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Artificial Intelligience in the Transition to Circular Economy

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ABSTRACT: *This paper explores the potentials of Artificial intelligence in the transition to a circular economy. A circular economy is an emerging economic model that is restorative or regenerative by intention and design .The model emphasizes that by keeping materials at their optimal use and value continually, the system can be optimized. The CE model operates a repetitive evolving cycle. That is, waste is designed out of the economy, and is repackaged (returned) back into recycling and reuse of materials. It portrays a sustainable and productive economy model that is financially, economically and socially feasible. Circular economy (CE) describes a shift from the traditional linear economy of "use-make-dispose". Digitalization has been proposed as the driving force of the new circular economy. Artificial Intelligence (AI) is one of the key drivers of the Fourth Industrial Revolution. Application of Artificial intelligence has a commensurate benefit in the domain of circular economy. These include: applying real time traffic data to reduce traffic congestion, optimization of energy usage for cooling servers in different data centers and enhancing collaboration between car sharing companies and automotive companies. This work provides an initial step towards a better understanding of the roles of Artificial intelligence in the transition to a circular economy.*

KEYWORDS: *artificial intelligence, circular economy, transition, model, digitization.*

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I. INTRODUCTION

With the unprecedented growth in waste product globally, there are increasing demands for measure to curtail the menace of waste pollution in our environment. The challenges and gloomy effects of the present day economic model are massive, cumulative and set to move along with the global economy, which could be duplicated over the next 20 years.

Plastic pollution (exist at the microplastic or macro level) has become a major public discourse and has subsequently triggered call for policy action globally.it has been established that a single scientific discipline cannot solve complex environmental issues such as plastic pollution alone (Backhaus & Wagner, 2018; Vegter et al., 2014). Globally, with a total production of 355 million metric tonnes recorded in 2016, plastic have emerged as the most abundant anthropogenic materials aside concrete and steel (PlasticEurope, 2018).Though, beneficial to mankind, it is estimated that about 8300 million tonnes of plastics, which represent 70% of the total amount have become a waste of which 84% or 4900 million tonnes has been disposed of in the environment (Geyer, Jambeck &Law, 2017).According to (Zero plastic waste Canada, 2018), it is estimated that 95% of the material value of plastic packaging is lost to the economy after only a single use, resulting to the lost of approximately of $150 billion annually. Annually, Only 12% of the estimated 3.84 million tonnes of plastic used is collected for recycling and huge portion of this is never recycled. Without mincing word, this approach is highly wasteful and harmful to the immediate environment.

Circular economy (CE), an emerging economic model, promises a way out of this wasteful approach. The circular economy (CE) is arguably one of the most discussed terms in the environmental economic domain, a main focus for European Union Horizon in 2020 strategy (Sylvie Giesendorf & Felicitas Pietrulla, 2017). The model is being embraced globally by business and governments because of its inherent potentials to capture economic value while fostering environmental sustainability. The concept of a circular economy is geared towards restorative and regenerative model. It starts from the *Cradle to Cradle* principle of biological nutrients (regenerative) and technological nutrients (restorative). The model emphasizes that by keeping materials at their optimal use and value continually, the system can be optimized. (Ellen MacArthur Foundation, 2016) reiterates

that there are exist several schools of thought on the CE; however, the core principles of CE lies in the efficient management of resources. The CE model operates a repetitive evolving cycle. That is, waste is designed out of the economy, and is repackaged (returned) back into recycling and reuse of materials. Circular economy portrays a sustainable and productive economy model that is financially, economically and socially feasible. Circular economy (CE) describes a shift from the traditional linear economy of "use-make-dispose" as shown in figure 1. Research has shown that circular economy can create a net benefit of EUR 1.8 trillion by 2030, while solving accumulating resource- related problems, creating jobs, driving innovations and producing considerable environmental gain (Ellen MacAthur Foundation, 2019).

Digitalization has been proposed as the driving force of the new circular economy. Furthermore, technological innovation is a key factor to bring the dreams of circular economy vision to fruition. For instance, intelligent and connected assets can enable predictive maintenance to prolong the asset life; Blockchain can create traceability and transparency in supply chains to reduce waste; and repair is made easier by 3D printing of spare parts. The Ellen MacArthur Foundation highlights the contribution of intelligent assets and connectivity in the advancement of Circular Economy. In spite of this advancement, there is still a vague knowledge of how new digital technologies such as Big Data and Internet of Things(IOT) can be adopted to support the transition to Circular Economy (Aris Pagoropoulosa et al,2017).

