Workforce Mapping of Fourth Industrial Revolution: Optimization to Identity

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Abstract. The most challenging issue in Industry 4.0 is the reduction of the human workforce. This study proposes a mastery concept in identifying a job that can be replaced in Industry 4.0 by machine and a job that hardly replaced by machine. It explains in a job matrix format distinguishing types of jobs that need machine or technologies for optimization and jobs that require compassionately for maintaining an identity as a human being. The matrix defines the nature of a job into a routine human to human interaction, complex human to human interaction, human to machine interaction, and finally machine to machine interaction. The job matrix can become a tool for an organization to develop strategies in the Industry 4.0. The research was based on a qualitative method where secondary data gathered from the literature review analysis. The routine job and non-compassion task required will be replaced by machines and technologies. While, job nature with complexity in decision-making, creativity, innovation, and compassion will remain sustainable in the Industry 4.0.

1. Introduction

Previous researches emphasize the Industry 4.0 or 4th Industrial Revolution (4IR) is all about production efficiency that impacts the reduction of the human workforce due to the advancement of technologies include Internet of Things (IoT), big data, 3D printing, artificial intelligence, sensor technology, and robotics. These technologies support the manufacturing sector to create ‘the Smart Factory’ [1]. Since there will be many structured or routines replaced by technology, it is believed rising the unemployment rate with increasing population and declining employment opportunities. For instance, in the context of smart factories, many factories transform into highly autonomous and many human workers are replaced with robots, AI, or expert systems. The benefit of the change would only be focused among the elites and the income became more polarized. It is estimated that in the US alone, 47% of the workforce will be laid off due to business automation [2].

There will be a decline in a traditional job and instead, there will be an increasing demand for skillful labor, that can program and design new digital systems [3]. The increasing level of digital innovation is causing many manufacturing jobs to become obsolete. More efficient production caused by new technology will cause the rationalization of input factors. Some workers will get laid off as a higher output can now be generated with less labor and with the help of smart machines [4]. Workers who are most at risk of losing a job, are those working in production, logistics, and transportation [5]. Focusing on the manufacturing industry currently which still relies heavily on labor input in production, a wave of cultural resistance to industry 4.0 implementations is expected [6]. While workers in physically demanding roles will be replaced. However, complete automation is not realistic, Industry 4.0 is more about assisting or optimizing human workers to perform rather than replacing them completely [7]. With changing the industrial landscape, the nature of the jobs will change as well.

The study attempts to examine and address jobs and employments impacts that Industry 4.0 has on the derivatives technologies, by mainly proposing on job matrix identification. Before proceeding to these job implications, a brief explanation is provided on the process of Industry 4.0 with particular reference to its development and implementation strategies. The job matrix will serve as a theoretical framework in order to properly assess the current and future jobs that will emerge and disappear in Industry 4.0. It also provides a baseline framework for educational institutions in redefining the strategies for supporting Education 4.0.

2. Industry 4.0

A shift from the manually based manufacturing system to large-scale mechanization initially began towards the end of the 18th century in Britain. This period, which involved massive technological changes and a series of innovations, is called the industrial revolution. Not only that the advent of mechanization resulted in an increase in productivity and economic rewards as well as improvement in the standard of living of the British people, but the technical innovations also generated greater intellectual ingenuity [8]. Following the success of the first revolution, the process has led to the emergence of a sequence of industrial revolutions and has spread to other parts of the world, hence becoming a worldwide phenomenon. The second industrial revolution took place in the late 19th century which witnessed the emergence of electricity to create mass production and fast forward to the late 20th century, the third industrial revolution occurred which gave rise to the use of information technology and electronics to automate production.

The fourth industrial revolution or in another term, industry 4.0, is progressing which involves the use of technologies such as Internet of Things (IoT), artificial intelligence (AI), Radio Frequency Identification (RFID), sensor technology, cloud computing, 3D Printing, and Big Data. These technologies allow the flow of real-time information forming Cyber-Physical-Systems (CPS). The main roles of CPS are to fulfill the ability and dynamic requirements of production and to improve the effectiveness and efficiency of the entire industry [9, 10, 11]. In addition, Industry 4.0 facilitates interconnection and computerization into the traditional industry. The aims of Industry 4.0 are to offer ICT enabled mass customization of manufactured products; to make automatic and flexible adaptation of the production chain; to track parts and products; to ease communication among parts, products, and machines; to apply human-machine interaction (HMI) paradigms; to make IoT-enabled production optimization in smart factories; and to provide new types of services and business models of interaction in the value chain" [12]. While Industry 4.0 also brings disruptive changes in supply chains, business models, and business processes [13].

