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Information and Communication Technology in Industry 4.0

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ABSTRACT

This paper presents an overview of information and communication technology (ICT) in the era of Industry 4.0. Due to rapid advancement in ICT and the more powerful computing power of computer hardware and increase speed of the internet, the development and integration of IT, internet and other devices has grown exponentially. E-commerce, internet of things, big data, deep learning, augmented reality and smart city are just few of the areas with increased application which is forecasted to have exponential growth in few years to come.

Keywords: E-commerce; Internet of things (IoT); big data; deep learning; virtual augmented reality, smart city

INTRODUCTION

Information and communication technology has changed dramatically from its first day of introduction. More and more of the people on the planet are dependent of the use of this technology for daily activities. The high rate of smartphone penetration has changed the way people shop, carrying out their banking transactions, entertain themselves and get connected through social media. Increased connectivity with high broadband speed has catapulted many applications with the use of the internet. Most of telecommunication providers get their revenue not from calls or SMS but rather from data. This paper describes the overview of the trend in information and communication technology and how it affects our daily life and the way business is run in years to come.

INDUSTRY 4.0

The idea of Industry 4.0 has been around since the 1980's when flexible manufacturing systems (FMS) and computer integrated manufacturing (CIM) was first introduced. However, CIM did not take off due to limited capacity of machine-to-machine communication, sensor technology, digitalization, data storage and data transfer. The internet technology back then was rather primitive and could not handle large amount of data transfer and the connectivity speed was rather slow. Industry 4.0 introduces what is referred to as "smart factory or smart manufacturing" in which cyber physical systems monitor real time physical progress of the factory and are able to make decentralized decisions. In smart factory, information and communication technology and automation are fully integrated and work with little human intervention. Business partners, suppliers, original equipment manufacturers (OEM) and customers are networked and consolidated into one system with free information flow from purchase order to final delivery.

Industry 4.0 was meant to describe technological changes in manufacturing and set out priorities of a consistent policy framework to preserve the global competitiveness. The title 4.0 indicates that Industry 4.0 is considered the fourth industrial revolution, a logical continuation of the previous three industrial revolutions. The idea is a comprehensive interconnection of all elements of the value-added process, starting from the raw materials and pre-products through to customer interconnection and the associated logistics and service processes. By converting analogue data into digital data, the information available in the supply chain can be used by all players from any location and at any time. Industry 4.0 is a combination of several novel technological advancements which include information and communication technology, cyber-physical systems, network communications, big data, cloud computing, modelling, virtualization and simulation and improved tools for human-computer interaction and cooperation.

Industry 4.0 is referred to as production or manufacturing based industries digitalisation transformation, cyber-physical systems driven by connected technologies. Full digital engineering enables the collection and exchange of product data throughout the entire chain involved in the development of products. Industry 4.0 is enabled by technologies that integrate the digital and real worlds, such as (CGI, 2017):

a) The internet of things (IoT): Connecting more and more systems, devices, sensors, assets
   and people through networks ranging from wireless, low-power wide-area networks (WAN) to
   wired high-capacity networks
b) Mobile solutions: Including smartphones, tablets, wearable sensors and smart glasses

c) Cloud computing: Including low-cost processing and data storage solutions
d) Cyber-physical systems (CPS): Monitoring and controlling physical processes using sensors,
   actuators and processors, based on digital models of the physical world
e) Big data analytics and business intelligence: Turning data into actionable insights, which
   include early warning algorithms, predictive models, decision support, workflows and dashboards
f) Advanced manufacturing technologies: Including robotics and 3D printing

The capability to collect, distribute, share and analyze data to make decisions based on real time information and predictive analytics, and create new business value has increased to adaptability of Industry 4.0. The advancement of technology in sensor, bandwidth, big data, data analytics, cloud storage and processing speed as well as digitalization of the value chain have driven innovation as well as creation of new business models. Operations cost can be reduced with elimination of low skill operations, consistency in quality and higher productivity.

