Industry 4.0 and Potential Opportunities

Eng. Andrew Nguli Masila[1]

[1] Telecommunications and Technology Expert, P.O. Box 6654-0300, Nairobi, Kenya

Abstract
Industry 4.0 involves a set of technological changes in manufacturing and sets out priorities of a coherent policy framework. The framework provides a comprehensive end-to-end approach to transformation initiatives. Generally, Industry 4.0 refers to the means of automation and data exchange in manufacturing technologies including Cyber-Physical Systems, Internet of Things, big data and analytics, augmented reality, additive manufacturing, simulation, horizontal and vertical system integration, autonomous robots as well as cloud computing. Other definitions look at Industry 4.0 as Utilizing the power of communications technology and innovative inventions to boost the development of the manufacturing industry. Industry 4.0 concepts apply across various other industries besides manufacturing and promise great transformation and disruption as well. This paper will seek to further define Industry 4.0 key pillars and impact of its adoption. A further look at industry 4.0 main themes based on the foundation provided will be explored to help bring the subject in the context of direct application.

Keywords: Cyber-Physical, Big Data, Smart, Cloud Computing

1 Introduction

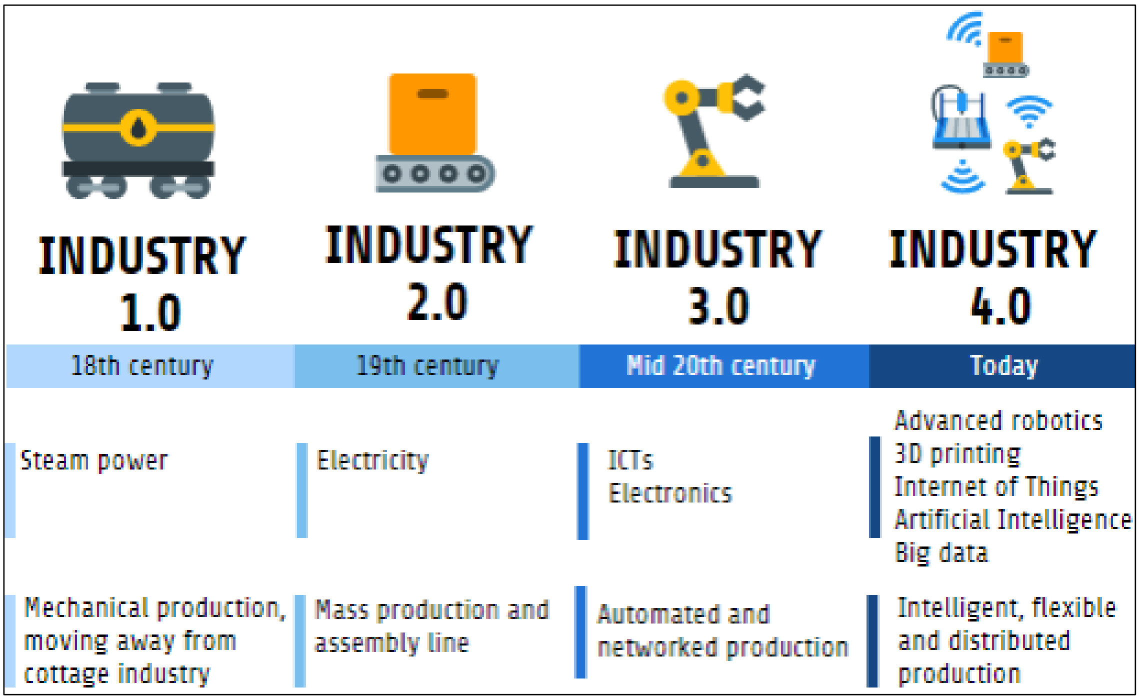

Fig. 1. Industry revolution from industry 1.0 to industry 4.0.

Industrial revolution has undergone several phases. In phase one mechanization was introduced through water and steam power. In phase two invention and wide us of electricity enabled mass production and assembly lines. In phase three computerization and automation added more efficiencies and ushered in the era of information technology. The subject of focus here is phase four also referred to as industry 4.0 with the advent of smart-factories and cyber-physical systems.