Artificial Intelligence (AI) is one of the key drivers of the Fourth Industrial Revolution. Development in Artificial Intelligence (AI) have produced powerful analysis algorithms, its application traverse every human endeavors: these include; Medicine, Business, Education, Oil Exploration etc.AI is an area of computer science that deals with the development of machines that work and react like humans.AI deals with models and machine that does human-like cognitive functions such as reasoning and learning. Some of the applications include: pattern recognition, prediction, optimization and recommendation generation based on data from different sources and format. To a great extent, AI achieves this by employing algorithms that find patterns and extract useful information from (large amounts of) data. Application of Artificial intelligence has a commensurate benefit in the domain of circular economy. These include: applying real time traffic data to reduce traffic congestion, optimization of energy usage for cooling servers in different data centers and enhancing collaboration between car sharing companies and automotive companies.AI is promising, the potential value unraveled by AI in assisting to remove waste in a circular economy for food is estimated to be USD 127 billion a year in 2030.This feat is accomplished through various opportunities at the farming,processing,logistics and consumption levels. Some of the applications include: using image recognition to determine when fruit is ready to pick; matching food supply and demand more effectively; and enhancing the valorization of food by-products (Ellen MacArthur Foundation,2019).The fourth industrial revolution (AI&IOT) can accelerate the of the transition from linear economy to circular economy as depicted in figure 3. (Ellen MacArthur Foundation, 2019) argued that the potential to drive the use of AI in circular economy is substantial and presently largely untapped. AI can help to unravel the economic potentials of circular economy by improving design, operating business models, and optimizing infrastructure (Ellen MacArthur Foundation, 2019).

The main focus of this paper is to examine the contribution of Artificial intelligence in the transition from linear model economy to circular economy. This work provides an initial step towards a better understanding of the roles of Artificial intelligence in the transition to a circular economy.

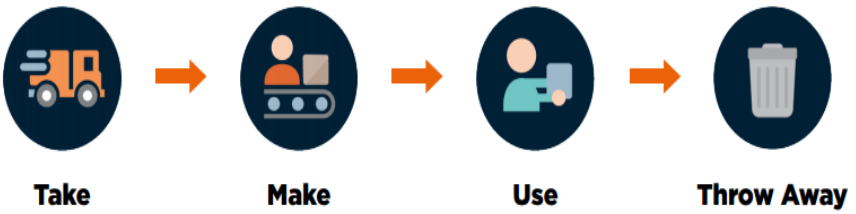

Figure 1: Source: (Ellen MacArthur Foundation, 2018).

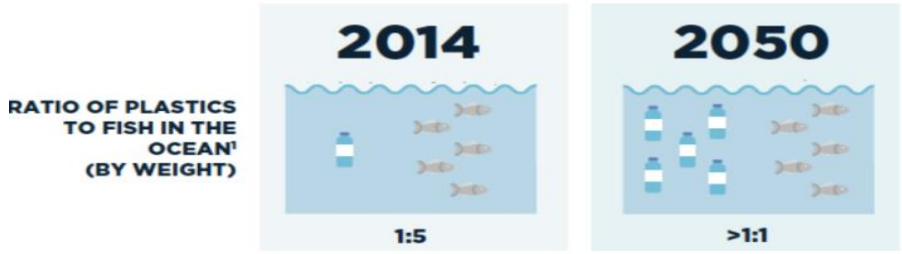

Figure 2: Source :(Ellen MacArthur Foundation, 2018).