2.1 Industry 4.0 and Technologies

As mentioned in PWC report (2016), the most digitalized countries in the world are Japan and Germany and it is expected by 2020, digitalization will reach 72% across the globe. It is also expected that cost will reduce by 3.6% and productivity will rise by 15% in the next 5 years [14]. The use of technologies and digitalization has an ability to lower cost and has a great reliability, therefore, making sense for industrial applications [15]. Smart manufacturing involves various technologies powered by 5G networks including cyber-physical production systems (CPS), IoT, robotics or automation, big data analytics, and cloud computing to realize the vision of a data-driven, connected supply network [16]. A smart factory is a production facility with few or without humans.

Internet of Things (IoT) has evolved into the integration of many different technologies such as embedded systems and wireless connections as well as machine learning [17]. The sensors collect data in real-time and this can help optimize the manufacturing process. IoT as a global network that allows communication between things-to-things, human-to-things, human-to-human by providing a unique identity to every object. Anything and everything can be connected [18]. From the interconnected network, it churns out huge volumes of data flowing to a computer for analysis. Many of the Internet of Things content has been created through RFID tags and IP addresses linked into an EPC (Electronic

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Product Code) network [19]. The Internet of Things is pivotal to the evolution of Industry 4.0 and IoT generates big data.

Big data is widely defined as "high-volume, high-velocity and/or high-variety information assets that demand cost-effective, innovative forms of information processing that enable enhanced insight, decision making, and process automation" [20]. A wide range of areas could benefit from the adoption of Big Data, one particular example is business activities. For businesses, the effective use of this advanced Big Data analytics helps to support productivity growth, to improve marketing strategies and to make better predictions as well as real-time decision [21].

Furthermore, a fifth-generation (5G) will establish the foundation of Industry 4.0 to accomplish latent, long, reliable, and secure communication and to meet the complex demands of emerging business paradigms [22, 23]. Although 5G is still in its infancy, the technology of the 5G is a necessary developmental step for the Machine-to-Machine (M2M) communication associated with Industry 4.0 and with the IoT, as industries are becoming more complex and more knowledge-intensive, massive data appear with Industry 4.0. [24].

With cloud computing, cloud manufacturing is a smart networked manufacturing model that uses cloud computing, which aims to meet growing demands for higher product individualization/customization, broader global cooperation, knowledge-intensive innovation, and increased market- response agility". Cloud manufacturing also enables the creation of intelligent factory networks that offer ubiquitous information provision. Cloud computing systems and cloud manufacturing may play an important role in the realization of "Design Anywhere Manufacture Anywhere" philosophy [25].

Smart machines like expert systems, digital assistants and autonomous devices are changing manufacturing processes. Advancements in robotics and Artificial Intelligence is now disrupting industries once considered safe from automation. Robots are becoming more autonomous, flexible, and cooperative day by day and at certain they will interact with one another and work safely side by side with humans and learn from them [26]. An autonomous robot is used to perform autonomous production methods more precisely and also work in the places where human workers are restricted to work. Autonomous robots can complete given tasks precisely and intelligently within the given time limit and also focus on safety, flexibility, versatility and collaboratively [27].

2.2 Industry 4.0 and Applications

Industry 4.0 can be summarized as an integrated, adapted, optimized, service-oriented, and interoperable manufacturing process which is correlated with algorithms, big data, and high technologies. More examples are driverless cars, delivery drones or 3D printers which based on an individual template whereby it can produce highly complex items without making any changes in the production process or human action in any form is necessary [28]. Due to these, production processes will be fully automated in the future, and humans will be used as a production factor only in each case. [28].

Industry 4.0 also can optimize social work and it will be more opportunity for employment. For instance, local Malawians use a drone to join the humanitarian cause [29]. Encourage the usage of drones in solving logistic problems such as medicines and food supplies in remote areas [30]. To make people to fully accept these drones, the key agents must try to engage with the community about the benefits of these drones that may change their fallacy of these humanitarians' drones. The key agents include UNICEF, their local partners and those involved in the humanitarian drone mission. For instance, letting the local communities study the drone and watch the drone to completely hover by the operators [31]. As organizations provide the humanitarian cause, they should not focus on giving better services by delivering supplies and providing medical aids only but they also socially responsible to minimize the local fear and assure them that the drones are not used as a weapon to cause them harm.

