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CLOUD COMPUTING AND BIG DATA IN THE CONTEXT OF INDUSTRY 4.0 : OPPORTUNITIES AND CHALLENGES

Abstract:

The global industrial systems have changed in the last few years due to great technological advancement in many fields. The Industry 4.0 concept has emerged in 2011 in Germany and later has been adopted and investigated by both academic and practitioners in many other advanced countries. Two main new technologies associated by and will have a great impact on industry 4.0. In this review paper, we shielded the light on cloud computing and big data. We present the possibilities and challenges associated with these technologies. The review reveals that sharing, efficiency in production and information sharing are the main possibilities of cloud computing meanwhile the security and privacy are main concerns. From other hand big data brings many opportunities like cost reduction, support the efficiency of decision making, however challenges related to large-scale parallel system and technical challenges still need to be addressed.

Keywords:

cloud computing, information technology, industry 4.0

JEL Classification: M15, O32, O32

1. **Introduction**

The latest advancement of human ingenuity in many fields especially in information and communication technology like high speed network and processing power led to cloud computing, internet of thing, big data analytics and other new innovative application. The aforementioned technologies started to be more important and the manufacturing industry started to exploit it in new innovative way which is totally different than the traditional way of manufacturing. The new concept of fourth industrial revolution has been coined in Germany in 2011 in the government high-tech strategy for 2020. It means that we have new age of manufacturing by exploiting the advancement of technologies. (Pereira & Romero , 2017).

Three great advanced movements were considered as turning points in manufacturing history. First one was the steam engine, the second industrial revolution was electricity and the third was triggered by the invention of integrated microchip and the use of information technology (Pereira & Romero, 2017). In this paper we will focus on two main underpin of the industry 4.0 : cloud computing and big data and show the main opportunities of these technologies and challenges it faces.

2. The fourth industrial revolution

Fourth industrial revolution or Industry 4.0 can be defined as " an umbrella term for a new industrial paradigm that embraces a set of future industrial developments regarding Cyber-Physical Systems (CPS), Internet of Things (IoT), Internet of Services (IoS), Robotics, Big Data, Cloud Manufacturing and Augmented Reality" (Santos et al. ,2017) . According to Schwab (2016) the fourth industrial revolution will have a huge impacts on our lives, work and the way we connect to each other. It is unlike other turning point or revolutionary innovation we have experienced before. We have experienced the industrial revolutions that consider as a turning point of production in human history. First one was distinguished by using steam engine , the second one was distinguished by using the electricity to generate huge production , and the third one was introduction of microchip and information technology to automate the manufacturing . What make this stage a new revolution and not an extension of the third industrial revolution is its speed , scope , and system impact. Also Santos et al. (2017) the concept of industry 4.0 was coined by German ministry of education and research in 2011 to attract the attention toward the acceleration of the digitization of manufacturing and it is based on the integrating of a several breakthrough technologies that create ecosystem of short, independent and decentralized manufacturing . Also industry 4.0 aiming at using of data processing and information technology and to decrease of process complexity and long term cost by connecting all the individual network. Meanwhile increasing the efficiency and the effectiveness of the operations of many industries. Figure 1 presents the main concepts

and technologies associated with industry 4.0 according to The Boston Consulting Group (2015)

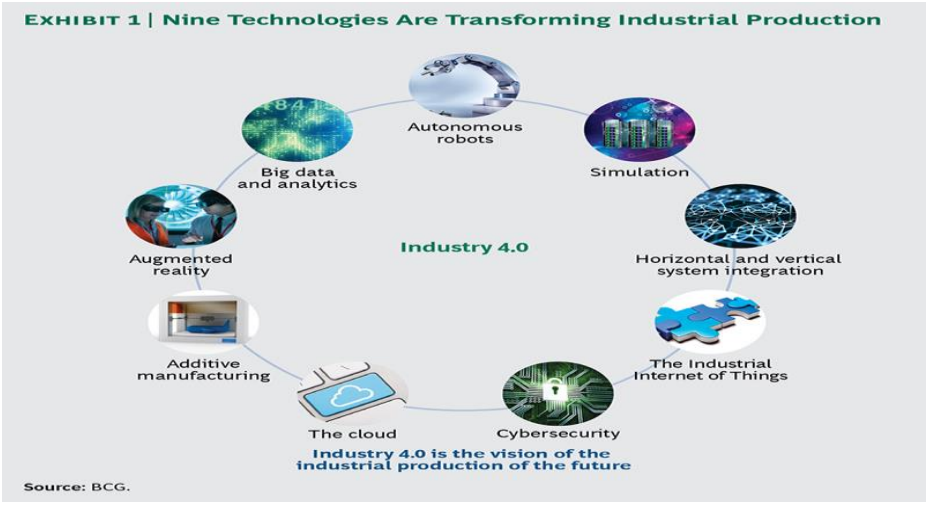

Figure 1: Nine technologies are transforming industrial production (Boston Consulting Group , 2015)