Industry 4.0 Industry 4.0 is closely linked to an initiative by the German government which was then aimed at maintaining the global competitiveness of the German manufacturing industry. As per figure 1 it has been adopted in other corners of the world and in more industries apart from manufacturing.

Shifts in organization focus are closely related to developments that have led to industry 4.0. From the 1900's, there was organizational focus on efficient manufacturing and mass production through mechanization and adoption of electricity. From the 1960's, distribution was key and global connections through air transport and water transport across continents facilitated this. From the 1990's, information technology was a key differentiator especially with internet and this helped to create global value chains. From the 2010's. organization focus has been shifting to the customer. As the customers become more empowered there is need for higher levels of customer obsession. This underscores the need for adoption and application of industry 4.0.

Advances especially in telecommunication technologies and the entire ecosystem has also come to shape industry 4.0. Relevant technologies around 5G and IOT are key to enable cyber-physical ecosystems. These technologies support ultra-low reliable latency, Ultra-High Bandwidth and Massive Connective creating more efficient communication systems, connecting people and things and allowing for fully automated networks.

There are several pillars among them; advanced robotics, internet of things, bid data, augmented reality, horizontal/ vertical integration, simulation, cloud, additive manufacturing and cybersecurity that are integral to application of industry 4.0.Contextual application of the pillars have the potential to yield competitive advantages as well as increase efficiency levels.

In this paper we will delve into these key pillars and how they can be applied. There will also be a case studies on the impact of application of the key pillars. There will also be a look at emerging opportunities in Kenya driven by industry 4.0.

2 INDUSTRY 4.0 KEY PILLARS

Industry 4.0 is supported by pillars that are distinct, and it is possible that more than one pillar is applied at a time as per need. Besides addressing known issues, the pillars can be used for total transformation. We will explore each of the main pillars looking at the both the description and potential application of each. The pillars we will be exploring are advanced robotics, internet of things, big data, augmented reality, horizontal/ vertical integration, simulation, additive manufacturing and cybersecurity.

Robots are an important pillar of Industry 4.0. Tomorrow's smart factories will depend on new types of machines, such as collaborative and mobile devices that are interconnected. The goal of Industry 4.0-enabled robotics is zero downtime and maximum efficiency. As robots use more sensors and become more digitally connected, they will become much less susceptible to disruptions (Weber, 2020). Collaborative robots, which are going to work with humans in the industry, making a significant amount of processes more efficient, are more sophisticated than their predecessors; these robots will allow to obtain a considerable decrease of costs related to the building of fences or safety cells that, in the previous days, kept the robots isolated from the humans. As robots become more autonomous, flexible and cooperative, they will be able to tackle even more complex assignments, relieving the workers from monotonous tasks and increasing productivity on the factory floor (AMFG, 2019).

As more systems and devices get connected in smart ecosystems there is need to ensure that the same is supported by proper platforms. Internet of things is a result of connecting all these things and the resultant smart ecosystems. This helps to bridges the physical and virtual worlds. The increasing networking of people, objects and machines with the Internet is leading to the emergence of new business models (Lisa & Alexander, 2019). This involves having sensors that generate the data, proper networks to support massive connections that are mainly autonomous and a platform to control all the devices, handle the data they are sending and control the ecosystem driven by use cases.

Smart systems in industry 4.0 generate high amounts of data at high velocity. This data needs to be processed to inform resultant action and insights in a proper pipeline. Big data analytics is the use of advanced computing technologies on huge data sets to discover valuable correlations, patterns, trends, and preferences for companies to make better decisions (RGBSI, 2020). In Industry 4.0, big data analytics plays a role in a few areas including in smart factories, where sensor data from production machinery is analyzed to predict when maintenance and repair operations will be needed. Through application of it, manufacturers experience production efficiency, understand their real-time data with self-service systems, predictive maintenance optimization, and production management automation.

Augment reality is the superimposition of digital and virtual elements onto a physical environment enabling real-time combination of the various elements usually using 3D visualization. This is used to enrich experiences with several applications in industry 4.0. It bridges the gap between the digital and physical worlds by superimposing virtual images or data onto a physical object. For this, the technology uses AR-capable devices, such as smartphones, tablets and smart glasses.