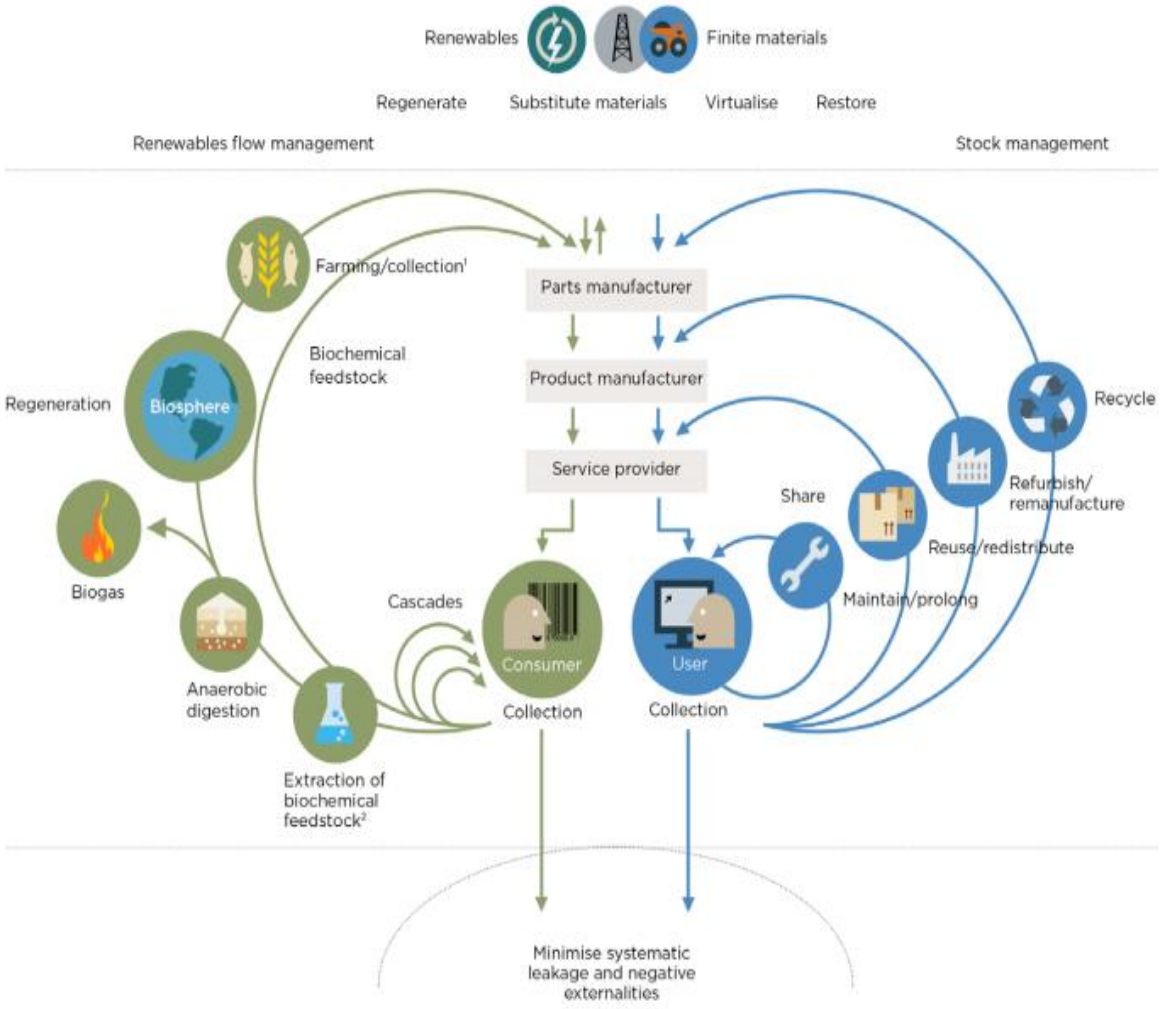

Figure 3: The Circular Economy System

II. ARTIFICIAL INTELLIGIENCE AND CIRCULAR ECONOMY

Artificial intelligence has shown promises as a viable platform to speed up the transition to circular economy. Artificial Intelligence (AI) is one of the key drivers of the Fourth Industrial Revolution. .AI is promising, the potential value unraveled by AI in assisting to remove waste in a circular economy for food is estimated to be USD 127 billion a year in 2030.This feat is accomplished through various opportunities at the farming,processing,logistics and consumption levels. Some of the applications include: using image recognition to determine when fruit is ready to pick; matching food supply and demand more effectively; and enhancing the valorization of food by-products (Ellen MacArthur Foundation, 2019). Figure 4 described some of the 4IR solutions for circularity.

(Ellen MacArthur Foundation, 2019) reiterates that AI can serve as a platform for a speedy transformation to a circular economy .The paper identified three key aspects of circular economy where AI technologies can be applied. These include.