2.3 Industry 4.0, Creativity, and Identity

There is a great link between robotics and machine learning that can solve complex problems will have a significant impact on making a decision strategy [32]. Apparently, increasing demand for a specialist or highly skilled labor (i.e. software specialist, mechatronics and data analyst) proven to be skilled under artificial intelligence and machine learning can be highly demanded careers. Industry 4.0 has created vast opportunities to overcome temporal and spatial barriers as well as to create new values especially through the Web or Apps inspiring business to embrace the digital world through electronic business (e-business) or electronic commerce (e-commerce). Data analytics skills, data scientists, data visualization, AI, machine learning are in high demand jobs because any sectors either public or private organization realize that big data is an asset for the organizations. Therefore, these skills are more challenging to recruit talent with the necessary skills. In addition, there are human skills that machine and its technologies cannot replicate such as creativity (ability to create), innovation, compassion, imagination, feeling, and so on. Furthermore, the side impacts of adopting these technologies may need to be on the priority list for consideration. For instance, the emergence of the Internet in people's every day lives may lead to a disorder that can be called Internet addiction. According to Wang and Wang (2013), internet addiction is a type of behavioral addiction that resulted from the excessive use of the Internet in which can be also diagnosed as a mental health problem [33, 34, 35]. Musai and Darkesh (2014) however stated that due to the diverse functions that the Internet brings, it can consequently affect the way that people socialized in their everyday lives [36]. The increasing use of the Internet has indirectly changed the way that people communicate with one another as people now communicate virtually [37]. These problems created from the massive adoption of technologies that requires human to human intervention and highly human/social skills to maintain human identity [38]. Therefore, Industry 4.0 is not going to take all the jobs and works rather it will require more jobs in the field of human sciences and its application to maintain as human identity [39].

3. Methodology

The research deployed an exploratory qualitative study. It is a systematic approach to the literature review is based on the knowledge that plays a major role in evidence-based practices. Keywords in getting literature review include 'Industry 4.0 AND jobs', 'Industrial revolution 4.0 AND employments', as well as 4th Industrial Revolution AND Job AND Employment. In principle, systematic reviews are formulated around the research question. In this study, the objective is to answer the question of "What the job's nature that will emerge and disappear in Industry 4.0?"In-depth literature reviews were collected mainly from the reliable or official website and online database journals such as Scopus indexed journals, Emerald, Science Direct, and ABI/Pro-Quest. In conducting this research, secondary data from earlier studies were used for data collection. The review of the previous studies was used to set up a better understanding of the pertaining issue about job nature in the context of Industry 4.0. Then, the analysis from the review led to the development of job matrix identification as a working model.

4. Formulating Jobs in Industry 4.0

To put it in simple statements, when highly intelligent technology such as robotics that can pose for self-automation to happen, despite how seemingly efficient and good it can contribute to the productivity, so will it contribute to an increase of unemployment rates that can cause resentment and dissatisfaction among people? In another way to express this would, it leads to the clash between mankind and technology? Technically, one should often be asked or bothered with questions in regards to being technologically advanced, is it ethical to use or rely on advanced technology to kill people, to spy on people, or to take away jobs from people? To be relevant to the topic, how long will we trust technology in terms of drone and will we not consider it to be deceitful to mankind in the future?

From the above review, Figure 1 shows the form of a matrix to provide an overview of the types of jobs that will be completely replaced by automation and jobs that will remain, even continue to develop. The matrix is divided into four parts and two axes (horizontal and vertical). The horizontal axis describes the type of work from routine to complex work. Routine and complex are in the context of the decision making process. For example, in a smart factory, when a factory receives an order from a customer to produce an item, without the intervention of the customer sales staff, the machine can process the order directly into a finished product without the participation of human workers. But many people and new jobs will be needed to maintain the smart factory. Human workers are needed to make IoT work and analyze the big data created by the automation process. Therefore, complex processes that require human workers and that are now that there are still many types of jobs that require high expertise and complex in managing routine processes carried out by machines.

While the vertical axis is to explain the dominant type of work whether machine-centric or human-centric work. Machine centric is a job that focuses primarily on machines as main actors to optimize results without the need for compassion, motivation, feeling, love and the like. An example is a robot in manufacturing can do 24 hours and 7 days without feeling sad, tired and bored. Whereas human-centric jobs are in natural contact directly with fellow human beings as subjects of interaction that require compassion, love, feeling, motivation and innovation. All intangible components are the Identity of humans that cannot be replaced by machines and technology. This type of work will be difficult to be replicated by technology. Whereas if there is a technology that is used only as a tool for process optimization. Furthermore, the following job matrix differentiates into two large groups based on knowledge management. Complex work is work that is usually for the category of knowledge development or creation. Whereas routine work is in the category of knowledge application and implementation. Then the job matrix will explain in more detail the cluster jobs into four categories as follows.