Horizontal integration in industry 4.0. refers to connected systems from machinery, IOT devices to engineering processes for seamless operations. Vertical integration is the integration to other functions often outside engineering both within and without the organization to influence decisions and actions e.g. in sales functions (Copadata, 2020). This integration enables global operations and often automated processes with higher efficiency and productivity enabling Just-In-Time delivery.

Simulation modelling is the method of using models of a real or imagined system or a process to better understand or predict the behavior of the modelled system or process. Further in industry 4.0 is the concept of digital twins which extends the capability of simulation from what may happen in the real world to what is happening in the real world. Digital twins enable the entire life cycle from design, execute, change to decommissioning (Raghunathan, 2019).

As smart actors in the industry 4.0 ecosystem generate more data coupled with vertical and horizontal integrations with global supply chains with need for compute and intelligence to handle complex use cases like digital twins then the cloud becomes a viable option to rapidly scale for storage and compute. The cloud also offers high resiliency for smart ecosystems and lower barriers of entry to take advantage of smart ecosystems.

Additive manufacturing is an essential pillar in industry 4.0. In the age of the customer and need for personalization and customization there is need for non-traditional manufacturing methods. This is also linked to 3D printing and initially mainly used in prototyping and now embedded into manufacturing. It also enabled decentralized manufacturing where certain parts can be produced at place and point of need.

With cyber-physical systems and internet of everything scenarios, cyberattacks from various threat vectors are more likely. Hence it is key to embed cybersecurity practices in practice as a breach at any point can have huge implications. A rapidly increasing number of Industry 4.0 cybersecurity incidents emerge, additionally stressing the need to strengthen cyber resilience (Enisa, 2018).

3 Industry 4.0 Implementation Case Study

3.1 Use of Augmented Reality in the Aircraft Industry

Boeing, an aircraft manufacturer, is leveraging augmented reality through wearables to increase productivity and minimize errors. This is specifically for the wiring process.

Over 100 miles of wiring go into every new Boeing aircraft, tucked away overhead and underfoot from the cockpit to the wheel wells. This translates to thousand of miles of wiring and tens of thousands of hours of work each year depending on the number of aircrafts manufactured. To ease this complex task, Boeing is now using smart glasses. Each aircraft model has its own wiring configuration and there is no room for error in this sensitive task.

Previously technicians used printed out circuit diagrams and laptops. This was cumbersome especially that they had to look away from the highly sensitive process and as well take their hands off the wiring task. It was also cumbersome while seeking remote support from the design engineers. It often meant the technician had to abandon the task at hand.

Using smart glasses employing augment reality to layer a virtual design onto real aircraft build, the technician on the ground does not have to take their eyes and hands off the actual wiring task as the reference wiring diagram is overlaid to the physical task at hand. Using voice recognition, the technician can get specific commands based on the task at hand and the current view of the smart glasses. In case remote support is required from the specialist engineers, then a video feed is available from the smart glasses and assistance is provided seamlessly.

Using the pillars of industry 4.0 Boeing has been able to cut its wiring production time by 25% and reduced the error rates to zero. Wearable devices drive efficiency, accelerate production time, increase first-time quality, and train workers (Ballard, 2017). Typical smart glasses are as per figure 2 below.

