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Examining the Roles and Challenges of Human Capital Influence on 4th Industrial Revolution

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Abstract. Industrialization is an improvement of existing manufacturing processes through invention or the creation of new technologies to make activities easier for human to execute. The fourth industrial revolution has several technical factors that needs to be studied properly to ensure it safety and feasibility, however the inclusion of the human component as the central and main focus in this revolution is rarely mentioned. This overview critically examines roles and challenges encountered by man in the new industrial revolution. The collaboration of human-machine component and their performance was also in this paper.

Keywords: Industrialization; Revolution; Capital; Manufacturing; Challenges

INTRODUCTION

The trend in the industrial revolution over the years is to improve production processes by making work easier and faster for the human operators, this therefore increases productivity in manufacturing industry [1]. The term industry 4.0 is sometimes regarded as a buzz word commonly used by CEOs or PR managers but it is more than that, although at its infant stage the new industrial revolution has numerous positive potentials that are yet to be tapped into. As we are about to critically look into this current industrial revolution it is also important to briefly recall the previous industrial revolutions which in no small way have transformed the manufacturing sector [2]. The introduction of first industrial revolution started in 1760 with the use of steam engine as the major invention and this resulted in new manufacturing process and also in the creation of factories [3]. The second industrial revolution came in the late 1800s and this was the era of mass production with the aid of assembly line which was powered by electrical energy [1] . The third industrial revolution commenced in late-1900s, this era was known as the digital revolution which involved the use of electronic chips, computer and internet, and this led to the use of automation in manufacturing [4]. The fourth industrial revolution however is dependent on the use of existing and new technologies and concepts such as artificial intelligence, additive manufacturing, smart factories etc.

The creation of industry 4.0 on existing technologies does not downplay its effect in manufacturing sector as it is geared towards sustainable manufacturing and clearly different when compared to the third industrial revolution because products, machines, and humans are “smarter” as they are interconnected with one another to ensure increase in efficiency and productivity [5, 6]. The new industrial revolution is sometimes referred to as evolution because it incorporate both new and existing technologies to perform task, but the ability to connect systems, product, equipment with one another using different technologies is what distinguishes it from the third industrial revolution [7]. The introduction of any new technology such as computers, robots, CNC machines, 3D printers etc., was mostly expensive but over time it became cheaper and better, also the advent of this era came with a price and multinationals with the capacity and will engaged this new production process to improve and maximize production, and this was carried out by closely monitoring activities in the production center which included interaction of workers, materials, machines and products in order to gather, analyze and exploit data to make important decisions [8].

According to [3] industrial revolution started off in Germany and ever since many developed nations have subscribed to the vision that goes beyond the creation or invention of a system or machine to improve productivity, rather it encompasses all aspects of production using important and non-negligible components of such as like big

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data and analytics, industrial internet of things (IIoT), cloud computing, cyber physical system (CPS), system integration, simulation and 3D printing. This components are essential because incorporating them into the manufacturing sector increases productivity and minimize cost.

[9] stated that it still uncertain how this new industrial revolution will take shape, because it's at the infant stage and the present manufacturing systems in majority of the companies worldwide are not able to meet the requirements of industry 4.0 which means it will take some time before the 4th industrial revolution can completely take over from the third. [10] proposed a framework in order to achieve a successful and complete implementation of industry 4.0 through non-stop and ever increasing evolution of automation and intelligence in the factory. The manufacturing floor in this industry 4.0 uses an intelligent system and it is highly automated. [11] has doubts about how this new industrial revolution will help in shaping the future of work as there is no full deployment across the entire industrial sector.