E-COMMERCE

At its core, e-commerce refers to the purchase and sale of goods and/or services via electronic channels such as the internet. E-commerce was first introduced in the 1960s via an electronic data interchange (EDI) on value-added networks (VANs). The medium grew with the increased availability of internet access and the advent of popular online sellers in the 1990s and early 2000s. Amazon began operating as a book-shipping business in 1995. E-Bay, which enables consumers to sell to each other online, introduced online auctions in 1995. Like any digital technology or consumer-based purchasing market, e-commerce has evolved over the years. As mobile devices became more popular, mobile commerce has become its own market. With the rise of such sites as Facebook, Instagram, Twitter and Pinterest, social media has become an important driver of e-commerce.

E-commerce refers to commercial transactions conducted online using computer or mobile device. Electronic commerce, or e-commerce, (also written as *eCommerce)* is a type of business model, or segment of a larger business model, that enables a firm or individual to conduct business over an electronic network, typically on the internet. Electronic commerce operates in all major market segments: business-to-business, business-to-customer,

business-to-government, government-to-business, customer-to-customer, and customer-to-business. It can be thought of as a more advanced form of mail-order purchasing through a catalogue. The concept is shopping via virtual supermarket. Almost any product or service can be offered via e-commerce, from books and music to financial services, on-line bill payment, on-line banking, food ordering, hotel bookings, as well as plane and bus tickets.

Amazon and Alibaba, by contrast, are primarily e-commerce-based business that built up its operations around online purchases and shipments to consumers. Individual sellers can also engage in e-commerce, establishing shops on their own websites or through marketplaces such as eBay, Lazada, 11th Street, Zalora, Tokopedia, Bukalapak, Shopee Indonesia, Blibli or Elevenia. Such marketplaces, which gather multitudes of sellers, serve as platforms for these exchanges. The purchases are typically fulfilled by the private sellers, though some online marketplaces take on such responsibilities as well. E-commerce transactions are typically be done through a computer, a tablet, or a smartphone in which payment can be made on-line using credit cards, debit cards, mobile payments, bank transfer, electronic bill payment, electronic cheque and mobile wallet. From mobile shopping to online payment encryption and beyond, e-commerce encompasses a wide variety of data, systems, and tools for both online buyers and sellers. Most businesses with an e-commerce presence use an e-commerce store and/or an e-commerce platform to conduct both online marketing and sales activities and to oversee logistics and order fulfillment.

Companies like Amazon and AliBaba thrive on e-commerce and has challenge the traditional bricks and mortar retail operations. On-line business has also changed the way customers book flight ticket as well as hotel accommodation. AirBnB, Traveloka, Expedia, Agoda, Booking.com, Skyscanner, Uber and Grab have dramatically changed the way conventional business operates. All of these companies are running business even without owning any asset in their respective business. With better multiple internet security for on-line financial transaction and the availability of various modes of payment with multiple layer of end-to-end encryption, there is an explosion in the number of purchasing transactions using the internet. Payment can be made from anywhere in the world, in any amount and currency have made e-commerce very successful not to mention the convenience at the users fingertips. Alibaba and Amazon are also testing to use drone to deliver goods to customers. Both companies have successfully used robots to pick up and sort goods for customer delivery in their warehouses.

The changing market represents a vast opportunity for businesses to improve their relevance and expand their market in the online world. Researchers predict e-commerce will be 17 percent of U.S. retail sales by 2022, according to Digital Commerce 360. The U.S. will spend about USD460 billion online in 2017. These figures will continue to climb as mobile and internet use expand both in the U.S. and in developing markets around the world. Research predicts that the future of e-commerce is a bright one. By 2022, e-commerce revenue in the U.S, alone is expected to reach USD638 million with the toys, fashion, electronics, hobby and DIY seeing the largest growth. This means they'll expect to be able to research, browse, shop, and purchase seamlessly between different devices and on different platforms (like a standalone web store, an Amazon or Alibaba presence, etc.) Other trends to watch for in the future of e-commerce include digital currencies, e-wallet and the use of augmented virtual reality for on-line shopping experience. E-commerce has also been used as a platform for social entrepreneurship where products from indigeneous people or village farmers are marketed on-line.

