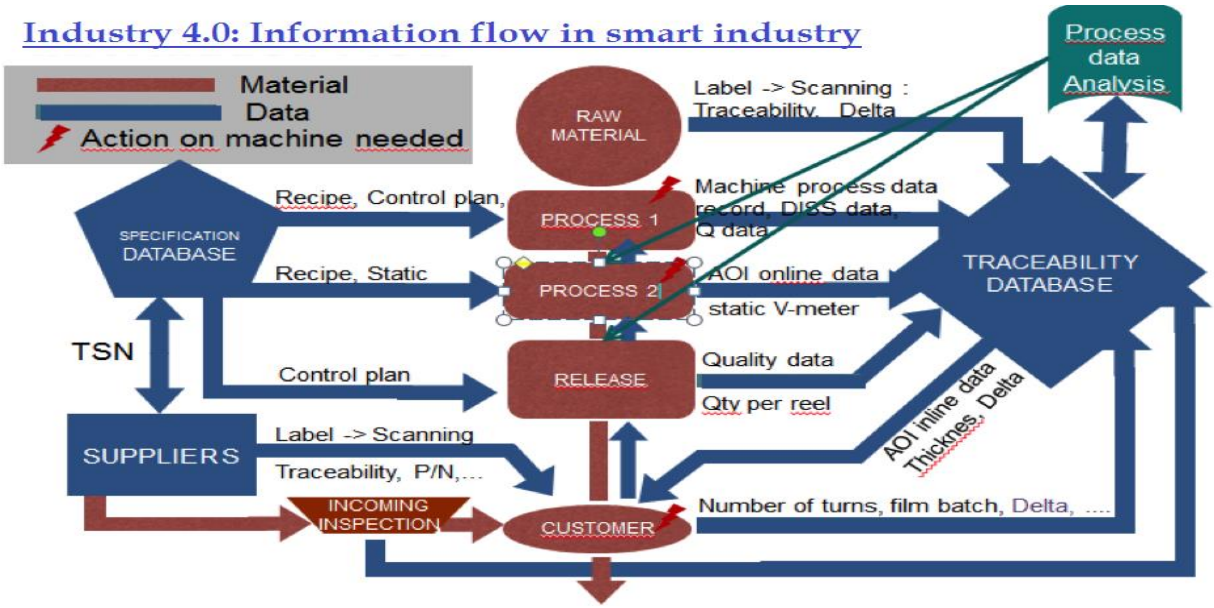
4. INFORMATION FLOW IN A SMART INDUSTRY.

There are basically two information channels, they are input & output channels. The Input channel is used to load the specification of the process into each step. This means loading parameters into a particular machine or providing the control plan for the operator in the process.



The Output channel collects all process-generated data. This includes development of tools for detecting defects, characterization data (dimensional), and quality data.

Both pipelines of information, coexisting with the traditional flow of material, configure the basic network for the development of a 4.0 industry:

The Material flow will aim to fully link material and data flow. The process should drive the material automatically through the process steps, collecting and providing all necessary outputs, inputs, feedback and prognoses. (Figure2). This step may also include a lean review of the existing process and process steps.

The Data Input process needs to be reengineered to automatically set-up machines, automatically execute control plans, based on the knowledge of the product to be manufactured. This requires standardization of the recognition and identification of the product.

The development of analysis and inspecting tools. The control and knowledge of several parts of the process need to be improved in order to increase the control on the process and its output. In particular, an automatic inspection system needs to be developed, at least in the slitting part of the process. Besides, all machine data and further measurements[5] need to be collected and integrated.

The Machine (legacy systems) integration has the current processes consist of existing machines and owned software. These independent systems need to be integrated to receive data and provide outputs.

The Data Generation process will be able to generate all kind of data about key process parameters and measurements

The revolution in industry 4.0 in smart industry is with Business intelligence.