Analyst in the developed nations are concerned about how industry 4.0 will help tackle issues like unemployment, urbanization, immigration etc. and also they are particular about the quality and number of jobs that are currently provided in the technological improved factories [4]. Even though there are document that show the importance of human factor in this industrial revolution, [12] stated that several researches that were carried out are technology centered not focusing on the role and impact of human, therefore it is unclear how both human and technology will be integrated. This could lead to two different approaches that are on the extreme ends which are human-centered approach or technology-centered approach [13]. [9] affirmed that the first approach that is human-centered is controlled by the human and to make decisions and supported by the intelligent machines. The second however is the technology based and the task of man in this approach is determined by technology which means man will have to assist the machine in accomplishing tasks [14]. The technology-centered approach is un-stainable due to the fact that it eliminates the decision making and control of man in manufacturing. The main reason for this type of approach is the rise in globalization that ensured human-centered approach isn't given full recognition because of the need to be more productive.

BRIEF OVERVIEW OF INDUSTRY 4.0

The integration of technologies especially newly developed ones has change the entire outlook of manufacturing which led to the recently introduced fourth industrial revolution [15]. The main purpose of industry 4.0 is have a sustainable manufacturing setting that makes efficient use of resources and has little or no waste. This result from the union of technologies and manufacturing brought about the rise of smart factories that takes into consideration all aspect of production required for a particular product which enables the company to achieve their objective effectively [16]. One major pillar of industry 4.0 is data analytics and the ability to generate, interpret, analyze, and communicate this data effectively is very important as it connects several other technologies within industry 4.0 to create value.

Building blocks of industry 4.0

According to reports from KPMG there are six basic principles that govern the new industrial revolution they are services and networks, strategy and business model, technology, finance and risk management, employees and competencies, systems and processes, and lastly services strategy, this principles are divided to an overview of other tenets within these principles by KPMG in 2016. Industry 4.0 is described as the integration of existing and new technologies in a manufacturing system, and this technologies can be divided into two front-end technologies (smart supply chain, smart working, smart manufacturing, and smart product) and back-end technologies (internet of things, cloud computing, big data, and analytics) [5].

The front-end technologies refers to upcoming technologies such as smart manufacturing which comprises of an intelligent, digitized and interconnected factory used by smart workers to produce smart product using a smart supplying chain [17] . This front-end technology is based on operational and market needs which improves value chain. The front-end technologies are dependent on the back-end technology for maximum productivity, it helps the front-end technologies to be intelligent and connected with one another, and the concepts in the back-end technology are bedrock of industry 4.0 which distinguished it from other industrial revolutions. The base or back-end technologies are what make industry 4.0 to be sustainable as effort is directly towards 100% resource utilization eliminating waste and pollution which are major challenges of humans in the 21st century [18] .

[1] affirmed that industry 4.0 is driven by four main technologies namely Industrial Internet of things (IIoT), Internet of things (IoT), Cloud manufacturing and Smart manufacturing. It was also stated in this paper that for manufacturing in the industry to be fully automated integrated and optimized several technologies (Big Data Analytics, Autonomous Robots, Simulation, System Integration: Horizontal and vertical, Industrial Internet of Things, Cyber Security and Cyber Physical System, Cloud Manufacturing, Additive Manufacturing, Augmented

Reality) of industry 4.0 must be in place [19]. This increases efficiency of the manufacturing line and fosters better relationship among producers, suppliers and customers.

Conceptual impact of industry 4.0

There are several areas in which industry 4.0 has impacted on the manufacturing sector, economy and the society in general. The views on productivity of industry 4.0 varies but it is mainly determine by the new technologies incorporated in it, and the technologies that makes up industry 4.0 helped in reducing material waste, saving time, and utilizing resources in the best possible way. This means that investors get value for the invested in the technologies. However this assertion on productivity is relative as it varies with size of the companies (West, 2015). Majority of the companies that invested in new technologies are top companies with enough capital to acquire these new technology and inference cannot be drawn from only a few that can afford it for now [20]. However the impact industrial robots was studied in 17 different countries and it is evident at the national economy level as their input in production resulted in growth of the economy and a sharp increase in productivity. An increase in the investment of technology however leads to increase in productivity in terms of profit as shown in figure 2, better quality and higher performance which is made possible by the advent of new tools [8]. Growth in this industrial revolution in terms of revenue is one aspect that attracts investors as they plan to make maximum profit from their investment. This growth however is made possible through the use of big data technology which assists key decision makers such as managers and CEOs to make good decisions based on the received data. The use of big data in companies has proven to be very efficient in the aspect of logistics and supply chain which also it improves the financial performance and give the company the capacity to have more reach i.e. an expanded market which gives them an edge against their competitors [15]. The arrival and changes in technology has never led to decrease in employment rather it increases the employment ratio, the only decrease will come from jobs that are no longer relevant and considered as tasking or low value added jobs which can be taken care of by machines through automations or through the use of software. However several jobs are created at the advent of every industrial revolution all that is required is the skill needed to fill in these roles [21].