INTERNET OF THINGS (IoT)

Improved connectivity speed and high penetration of smartphones make IoT more applicable in many instances. Data collection, transmission, process and analytics connected with automated device with wi-fi capabilities and sensors built into them can perform many functions across the network. Sensors embedded within any device can detect signal and send it through the internet and if it is a closed loop systems equipped with actuators, certain programmable functions can be performed by the automated sytems. Advanced computing with deep learning can make the systems more intelligent and self taught. Broadband internet with increased speed, high smartphone penetration, and lower connectivity cost for both hardware and software are driving the development of IoT.

IoT initially started with machine-to-machine (M2M) communication where two or more machines exchanging data for the purpose of monitoring or performing sequential process. Internet of things is the network of physical devices embedded with electronics, software, sensors, actuators, and connectivity which enables these things to communicate and exchange data and to perform certain activities or functions all through the internet. The initial output of IoT could be some data display, alarm or some performed function if it is connected to an actuator. Sometimes, these devices communicate with other related devices and act on the information they get from one another. The devices do most of the work without human intervention, although people can interact with the devices - for instance, to set them up, give them instructions, by-pass certain functions or access the data.

A thing in IoT can be a cardiac patient with a heart monitor implant, a swimmer or runner with wearable to measure the distance, calories burnt, heartbeat and pulse, a pet dog with a biochip transponder, a truck with built-in GPS to monitor the movement or any other object that can be assigned an IP address and is able to transfer data over a communication network. IoT utilizes the sensor network of smart devices that connect people, objects, systems and other applications to collect and share data acquired from their environments. Data collected will be sent to a gateway where the data is transferred to the cloud servers or local device or CPU for further analysis. IoT has evolved through the integration of wireless technology, microelectro-mechanical systems (MEMS), web-enabled smart devices, sensors and radio frequency.

Supervisory control and data acquisition (SCADA) is a system of software and hardware elements that allows industrial organizations to control industrial processes locally or at remote locations, monitor, gather, and process real-time data, directly interact with devices such as sensors, valves, pumps, fans, motors, pressure vessels and more through human-machine interface (HMI) software and record events into a log file or data logger. The internet of things is also a natural extension of SCADA. The hardware gathers and feeds data into a computer that has SCADA software installed, where it is then processed and presented it in a timely manner. The evolution of SCADA is such that late-generation SCADA systems developed into first-generation IoT systems. One application is in system maintenance, where M2M gateway and virtual private network (VPN) technology are used in remote monitoring. Service engineers can remotely view real time conditions of plant area, diagnose problem and help maintenance engineers to perform rectification to avoid plant breakdown and maximizing plant process availability and safety.

The increased use of radio frequency has enabled IoT to be adapted to many applications. Development of low power sensor and wireless sensor as well as the ability to integrate with mobile phone network has speeded up the application of IoT which has successfully been applied in healthcare, agriculture, construction, smart city, asset maintenance and manufacturing. Bluetooth technology can also be used in data transmission for short range applications. The biggest advantage of IoT is that monitoring and control can be done continuously with little or no intervention from human. It is expected that there will be 20 billion internet-connected things by 2020 involving dedicated function objects such as vehicles, aircraft engines, oil and gas platforms, petro-chemical plants, manufacturing factories, farming and buildings. Future applications will include smart cities where energy consumption can be monitored, waste can be reduced and security can be improved.