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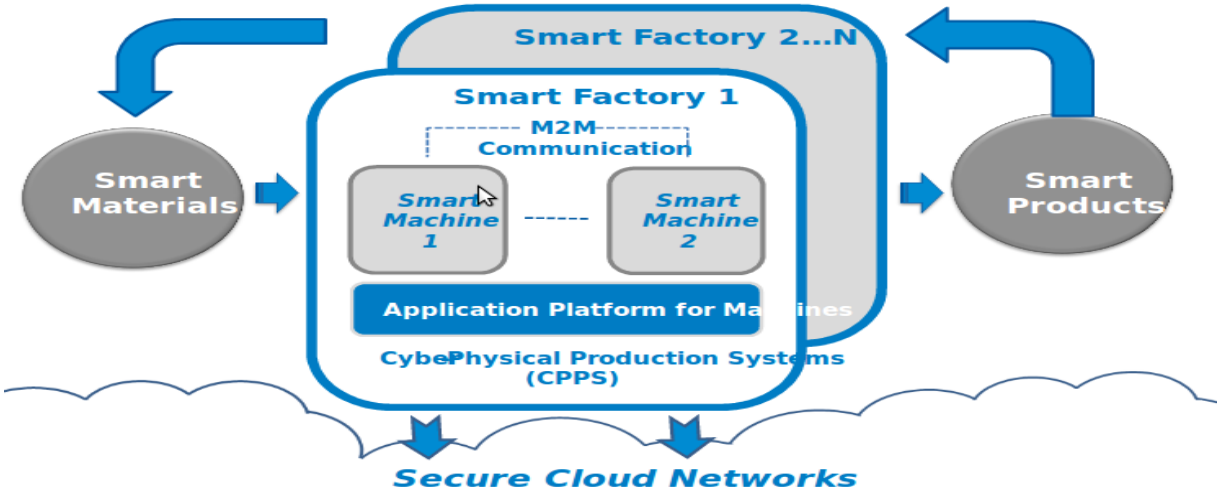
Figure:3 Technology stack in industry4.0

All the information gathered in the previous steps needs to be analyzed along the different steps of the process in order to provide feedback of the previous steps[6] and also to provide a prognosis for adapting the future course.
Industry 4.0 has the technology stack (figure3) but there are far more than cyber security, the IoT, big data, cloud computing, autonomous robots, augmented reality, additive manufacturing and so on.

The artificial intelligence and machine learning, there is also virtual reality, although overlapping with simulation there are digital twins, next to autonomous robots there are also collaborative robots, on top of cloud computing, edge computing .

5. CONTRIBUTION OF IOT IN A SMART INDUSTRY.

The Internet of Things (IoT) for the Industry connects material and physical facilities of the plant via a wireless transponder (RFID), integrated or attached to these objects.



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Internet of things with associated interface protocols is used for sharing of information throughout all stages of the product life cycle, including design, manufacture ,supply chain and aftermarket support.

The field reality consequently brings reliable, comprehensive and automated data to the information system, whatever the stage of the process.

Figure4 depicts the network of multiple smart factories[7] in a cloud based environment. The sensor is used for machine to machine communication and is interface to cloud like Azure with associated analytics is used to arrive at optimum business decisions.

Connected objects also provide a cross- visibility at different levels of management of the company. The connected objects for Industry bring new value to industrial by logging in:

5.1 **People**

Connected Objects for Industry provide a level of visibility and information never before achieved in Manufacturing operations, Assembly, Maintenance and Supply Chain. Sharing all this information via the Internet, connected objects allow access to the right information from any mobile device at anytime and anywhere to different level of management of the company, suppliers, maintenance companies and even to distribution channels.

5.2 **Business Processes**

Connected objects for Industry can create a link and continuity between the different processes of the company from Logistics to Maintenance interventions through Production. For example, UHF RFID tags on each of its spare parts that allow knowing their availability and real-time location (Logistics) from wireless mobile terminals (PDA) in case of Maintenance intervention. This link between the processes allows the company to save tens of thousands Indian currency.

5.3 **Data**

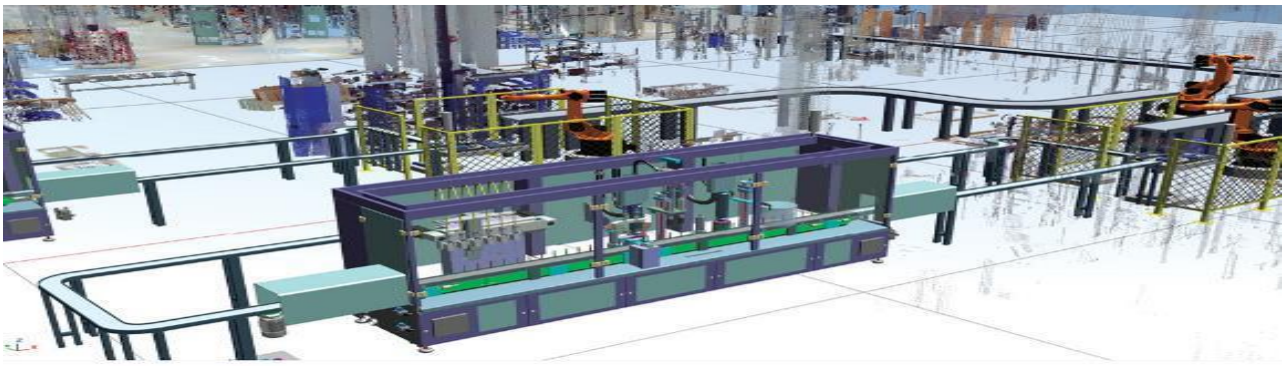
Connected objects for Industry promote the deployment of industrial connected mobile devices (PDAs, Smartphones, Tablets) to interact with it. These connected mobile devices collect and generate contextual data associated with objects which are then processed by software platform hosted in the information system of the Company (or in a SAAS or cloud version) in order to broaden access to data.