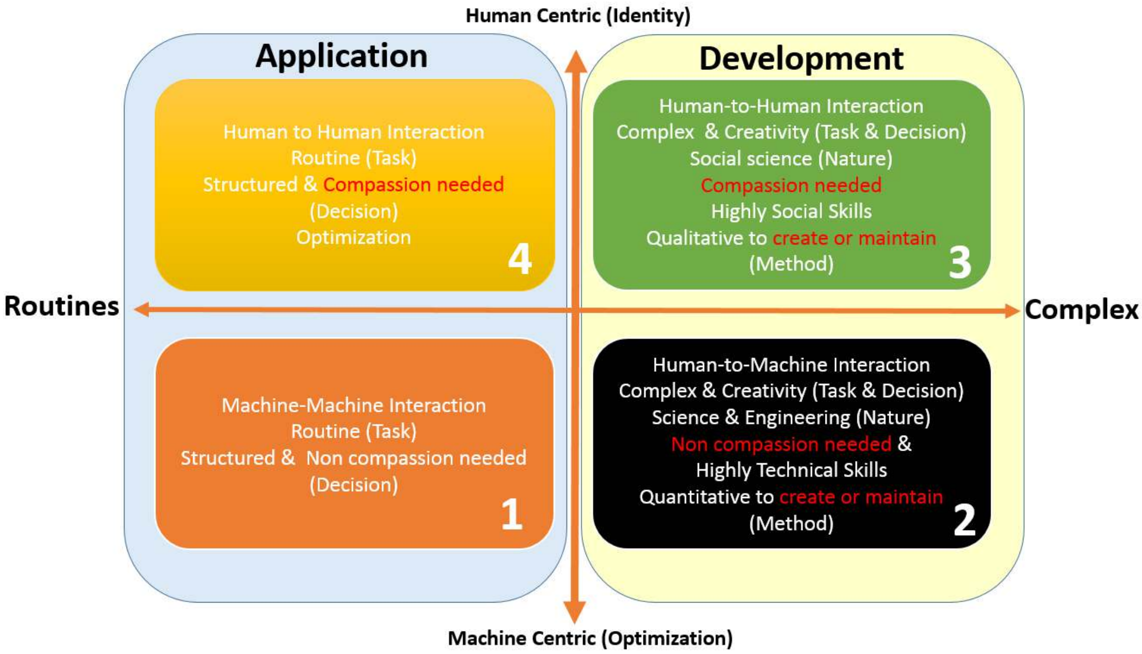

Figure 1. Job Matrix of Industry 4.0

4.1. Routine machine-to-machine interaction

The first cluster job (1) is routine machine-to-machine interaction or fully machine interaction. There are several characteristics of this Cluster is the optimization of business processes which can all be done by machines and technologies. In this cluster, there will be very little or no work that needs to be done by humans because all processes can already be digitalized and automated by machines. So the work in this cluster is very small in terms of human identity. The jobs in this section were previously labour-intensive and they are now transferable for automation. The characteristics of this work are usually routine, structured, not complex in the decision making the process, and most importantly the need for intangible factors such as feeling, boredom, motivation, and compassion are not required. This type of work is typical of smart factories where the optimization process in production can be maximized. An example is the smart factory can still work 24/7 without exchanging work shifts because there is no need to feel bored and need to rotate the tasks of each component. A smart factory can also still be able to work even in dark conditions without the need for lighting so it really saves energy or smart energy. Examples of jobs lost in this group include truck drivers, security guards, telesales, cashiers, customer support, data entry, dishwasher, agriculture laborers, construction workers, and many more. Cluster 1 is included in the knowledge application category. This is because these technologies are used solely for work processes. Cluster 1 has the limitation that they carry out work or apply for work without being able to make very complex decisions. Because taking a decision that is very complex is the identity of humans. Finally, what do people in this group need to do? They have to transform or upgrade their knowledge into different clusters such as groups 2, 3, or 4 as shown in Figure 1. So let machines and technology in Industry 4.0 help us do routine work while we do work that makes meaning or identity for us as humans.