BIG DATA

According to a recent market report published by Transparency Market Research, the total value of big data was estimated at USD6.3 billion as of 2012, but by 2018, it is expected to reach the staggering level of USD48.3 billion which is almost a seven fold increase. Big data is any voluminous amount of structured, semistructured and unstructured data that has the potential to be mined or analyzed for information. Such data can come from different sources, such as business transaction records, the collected results of scientific experiments, search engines, social media or real-time sensors used in the internet of things. Data may be raw or preprocessed using separate software tools before analytics are applied. Data may also exist in a wide variety of file types, including structured data, such as SQL database stores; unstructured data such as document files, voice, image; or streaming data from sensors. Further, big data may involve multiple, simultaneous data sources, which may not otherwise be integrated. For example, a big data analytics project may attempt to gauge a product's success and future sales by correlating past sales data, product return data, competitor's sales and online buyer review data for that product.

Amazon uses big data to monitor, track and secure 1.5 billion items in its inventory that are laying around 200 fulfilment centres around the world, and then relies on predictive analytics for its 'anticipatory shipping' to predict when a customer will purchase a product, and pre-ship it to a depot close to the final destination. Wal-Mart handles more than a million customer transactions each hour (Sander, 2014), imports information into databases to contain more than 2.5 petabytes and asked their suppliers to tag shipments with radio frequency identification (RFID) systems (Edwards et al, 2001) that can generate 100 to 1000 times the data of conventional bar code systems. UPS deployment of telematics in their freight segment helped in their global redesign of logistical networks (Davenport and Patil, 2012). Other global logistics company such as DHL, TNT and FedEx use big data analytics to plan the routes of all parcel shipments in order to optimize the transportation cost. All parcels are now traceable through electronics tracker using QR code. Amazon is a big data giant and the largest online retail store. The company pioneered e-commerce in many different ways, but one of its biggest successes was the personalized recommendation system, which was built from the big data it gathers from its millions of customers' transactions.

Many organizations such as Facebook, Google, Waze, Expedia, AirBnB, WeChat, Amazon, Alibaba and Baidu are collecting, storing, and analyzing massive amounts of data commonly referred to as "big data" because of its volume, the velocity with which it arrives, and the variety of forms it takes (text, graphics, voice and video). Big data is creating a new generation of decision support data management. Businesses are recognizing the potential

value of this data and are putting the technologies, people, and processes in place to capitalize on the opportunities. Collecting and storing big data creates little value; it is only data infrastructure and must be analyzed and the results used by decision makers and organizational processes in order to generate value (Watson, 2014).

Many analytic techniques, such as regression analysis, simulation, and machine learning, have been available for many years. Even the value in analyzing unstructured data such as e-mail and documents has been widely applied to identify spam e-mail. With the advances in computer technology (i.e. hardware and internet speed) and software, new sources of data (e.g., social media, search engines) is readily available and big data analytics can integrate personal data from many sources and able to accurately profile an individual. A new area of practice and study called "data science" was developed that encompasses the techniques, tools, technologies, and processes for making sense out of big data. Cloud computing is one of the key enabler of big data by which the delivery of computing services—servers, storage, databases, networking, software, analytics, intelligence and more—over the internet or cloud.

DEEP LEARNING

Pattern recognition has its origins in engineering, whereas machine learning grew out of computer science (Bishop, 2006). Deep learning was developed through machine learning research. Deep learning is a form of machine learning that enables computers to learn from experience and understand the world in terms of a hierarchy of concepts which allows the computer to learn complicated concepts by building them out of simpler ones; a graph of these hierarchies would be many layers deep (Kim, 2016). The recent success of machine learning owes to the explosion of data that is available in some areas, such as image or speech recognition. This data has provided a vast number of examples, which machine learning systems can use to improve their performance. In turn, machine learning can help address the social and economic benefits expected from so-called 'big data', by extracting valuable information through advanced data analytics. Supporting the development of this function for machine learning requires an amenable data environment, based on open standards and frameworks or behaviours to ensure data availability across sectors (The Royal Society, 2017).

