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INDUSTRIAL REVOLUTION (IR) 4.0 INNOVATIONS

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ABSTRACT

The introduction of Industrial Revolution (IR) 4.0 has brought the creation of innovation either in industries or people's daily life. The implementation of IoT, cloud computing, grid computing, big data and other new fields of IT applications has benefited the manufacturing industries, services in government and corporate agencies as well as the whole human life. As the manufacturing sectors focus to increase productivity by utilising the existing technology or assets, it is believed that IR 4.0 is capable to achieve the goals, vision and mission of the organisations. This paper aims to introduce and explain in detail nine (9) elements of IR 4.0. Furthermore, examples of application for each element are further discussed in terms of industrial, government and human being practices. Implementation of IR 4.0 in education is believed to increase the teaching and learning pedagogies effectiveness, especially in the e-learning area. Nevertheless, to ensure that the dreams can come true, the infrastructures and info structures should be established into Industrial Revolution (IR) so that they can be implemented effectively and able to benefit the organisations and people.

Keywords: Industrial Revolution (IR), Internet of Things, Big Data, Augmented Reality, Cloud Computing

Introduction

Advances in technology change the way humans producing things and delivering services to people. The steps of production in the manufacturing sectors are different from the past due to the enhancement and improvisation of the processes. The advancement of technologies has changed the working conditions and lifestyles of people. These changes of technological advancement over the years are called the industrial revolution.

The industrial revolution started with the first revolution in the 18th century. The use of steam power and mechanisation production was popular in the manufacturing industries. The development of steam power for ships and locomotives brought massive changes to the local economy as humans and goods could move great distances in a few hours and days (Desoutter Industrial Tools, 2021). The use of machinery was 8 times better compared to the volume using the labour energy.

The second industrial revolution began in the 19th century whereby the electricity component and the production line were the main concern. For example, Henry Ford took the idea of adopting mass production from the slaughterhouse in Chicago and transforming it into automobile production. Previously, the process of assembling an automobile took place at one station until complete, which took

a long time and required a lot of human power. Today, vehicles can be assembled by part on the conveyer belt. Furthermore, they can be completely assembled at the end of the production line, which is significantly faster, low-cost and requires less human power. The third revolution started in the '70s in the 20th century with the implementation of computing technologies such as memory-programmable controls and computers. The technology automates the entire process without human assistance. Robots are the example of technology that perform the tasks that have been programmed without human intervention.

The 4th industrial revolution was characterised by the application of information and communication technologies to industry, which was built with the existence of infrastructures from the 3rd revolution and expanded by a network connection. The networking capabilities led to communication with other applications and encouraged the automation of all processes through system integration. Therefore, the smart factories will create an environment where production systems, components and people communicate via a network and production that is nearly autonomous.