4.2. Complex human-machine interaction
The second cluster job (2) is a complex human-to-machine interaction. Human-to-machine interaction is usually the type of jobs that are directly related to the process of creation, development, or maintenance of the types of work that exist in Cluster 1. Cluster 2 types of work require highly skilled human resources. This is because of the complexity of the work to optimize business processes that take place in Cluster 1. Industry 4.0 requires many people to be able to do the type of work in this section. Cluster 2 is the type of work that is needed a lot throughout the world. It is direct support for the existence of all automation processes that occur in Cluster 1. When many human workers have lost their jobs in Cluster 1, the opposite is the human worker in Cluster 2 who is in the top position most sought after. The characteristics of work in Cluster 2 require high creativity, highly technical skills, and are associated with complex development systems. The scientific realm of Cluster 2 is in Science & Engineering and usually a quantitative approach in the methods used in the problem-solving mechanisms because it is related to machine and technology. Since Cluster 2 is a human-to-machine interaction then it is machine-centric or the process of optimizing this work does not require a lot of human interaction and compassion. This is because the nature of the work is not directly related to human interaction. Examples of work in Cluster 2 are data scientist, data analytics, Apps Developer, cybersecurity, AI and IoT specialist, etc.

4.3. Complex human-to-human interaction
The third cluster job (3) is a complex human-to-human interaction where this type of work is very important to build a human identity. Indeed work in Cluster 3 does not directly affect the optimization of the production process as in Clusters 1 and 2, but Cluster 3 is crucial in defining the role of humans in Industry 4.0. Cluster 3 is the domain of social sciences that must be made a priority in Industry 4.0. The main problem in Industry 4.0 is not merely the loss of jobs replaced by technology, but overcoming the identity and moral crisis of the impact of technology requires the type of work that is in Cluster 3. Therefore, Cluster 3 requires high expertise in social science, religious studies, and humanities. Negative impacts such as identity and moral crises and the deterioration of social relations caused by excessive adoption of technology require solutions. An example is many parents who have difficulty handling their children's nomophobia, especially millennial generation. The impact of nomophobia can affect health, psychology, mental development, and social disorder. These problems require up-to-date solutions so that a lot of workforces is needed in Cluster 3. Cluster 3 requires solutions that are needed by those directly or indirectly affected by Industry 4.0. Therefore, one of the characteristics of Cluster 3 is the complexity of the nature of the job associated with fellow humans. Cluster 2 provides solutions for Cluster 1, and Cluster 3 provides solutions for people who work in Cluster 2 and Cluster 4. Furthermore, other characteristics of work in Cluster 3 require compassion, love, motivation, feelings and highly social skills approaches because of the type of work whose immediate object is to provide solutions for humans. Usually, the approach taken in the work of this

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Cluster is a Qualitative approach. Examples of work in this Cluster are as follows; physiologist, sociologist, Islamic scholars, CEO, managerial work, teachers, etc.

4.4. Routine Human-to-Human interaction
The fourth cluster job (4) is a routine human-to-human interaction. This is a type of routine work that requires human interaction and the interaction is not so complex in the decision making the process and finding a solution. This type of work has similarities with Cluster 3 because it is related to humans and also requires compassion. Human touch and social interactions are required to fulfill the job in this category. While the use of technology such as Apps in Cluster 4 is more to assisting tools, not the core of work demands. What distinguishes Cluster 3 is that it does not require high complexity in job structure and also decision making, because the process is usually routine. Examples of work in this Cluster are tour guides, social workers, hospitality businesses, elderly companions, caretakers, event organizers, etc. Human workers who lose their jobs from Cluster 1 can be directed to fulfill the jobs in Cluster 4, this is because the nature of jobs in Cluster 4 is less complex, routine but requires a human touch and social skills.

4.5. Education 4.0
Higher learning institutions should embrace the changes by revisiting or redesigning a new curriculum or approach to be more experiential learning to accommodate the changes due to Industry 4.0. Referring to the Job Matrix (figure 1) discussed earlier that there will be many jobs that will be replaced by technology and machines especially the jobs at Cluster 1. However, there will be many opportunities soon that new jobs will be created based on creativity, innovation, advanced skills, and soft skills. Therefore, higher learning institution needs to consider effectively embracing Education 4.0 strategies that generally require people who can have highly soft skills such as professions in Clusters 3 and 4 or advanced skills like professions in Cluster 2. Ultimately, creating graduates with complex decision-making skills, creativity, innovation and social skills that will not be replaced by machine and technology.

5. Conclusion
Industry 4.0 brings challenges and opportunities. It will be an exciting world to live in. Entertainment, professional services, manufacturing, healthcare, and finance will be vastly different than today. Technologies such as IoT, augmented reality, artificial intelligence big data, 3D printing will integrate seamlessly into human daily life, offering an unprecedented levels of comfort and support. Many new job opportunities will emerge and require human workers to be able to quickly develop new knowledge and apply to preserve well-being.

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