The increment rise in digitization mostly found in the manufacturing industry will result in an economic disruption as the use of different technologies get more advanced, some roles in the manufacturing industry will become obsolete which will cost some people their jobs however there's always an opportunity to improve and acquire the required skill as technologies in this era are dynamic and requires a constant upgrade by the users, it is the perfect opportunity to become a smart worker with the special skills need to create value and accomplish task however it will also be disastrous for those that remain as ordinary workers as robots and software are already accomplishing their task with 100% efficiency at lesser cost [22] . The introduction of this industrial revolution requires a lot of funding which would be invested in technologies and the payback period is what most investors are interested in as they want a value for their money in the shortest time possible, it was stated by PWC that most companies that invested in this technology expected a payback at the end of two years which is relatively fair. The high investment requirement is due to the fact that industry 4.0 is at its initial stage and it has been observed from the past that the introduction of new technologies are mostly expensive but becomes cheaper with time as companies begin to invest more and also more improvement. However those willing to take risk at the initial stage will benefit more if the investment turns out to be productive.

There are several challenges that affect the growth of the industry 4.0 and it is important that some of these challenges are tackled in order to have a smooth procession into the next industrial revolution. The intentional exclusion of companies from this industrial revolution remains a main issue, this could be due to several factors such as uncertainty, distrust in the use of technologies that are not familiar, the cost of investing in such technologies, integrity of security which could affect the entire operation of the system [8]. The exclusion of certain industries might not affect their production as they need to upgrade step by step to be sure of how to implement these technologies properly by waiting for it to be affordable as they have smaller profit margins, however certain industry such as automotive and electronics have to take quick action and implement these technologies quickly to compete effectively in the global market. In large organizations the impact of industry 4.0 can only be evident after the development and regular deployment of digital corporate strategy. The security of data is very crucial in industry 4.0, with the large volume of data that will collected in order to improve products or services and make better decision but the safety of the data must be assured in other to implement industry 4.0 in any organization. The access to data must be controlled, also security of the entire system including the network, sensors, products, data encryption must be under strict control. The implementation of industry 4.0 by organizations to release smart products that meet the needs of customer and are tailored to get feedbacks for implementation will definitely increase their advantage over other organizations during the learning process, therefore it is important to know exactly when to implement these strategies even though it seem "risky"

ROLES AND CHALLENGES OF HUMAN IN INDUSTRY 4.0

The human component of industry 4.0 is topic that is gaining attention lately as researches have come to the realization that a human centered approach is the best way to maximize the new industrial revolution. The technology centered approach which was earlier stated does not incorporate man into the system holistically rather it focuses entirely on the use of technology to make decision while humans take orders and have no input in the creation of value. Humans have several roles to play in this because the technologies are even created by them even though machines can be taught to get smarter or intelligent and predict better by feeding them data they are still not as flexible as human.

Human roles in industry 4.0

The advent of industrialization has always been to improve the manufacturing processes which enhances the work done by human, but it is mostly seen as a threat to humans because of the change in the design of work which is not convenient for most to adapt with, however the human role in industry 4.0 are based on their capabilities to make system perform functions that will produce results that are useful for growth of the organization. The new industrial revolution is dynamic in nature therefore it is important for the workers to hone skills necessary to perform functions useful for the management in making decisions. The role of human in this range from taking full control i.e. supervising or monitoring the entire system, to interacting with an intelligent machines and system to perform a task together also maintenance of the entire system which cannot be done by the machine must be carried out by the workers. Even though there are complex activities like sorting of unstructured data using big data to assist in making decisions, the three roles mentioned earlier are very crucial and cannot be replaced by using a machine as an independent system to perform task.