Deep learning is a set of computer learning methods attempting to model data in many situations with complex program architectures through deep neural networks. Deep learning allows computational models that are composed of multiple processing layers to learn representations of data with multiple levels of abstraction. These type of pattern recognition techniques have

enabled significant progress in the fields of sound and image processing, object detection, visual object recognition including facial recognition and medical imaging (radiology, CT scan and MRI), bio-metrics, speech recognition, voice command, computer vision, automated language processing, text classification (for example spam recognition and targeted marketing). The most representative characteristic of deep learning is that it is driven by data, and the decision process is accomplished with minimum interventions by a human. The program can learn by analyzing training data, and then make a prediction when new data is put and most suitable to big data. Deep learning discovers intricate structure in large data sets by using the backpropagation algorithm to indicate how a machine should change its internal parameters that are used to compute the representation in each layer from the representation in the previous layer. Deep convolutional nets have brought about breakthroughs in processing images, video, speech and audio, whereas recurrent nets have shone light on sequential data such as text and speech.

Companies like Facebook, Google and Apple have been using deep learning to study customer's behaviour based on the pattern of surfing on the internet. Advertisers are now using targeted marketing and by studying the personal profile of each computer user, advertisers can directly market the product to the individual user which is more effective. Most of e-commerce websites used deep learning to advertise their products that match certain customer profiles. Recent studies on this technology suggest its potential to perform better than humans in some visual and auditory recognition tasks, which may increase its applications in medicine and healthcare, especially in medical imaging. Some hospitals are testing computerized diagnostics using medical imaging for cancer which has proven to be more accurate in some cases than human diagnostics. Computer games developers also use deep learning to study the patterns and response of players in order to develop strategies to beat the human player. Deep learning has already shown superior performance than humans in some audio recognition and computer vision tasks. This has enabled the development of digital assistants such as Apple's Siri, Amazon's Echo, and Google's Home, along with numerous innovations in computer vision technologies for autonomous driving. Technology giants such as Google, Facebook, Microsoft, and Baidu have begun research on the applications of deep learning in medical imaging (Lee *et. al*, 2017). Facial recognition is also under test for applications such as airline check in, banking or online transaction, home and car security, immigration and other applications.

VIRTUAL AUGMENTED REALITY

According to the Augmented/ Virtual Reality Report 2017 (Digi-Capital, 2017), the VR/AR Market should reach USD108 billion revenues by 2021, while an overview by Goldman Sachs (2016) suggests a business of USD80billion in 2015. Virtual augmentation (VA) is the progression from virtual reality (VR) which was initially used by video game developers. However, the application of such technology in areas such as e-commerce, entertainment, medicine, military, advertising, manufacturing simulation, and training is gaining popularity.

Virtual Reality (VR) and augmented reality (AR) both aim to extend the sensorial environment of an individual by mediating reality through technology. The former relies on an alternative setting to experience, while the latter improves existent elements with additional layers of meaning. Virtual Reality is completely immersive by making the user to feel that they are experiencing the real environment not the simulated one by means of audio, visual, and tactual simulations. The use of VR can simulate environments that give the impression almost of a novel scene. Using a headset or similar device, the VR visitor normally stands in a certain space, or in some cases sits in a chair or lies on a bed. VR not only includes sight and sound, but if sensors corresponding to each of the five senses are applied to the body, the overall virtual experience can deliver a level of awareness that transcends the physical body. For the user, VR heightens the perception of being physically present in a non-physical world, a perception that is created as the user's awareness of physical self is transformed by being immersed in a virtual space. The use of VR in entertainment applications such as games and movies will deliver a relatively more realistic experience. VR could ultimately result in human consciousness itself being recreated within the virtual environment.