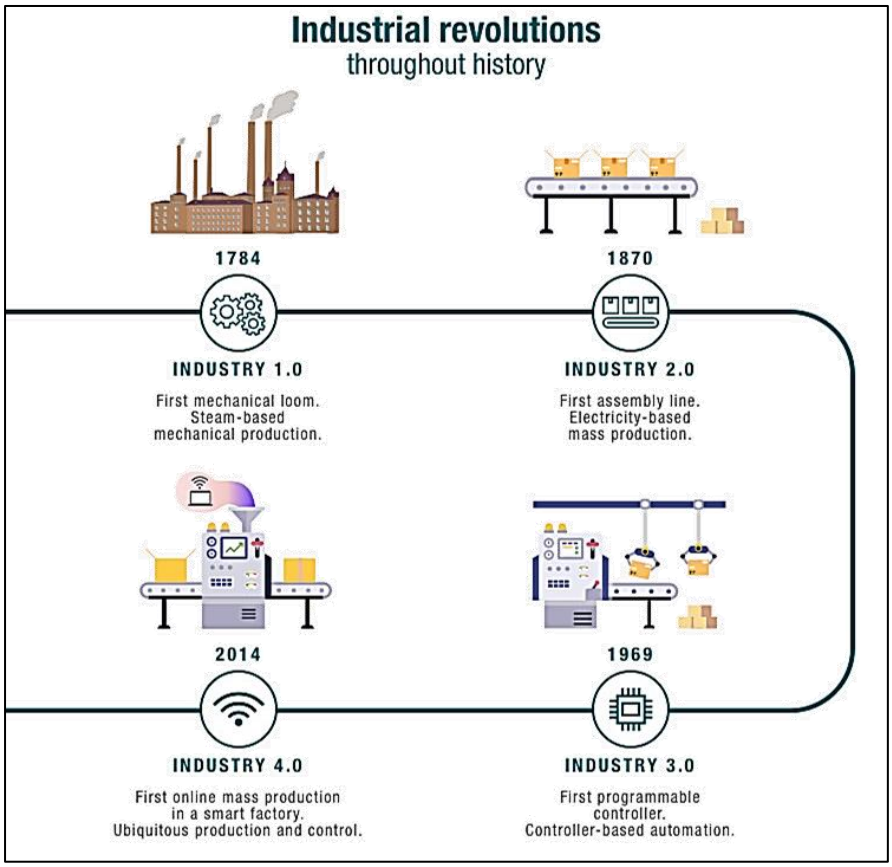

Figure 1: Industrial Revolutions (*Adapted from Iberdrola, https://www.iberdrola.com/innovation/fourth-industrial-revolution*)

Industrial Revolution (IR) 4.0 Elements

Generally, Industry 4.0 concentrates on the growing trends of process automation and data exchanged within the manufacturing industry. Industrial Revolution (IR 4.0) elements include: (i) Internet of Things (IoT), (ii) Cloud Computing, (iii) Augmented Reality (AR), (iv) Simulation, (v) Robotic Automation, (vi) System Integration, (vii) Additive Manufacturing, (viii) Big Data and (ix) Cybersecurity (Erboz, 2017).

i. Internet of Things (IoT)

IoT allows data transfer between objects and humans. It consists of three (3) main relationships in a digital network; between humans and humans, humans with objects and objects with objects. IoT architecture consists of three (3) layers; perceptions, networks and applications (Yang et al., 2011). The perception layer is referring to the peripherals that collect data from the environment such as barcode, camera digital or RFID. The network layer provides a platform for data transmission and the application layer is the interface between the users and IoT devices. The IoT is made based on the development of technologies, real-time analytics, sensors, wireless systems, automation, control systems and machine learning.

IoT platforms are designed to determine the actions based on the pattern of data detected and performed the required action, make recommendations and find the best solution. For example, when you are driving, the dashboard of your car suddenly displays a red signal indicating that the engine is having a problem. Through IoT technology, the sensor from your car will transmit the data to the car manufacturer. The manufacturer will then analyse the car faults and automatically make an appointment with the owner of the car to fix the fault at the nearest car dealer. Furthermore, the IoT ensures that the replacement parts are ready in stock whenever you arrive at the centre (TWI, 2021).

Many smart homes embedded IoT technology to save energy by automatically turning off the devices whenever the device is unused. Lighting, heating, air conditioning, security systems and other smart devices and peripherals are controlled through smartphones or tablets. Besides, IoT is also applied for healthcare purposes to monitor the sugar level, pulse rate and blood pressure of the patients to avoid serious malfunctions or injuries (TWI, 2021).

Figure 2: Smart home

Figure 3: Propeller sensor in an inhaler to trigger asthmatic attacks

ii. Cloud Computing

Cloud computing is on-demand access via the Internet facility, allowing the resources such as application systems, database systems, data storage, development tools, servers, mobiles and networking infrastructures to be used for sharing purposes to reduce capital expenses (Vennam, 2020). Cloud computing helps to lower IT costs by reducing the purchasing, installation and configuration costs as well as managing the resources available at a premise. In addition, cloud computing encourages the use of real-time enterprise applications instead of waiting for a couple of weeks or months for the supplier to install and configure the application at a premise after the purchase.