1. **Design circular products, components, and materials**. AI can enhance and accelerate the development of new products, components, and materials fit for a circular economy through iterative machine-learning-assisted design processes that allow for rapid prototyping and testing.
2. **Operate circular business models**. AI can magnify the competitive strength of circular economy business models, such as product-as-a-service and leasing. By combining real-time and historical data from products and users, AI can help increase product circulation and asset utilization through pricing and demand prediction, predictive maintenance, and smart inventory management.
3. **Optimise circular infrastructure**. AI can help build and improve the reverse logistics infrastructure required to 'close the loop' on products and materials by improving the processes to sort and disassemble products, remanufacture components, and recycle materials.

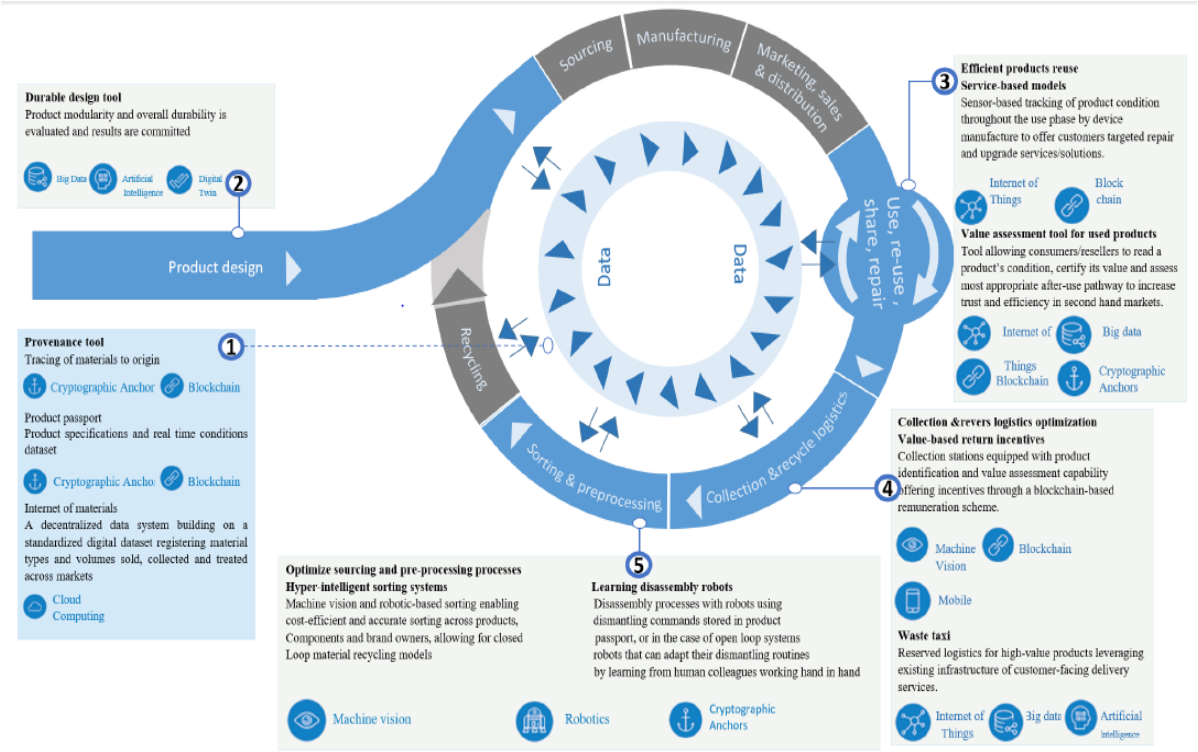

Figure 4. Industry 4.0 solutions for circularity (adapted from World Economic Forum and Accenture Startegy, 2019)

III. HOW CAN ARTIFICIAL INTELLIGENCE TECHNIQUES BENEFITS A CIRCULAR ECONOMY

This section highlights some of the AI Techniques that can be used to accelerate the transition to a Circular Economy.

Data Analysis

AI can be deployed to determine circular business models.Artficial intelligence combined both historical data and real time data discovered from interrogating products and their users ,thus, AI is capable of enhancing assets utilization and product circulation by predicting demand using smart inventory management(Stephen Wright,2019) .