Augmented Reality is a synthetic, computer simulated reality or recreation of a real-time environment where a user can interact with the replicated real environments. One recent example is the game of Pokemon Go which uses the mobile device GPS to locate, capture, battle, and train virtual creatures, called Pokémon, which appear as if they are in the player's real-world location. In the world of AR, it is also possible to superimpose text, statistics, or other information forms over real-life images or background scenes. This will bring life changes similar to those triggered by the birth of the internet. As this technology not only allows the explanation of immediate events/phenomena even where there is no prior memory or knowledge, it also makes it possible to obtain information which augments existing knowledge, such as up-to-date information and statistics (support ratings, sales, traffic news, etc.). Customizing such information to an individual's needs also appears feasible, especially when linked to profiles, data sets, and

productivity applications relevant to that user.

VR and AR are used to create powerful 3D interactive visual experiences for all kinds of purposes. providing interactive 3D surroundings simulated by a computer. AR is an integration of the real world and the virtual world, with the aim of providing additional information about something in the real world with information displayed in the virtual world. For instance a person could look at a painting or a machine in the real world, hold up their smartphone or tablet in front of the painting or machine, and see on the screen the painting or machine with additional useful information, thus augmenting reality (Nayyar et al, 2018). Augmented Reality and Virtual Reality systems use OHMD's (Optical Head Mounted Displays) which consists of various sensors such as IMU's (Inertial Measurement Units) that consists of accelerometer, gyroscope, and magnetometer. It also has a sound capture system, which consists of various microphones, and a camera to display virtual objects, environments, etc. The OHMD's generate a convincing sense of being in the mediated environment and consciousness of user's body in the computing environment (Sidiq et al, 2017).

SMART CITY

A smart city is a designation given to a city that incorporates information and communication technologies (ICT) to enhance the quality and performance of urban services such as energy, transportation and utilities in order to reduce resource consumption, wastage and overall costs. The overarching aim of a smart city is to enhance the quality of living for its citizens through smart technology to meet the needs of present and future generations with respect to economic, social and environmental aspects. The main goal is to create value for the entire eco-system in terms of finance, quality of life, health, security, transportation, education and time. Communications infrastructure is critical to enable smart cities to connect people, devices and and other physical infrastructures so that data can be transferred and analyzed for use in neighbourhood security, tranportation monitoring, energy conservation, waste management and other applications. The connectivity could encompass low band width wireless techologies such as Bluetooth and ZigBee to a dedicated fiber optics backbone. The next 5G networking technology aims to address higher bandwidth, adaptability, energy efficiency and real-time capabilities which will further drive the application and demand for smart cities.

Emerging trends such as automation, machine learning and the internet of things (IoT) are pushing smart city adoption in many parts of the world especially in deleveloped countries through the integration of big data, data analytics, IoT, and smart computing. Theoretically, any area of city

management can be incorporated into a smart city initiative. One example is the smart parking meter that uses an app to help drivers find available parking spaces without prolonged circling of crowded city blocks. The smart meter also enables digital payment, so there's no risk of coming up short of coins for the meter. In the transportation arena, smart traffic management is used to monitor and analyze traffic flows to optimize streetlights to prevent roadways from becoming too congested based on time of day or rush-hour schedules. Smart public transit is another facet of smart cities, used to ensure public transportation meets user demand. Smart transit companies are able to coordinate services and fulfill passengers' needs in real time, improving efficiency and satisfaction. Ride-sharing and bike-sharing are also common services in a smart city.

Energy conservation and efficiency are major focuses of smart cities. Using smart sensors, smart streetlights dim when there is no vehicle or pedestrians on the roadways. Smart grid technology can be used to improve operations, maintenance and planning, and to supply power on demand and monitor energy outages. Smart city initiatives also aim to monitor and address environmental concerns such as climate change, water and air pollution. Sanitation can also be improved with smart technology, be it using internet-connected trash cans and IoT-enabled fleet management systems for waste collection and removal, or using sensors to measure water parameters and guarantee the quality of drinking water at the front end of the system, with proper wastewater removal and drainage at the back end.