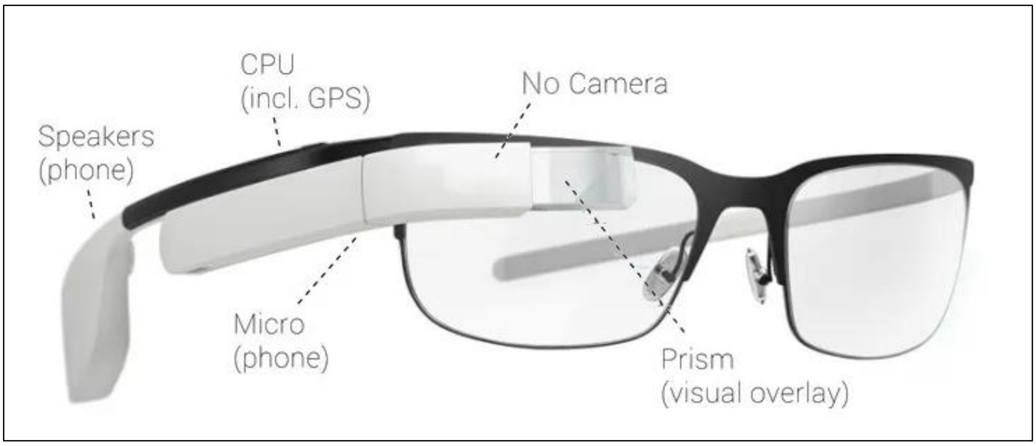

Fig. 2. An illustration of smart glasses.

4 Discussion

Industry 4.0 follows previous developments from the first, second and third industrial revolutions. Industry 4.0 is underpinned by several pillars which are some of the building blocks into Industry 4.0 integration into an organization. They can be widely viewed as an addition to existing operations and also have the ability for total transformation.

The pillars can be viewed as elements that need to work together for a powerful combination. As machines become smarter and connected, they leverage IOT and emerging technologies like 5G for connectivity. As they generate vast amounts of data then cloud technologies become necessary for compute and storage requirements. Big data technologies are required to take advantage of the vast amounts of data at high velocity and in real-time. All these capabilities enable advanced robotics, augmented reality, additive manufacturing and advanced simulations - digital twins. Digital transformation frameworks as well power horizontal and vertical integrations. With smart, interconnected, automated and autonomous systems there is are cyber-threats prevents and cybersecurity is key to ensure a safe interconnected ecosystem.

There are various reasons to adopt industry 4.0 into operations leveraging the various pillars. As per the aircraft industry leveraging augmented reality there was a notable increase in productivity and reduced time-to-market as relate to the aircraft wiring process. In the age of customer focus and personalization leveraging these pillars provides a competitive advantage and likelihood of organizations survival into the future.

Through global connectivity and adopting the pillars it is possible to leapfrog into Industry 4.0. The concepts of industry 4.0 are not only applicable to manufacturing but across most industries. In Kenya there is a great opportunity to leverage industry 4.0 in various industries for global competitiveness.

5 Conclusions

Industry 4.0 adoption has a lot of promises especially around increasing efficiencies and productivity. It is important to appreciate the key pillars and how they build up into Industry 4.0 hence the focus on the pillars. The case presented helps to show how to leverage industry 4.0 into operations.

In Kenya, there is a great opportunity to leverage Industry 4.0 and it is key for engineers to be at the forefront of the revolution. Strategy alignment at all levels in the society is key to ensure that intended outcomes are realized.

References

1. AMFG, https://amfg.ai/2019/03/28/industry-4-0-7-real-world-examples-of-digital-manufacturing-in-action/, last accessed 2020/10/30.
2. Ballard, https://www.aerospacemanufacturinganddesign.com/article/smart-glasses-transform-aircraft-production/, last accessed 2020/10/30.
3. Copadata, https://www.copadata.com/en/industries/horizontal-vertical-integration/, last accessed 2020/10/30.

4. Enisa, https://www.enisa.europa.eu/news/enisa-news/cybersecurity-is-a-key-enabler-for-industry-4-0-adoption#:~:text=The%20fourth%20industrial%20revolution%20(Industry,with%20the%20topic%20of%20cybersecurity.&text=With%20a%20great%20impact%20on,4.0%20and%20IoT%20are%20significant, , last accessed 2020/10/30.
5. Geissbauer, R., Schrauf, S., Berttram, P., Cheraghi, F.: Digital Factories 2020 Shaping the future of manufacturing. PWC, Germany (2017).
6. Lisa, W., Alexander, S.: IoT Basics: What Does Industry 4.0 Mean?. Vogel Communications Group, (2020).
7. Raghunathan, V.: Digital Twins vs Simulation: Three Key Differences. Entrepreneur, Asia-Pacific (2019).
8. RGBSI, https://blog.rgbsi.com/big-data-analytics-in-industry-4.0, last accessed 2020/10/30.
9. Weber, A., https://www.assemblymag.com/articles/95694-robotics-in-the-age-of-industry-40, last accessed 2020/10/30.