The major features and functionality in IoT enabled digital factory are the following;

5.3.1 Small Batch Manufacturing helps to increase the productivity using best in class technologies and adaptable automation tools to maximize the CNC machining efficiency

5.3.2 Visual analytics in manufacturing is an imaging tech lab[8] enables off end to end imaging solution development and porting & optimising to various vision platform.

The infrastructure augmentation can be done by 3D printing approach. Digital model of a particular system encompassing design specification, engineering models as built and operational(in-use) data is mentioned in figure5.



5.3.3 Artifical intelligence in manufacturing has designed SLU served as AI component to monitor product usage in the field

5.3.4 Visual reality in manufacturing has VVR visualization and virtual reality approach to enable manufacture manage there plant,product and process

5.3.5 Augmented reality in manufacturing has created AR/VR based[9] approaches to test for quality control check and manufacturing standard compilance.it has developed "pick to light "based on augmented reality in plant maintaince.

5.3.6 Manufacturing on cloud has developed mycloyd,mcod,cart and other tools around cloud services to assist enterprice in propelling business growth and enabeling superior digital experience.

5.3.7 Plant cybersecurity has develope frameworks,create vendors agnostic solutions that are tailored to fit the client IT requirements,assist with security transitions transformations programs

5.3.8 Manufacturing IOT define,build and run offering in IOT solution catter to organisation at different IOT adoption level

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5.3.9 3D printing is a global best practices in addictive manufacturing
5.3.10 Digital clone and simulation for their digital manufacturing[10] protfoilo and provide implementation services of plant simulations
5.3.11 Manufacturing automation has developed tools and accelerators to support faster development of COTs applications and improving tool to meet industry expectations
5.3.12 Robotics is cognitive robotics lab is to sevices various cognitive functionalities in therobotic architecture using open source technologies.

6. CONCLUSION & EXECUTIVE SUMMARY

The centralized overview of the business does not only help inform high-level strategic decisions but also immediately provides the organization with tangible operational efficiency improvements.
Faster order fulfillment, shorter R&D cycle better warehouse management can all be achieved by making your organization more lean and information driven. Sharing information between functional departments will eliminate manual processes and reduce human error.
Also the key advantages of Smart factory are Seamless digital networks, Virtual planning of products, Production and remote maintenance, decentralised control of production, Integration of IT systems and analytics. Thus with latest technological edge the industry revolution can reap the benefits.

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REFERENCES

[1] G. Qiao, R. F. Lu, and C. McLean, “Flexible manufacturing systems for customisation manufacturing,” Int. J. Mass Cust., vol. 1, no. 2, pp. 374–393, Jan. 2006.
[2] H. Jun-Wei, Y. Shouyi, L. Leibo, Z. Zhen, W. Shaojun, A Crop Monitoring System Based on Wireless Sensor Network, Procedia Environmental Sciences. (2011) .
[3] J. P. Womack, D. T. Jones, and D. Roos, The Machine That Changed the World: The Story of Lean Production. 1990.
[4] Y. Rogers, Moving on from weiser's vision of calm computing: Engaging ubicomp experiences, UbiComp 2006: Ubiquitous Computing. (2006).
[5] R. Caceres, A. Friday, Ubicomp Systems at 20: Progress, Opportunities, and Challenges, IEEE Pervasive Computing 11 (2012) .
[6] Industrie4.0 Working Group, “Recommendations for implementing the strategic initiative Industries 4.0,” 2013.
[7] I. Einsiedler, “Embedded System for Industry 4.0,” Product. Management., vol. 18, pp. 26–28, 2013.
[8] J. Zhou, ``Intelligent manufacturing-main direction of `Made in China 2025,'" China Mech. Eng., vol. 26, no. 17, pp. 2273_2284, 2015.
[9] J. P. Holdren, T. Power, G. Tassey, A. Ratcliff, and L. Christodoulou, ``A National strategic plan for advanced manufacturing," US Nat. Sci.Technol. Council,
[10] WashinJ. Wan, M. Yi, D. Li, C. Zhang, S. Wang, and K. Zhou, ``Mobile services for customization manufacturing systems: An example of industry 4.0," IEEE Access, vol. 4, pp. 8977_8986, 2016.