Smart city technology is increasingly being used to improve public safety, from monitoring areas of high crime to improving emergency preparedness with sensors. For example, smart sensors can be critical components of an early warning system before droughts, floods, tsunami, earthquake, landslides or hurricanes. Smart buildings are also often part of a smart city project. Outdated infrastructure can be retrofitted and new buildings constructed with sensors to not only provide real-time space management and ensure public safety, but also to monitor the structural condition of buildings. Attaching sensors to buildings and other structures can detect wear and tear and notify maintenance engineers when repairs are needed. Citizens can help in this matter, notifying officials through a smart city app when repairs are needed in buildings and public infrastructure, such as potholes, crack on bridges or water pipe leakage. Sensors can also be used to detect leaks in water mains and other pipe systems, helping reduce costs and improve efficiency of public workers. Chinese authority is using facial recognition to identify traffic offenders as well as road side crimes in many cities. Smart city technologies also bring efficiencies to urban manufacturing and urban farming, including job creation, energy efficiency, space management and fresher goods for consumers.

EXAMPLES OF SMART CITIES (Tech Target, 2018)

The smart city initiative of Kansas City, Missouri, USA, involves smart streetlights, interactive kiosks and more than 50 blocks of free public Wi-Fi along the city's two-mile streetcar route. Available parking spaces, traffic flow and pedestrian hotspots are all publically available through the city's data visualization app. San Diego installed 3,200 smart sensors in early 2017 to optimize traffic and parking and enhance public safety, environmental awareness and overall livability for its residents. Solar-to-electric charging stations are available to empower electric vehicle use, and connected cameras help monitor traffic and pinpoint crime.

The city-state of Singapore uses sensors and IoT-enabled cameras to monitor the cleanliness of public spaces, crowd density and the movement of locally registered vehicles. Its smart technologies help companies and residents monitor energy use, waste production and water use in real time. Singapore is also testing autonomous vehicles, including full-size robotic buses, as well as an elderly monitoring system to ensure the health and well-being of its senior citizens.

In Dubai, United Arab Emirates, smart city technology is used for traffic routing, parking, infrastructure planning and transportation. The city also uses telemedicine and smart healthcare, as well as smart buildings, smart utilities, smart education and smart tourism. The Barcelona, Spain, smart transportation system and smart bus systems are complemented by smart bus stops that provide free Wi-Fi, USB charging stations and bus schedule updates for riders. A bike-sharing program and smart parking app that includes online payment options are also available. The city also uses sensors to monitor temperature, pollution and noise, as well as monitor humidity and rain levels.

CONCLUSION

This paper has discussed various development in the area of ICT and how it will influence the way people live in the future. Industry 4.0 is one of the key drivers pushing the advanced development in manufacturing and other areas. However, these development in ICT can only be made possible with the advancement of data processing, data storage and data transmission. High speed broadband internet and Wi-Fi has become the backbone to these development. E-commerce has certainly changed the retail landscape where companies like Amazon and Alibaba are making inroads to compete head on with brick and mortar business. The projected increased sales in the future will definitely create new business model for all retailers and will change the landscape of the supply chain. IoT can and will disrupt how companies do

their business with intelligent device and automated control with little or no human intervention. The operation cost as well as human resource requirements will surely be affected. The advancement in data mining, business intelligence and data analytics has enabled big data to be fully leveraged in order to gain benefits from vast amount of available data in the area or advertisement, e-commerce, healthcare, agriculture and smart living. Deep learning which is under artificial intelligence make use of big data to process the information and turn it into something useful. The computer program can be made to be self learned for certain applications. Virtual augmented reality will change the way training is carried out (military or civilian), shopping experience, healthcare, tourism and others. Smart city which focus on sustainability and livable city can greatly benefits the city population through energy conservation, smart electrical grid, smart infrastructure, urban farming, healthcare, better security and more efficient public transport to name a few. There are huge prospects to be involved in the area of ICT and computing to develop new applications which can cause disruptions to conventional business model. ICT can create technopreneurs who can develop new business ventures.

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