Generally, cloud computing consists of three common models, namely Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS). IaaS enables the end-users to scale and shrink resources such as the servers, networking and storage based on the needed basis, utilisation, optimisation and overbuying the resources. PaaS provides software developers with on-demand platforms such as the hardware, complete stack of software, infrastructures, development tools for development, running, testing and managing the applications without cost, complexity and inflexibility of maintaining the platform at their premise. Meanwhile, SaaS is also known as a hosted cloud application that needs to be accessed via a web browser. The SaaS users must pay the monthly or annual subscription fee. SaaS offers automatic upgrading and protection from data loss.

The type of cloud computing consists of (1) public cloud, (2) private cloud, (3) hybrid cloud and (4) multi-cloud. The public cloud is a cloud in which the service provider might be making the computing resources accessible for free. Amazon Web Services (AWS), Google Cloud and IBM Cloud are examples of public cloud. Private cloud is only dedicated and accessible by only one customer, hosted at on-premises in the customer's data centre, highly secure and customised based on the premise infrastructures. Hybrid cloud combines public and private cloud services. The goal of the hybrid cloud is to establish a mixture of public and private resources for flexibility to choose the most optimal cloud for each application. The multi-cloud is the use of two or more types of clouds for two or more different cloud providers. Almost 85% of organisations have been reported using multi-cloud environments.

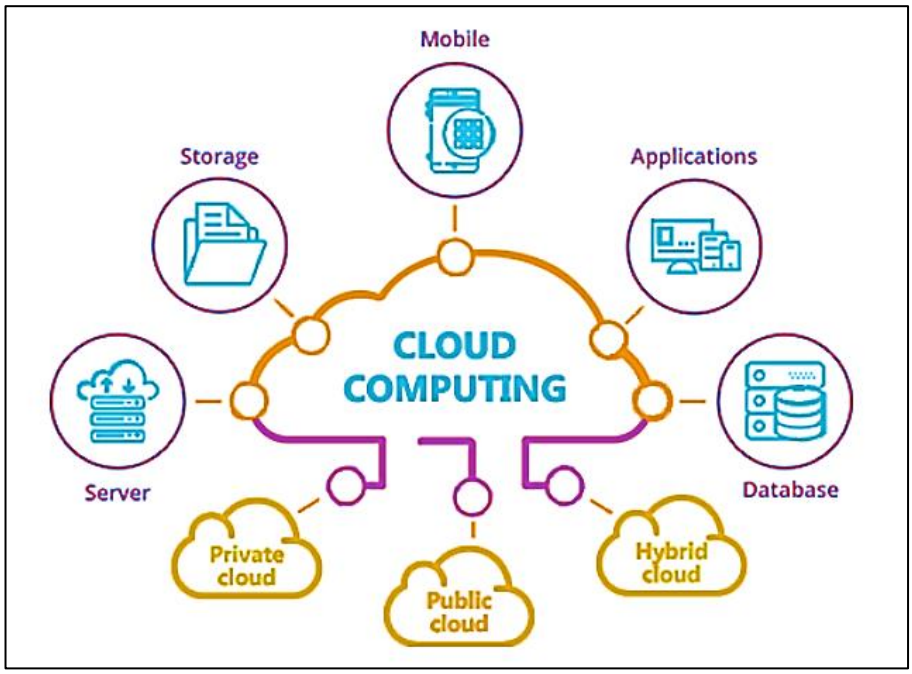

Figure 4: Cloud Computing Frameworks (*Adapted from* *https://www.networksunlimited.com/cloud-computing-trends-for-2019/*)

iii. Augmented Reality (AR)

Augmented Reality (AR) is an enhancement or improvisation of the real physical image upgraded through the use of digital visualisation, sound engineering and other sensory stimulus delivered through the technology. Among the popular AR applications are AcrossAir, Google Sky Map, Layar, Lookator, SpotCrime and PokemonGo.