The human and machine relationship is the integration of human input with machine input to achieve a desired goal, each element i.e. human and machine on their own has advantages and drawbacks but taking the advantages to complement each is important because one cannot do without the other in this present industrial revolution. Intelligent robots used in industry 4.0 are built to interact and assist human in accomplishing tasks, they are known as collaborative robots. The collaboration uses human flexibility combined with the efficiency, reliability, and precision of the machine. The main aim of this collaboration is to eliminate workers task that can be handle by robots i.e. low value task, and use the ability of workers such as flexibility, and spontaneous thinking to accomplish advanced tasks [18].

Both humans and robots have crucial advantages regarding industrial assembly processes. While robots ace at repetitive and monotonous assembly steps, humans are able to adapt flexibly to new situations and upcoming problems. Combining these advantages by means of direct human-robot cooperation seems to be interesting for producing companies but has not been realized yet. While the corresponding technologies are already available, appropriate safety standards to ensure occupational safety are missing and represent one of the main barriers for introducing direct human-robot cooperation [23]. In industrial environments under this present industry 4.0 the use cognitive technologies will ensure smooth relationship between humans and machines [12]. Majority of the human work will be assisted by smart machines through various mediums like voice recognition, machine learning, virtual or augmented reality etc. Therefore, to have both human and machine complement each other it is important for humans to develop new skills, and also there is a need for advanced learning models for machines to become smarter in other to increase efficiency [6].

Challenges encountered by human in industry 4.0

Technological changes over the years are known to increase efficiency of work performed or reduce error. For instance a person that digs with a shovel cannot be as efficient and fast as one that uses an excavator this shows that productive can be achieve with the help of mechanization as compare to human strength, also another example is the consistency and ability of machines to make less errors in terms and this is where automation comes into play as robot cannot be worn out of performing monotonous activities [21]. As stated in past literature by [9, 12], humans are usually beneficiaries of technological advancement as more job roles and openings tend to come up over the years even though it is not always on the increase, but it should be noted the advent of every industrial revolution is always in the favour of the human. However there are speculations that machines will take over the role of humans in the industry because all the activities will supposedly be carried out by machines, this isn't entire true as the machines are created to be more interactive with humans in order to provide solutions on a faster and more efficient scale [7] .

According to [7] there are several literatures that try to cover the relationship between a fully implemented industry 4.0 organizations and the work performed by humans in this system however there are gaps in these studies. For instance several researches carried out on the use of automation and break down of activities are useful because it enhances process of making decision through certain models and the creation of borders between automation and human control. Some other researchers discovered that the relationship or synergy between human

and machine revealed that ability of humans to adapt to a dynamic environment and for both to mutually support each other to accomplish task [24, 25]. The researches carried out on labour market revealed that there are positions that require certain uncommon capabilities that cannot be substituted by automation or artificial intelligence. However it was observed that the need for an upgrade in work design is not considered in majority of the researches conducted.

Some of the challenges human face in this industrial era includes;

- The ability to understand and govern the interaction between man and machine.
- How to calculate the value added to work by human in form of making decision, problem solving skill, individual performance during an activity, social behavior and creativity.
- Getting the required skill necessary.
- Lack of support from the management to train the workers.

CONCLUSION

This study shows that the inclusion of humans at the heart of the industrial revolution is a sustainable approach that will improve productivity, economic growth and also increase employment opportunities. It was discovered from literature that human-machine collaboration is an effective way in increasing efficiency, accuracy and precision by machine and also the flexibility of human complements the rigidity of the intelligent machine. Also the main challenge faced by humans is lack of skill. This overview shows that the human-centered approach is far better compared to the technology centered approach.

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