Hyper-Intelligent Sorting Systems

Machine vision and robotic-based sorting enabling cost-efficient and highly accurate sorting across material types and brand owners. Collected data across installations is stored on the cloud and used to continuously improve the identification algorithm.AI can also assist with waste and materials sorting, enabling their proper separation and collection for potential secondary use. While this can be done on municipality and

company level, AI could assist also with waste management at source – during the growing and extraction phase, at the production site and in the home.

Design

Iterative machine learning techniques can be used to design products, materials and components based on circular economy principles. Machine learning describes a computer program that is designed to extrapolate information based on observed patterns. Some of 0the machine algorithms include supervised learning ,unsupervised learning, reinforcement learning and evolutionary algorithms.

Learning disassembly Robots

Machine learning and Robotics have been used extensively to in disassembly process. Disassembly processes with robots using dismantling commands stored in product passport, or in the case of open loop systems robots that can adapt their dismantling routines by learning from human colleagues working hand in hand.

Computer Vision and object detection

Image analysis Algorithms are trained to determine whether a certain object is found within an image or not. It is a classification problem, as the algorithms learn to classify whether an object is an image, and if positive, where in the image such object is found. Some of the classification algorithms include: Support vector machine(SVM) , Logistic regression and Deep Neural Networks(NN).The application of Computer vision is found in recycling(sorting objects), waste management food production(identifying the colour and size of ripe crop).

Chat bots

Chat bots are conversational agents that can be used to engage humans. It is mainly used to understand someone request and provide response accordingly .NLP algorithms are used to derive meaning from text.Chatbot can be used in health sector for self-diagnosis, client contact and account management.

IV. CURRENT USES OF AI IN A CIRCULAR ECONOMY

STUFFSTR

Stuffstr provide a platform to buy and collect used products from consumers and sell them in second hand markets. An AI algorithm assist the company to set competitive prices for the seller, while offering them a good margin on the second hand market.AI helps them to refine sales strategy through constant experimentation and rapid feedback loop.

ZENROBOTS

ZenRobotics, founded in 2007 was the first company to leverage on AI and robotics in a demanding waste processing environment. The company used AI and robotics to recover recyclables from waste. The robots adopts a technology allows greater flexibility in waste sorting, enabling operators to react quickly to changes in a waste stream and increasing the rate of recovery and purity of secondary materials. Using AI, the Waste is monitored by cameras and sensors. The robots make autonomous decisions on which objects to pick, separating the waste fractions quickly with high precision.

NotCo

The company developed a robust process by using AI algorithms to originate plant-based foods that replace meat, fish, dairy and egg based products. A similar approach is being taken by New Age Meats, which uses AI to model and optimize the conditions for producing lab-grown meat. The machine learning algorithm identifies new plant-based foods and composes food formulas by detecting patterns at a molecular level and analyzing flavor molecules.

Tomra.com

This Company creates solutions for optimal resource productivity. They designed an algorithm that can analyze images to identify non-uniform produce that does not sell in grocery.it can arrange goods into grades so it can be put to best use, thus reducing waste.

Zehnplus.com

Zehnplus.com developed AI algorithms in its software design for clients to automate the touch points throughout the customer journey. Delivering real-time sales, billing and service that eliminate waste material and human interactions in the entire process.

V. CONCLUSION

A key principle of the circular economy is keeping materials at their highest and best use. Artificial intelligience(AI) can be a valuable tool to help accelerate and scale the transiton to a circular economy while creating new forms of value. AI is one of the key drivers of the Fourth Industrial Revolution.It is a wide-ranging tool that enables people to rethink how we integrate information,analyse data ,and use the resulting insights to improve decision making. Artificial intelligence can play an important role in enabling in the transition to circular economy.AI can complement human's skills and expand their capabilities.It allow human to learn faster from feedback,deal more effective with complexity,and make better sense of abundant data. The potential value unlocked by AI in helping out waste in a circular economy is estimated to be around 127 billion a year in 2030.This is achieved through diverse opportunities that cut across processing, logistics,farming and consumption stages.

We have presented a comprehensive work on the potentials of Artificial Intelligence in the transition to a circular economy. This work provides an initial step towards a better understanding of the roles of Artificial intelligence in the transition to a circular economy.In the future,as the technology develops,artificial intelligence techniques could be integrated to entire systems to empower the development of fully circukar socieities that satisify the needs of the present generations without compromising the future. This study hopes that several companies would embrace Artificial intellgience in the quest to achieving a cleaner and less wasteful environment.

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