3. Cloud computing

3.1 Key concepts

Cloud computing is considered as a new paradigm shift in information technology industry. Many of the authors consider it as the fifth utility service. That mean the information technology service will be consumed and paid as electricity and water services. It is not just technical concept but it is new business approach of selling IT services. The comprehensive and broad definition of cloud computing by U.S. NIST (National Institute of Standards and Technology) is “Cloud computing is a model for enabling convenient, on demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction ”. the main distinguished characteristics of loud computing are : 1. Assumption of unlimited computing resources 2. Pay-for-use model 3. Virtualized resources. (Avram ,2014) .cloud computing has many advantages over the traditional information technology services : 1.reducing the cost especially for the small and medium enterprises 2. Real time and 24/7 access to the IT resources 3. Facilitate the innovation 4. Open the way for new classes of applications that were impossible before . (Avram ,2014)

Cloud computing has three service models. (Amin, Sundararajan & Othman ,2014) :

1. Software as a service : the customer use the application which is executed on the service provider computer resources.

2. Blat form as a service : in this model the cloud service provider the basic tools such as the operating systems , development tools , servers which are needed by the customer to develop their own applications

3. Infrastructure as a service: here the customer has his own applications and only need the hardware.

3.2 Cloud computing in the context of industry 4.0

Cloud computing is expected to play a vital role in industry 4.0 and it is considered one of the basic element of the cyber-physical system (CPS). According to Yen et al.(2014) cloud computing in CPS of fourth industrial revolution will trigger new race of global IT development by allowing centralized shared and flexible expansion of computing resources. With its great capabilities of sharing, cloud computing will improve the efficiency of the production within the cyber-physical system and the machine failure reasons can be shared by cloud platform with other multinational branches in multinational companies case. Also a study by Givehchi , Trsek & Jasperneite(2013) about the potentials in the industrial automation systems revealed that there is a vital role for a cloud platform to integrate the information technologies such as a mobile computing and internet of things within industrial automation functions to be done by cloud computing .

From the other hand cloud computing as a new paradigm shift in delivering information technology services to manufacturing industry face some challenges that need to be addressed. According to the study by Givehchi , Trsek & Jasperneite(2013) there are some requirements need to be addressed for more successful usage of cloud computing and adoption in the future such as : cost reduction , adaptability , information integration , relative capability .

Also perceived advantages and organizational readiness are important factors affecting the decision of adoption cloud computing technology, but competitive pressures and trading partner support the main factor were found as directly affected the adoption decision . (Gangwar, Date and Ramaswamy,2015). According to Dillon , Wu & Chang (2010) the security concerns are the main challenges associated with cloud computing

and there are new security challenges have been introduced by cloud computing such as data loose and phishing.

4. Big Data

4.1 Key concepts

The data deluge time started. The term of big data became very popular in almost every industry and sectors of our lives like biological, business and environmental researches.

This concept appeared as a result of the huge amount of that has been produced recently which is never produced before. The international data corporation estimated that from 2005 to 2020 the amount of digital data increase from 130 Exabyte to 40000 Exabyte and from now to 2020 the amount of data on digital world will be doubled every two year (Yin & Kaynak,2015). Because of this explosion in the amount of data the term of big data was coined in order to refer to this new trend. According to National Institute of Standards and Technology(NIST) the big data refers to “Big data is where the data volume, acquisition velocity, or data representation limits the ability to perform effective analysis using traditional relational approaches or requires the use of significant horizontal scaling for efficient processing.” Also Mckinsey in their report (2011) defined big data as “datasets whose size is beyond the ability of typical database software tools to capture, store, manage, and analyze ”.

4.2 Big data in the context of industry 4.0

Big data consider as one of the basic technological advancements that will transform the industrial production. Big data has been recently adopted by manufacturing organizations and it led to great optimizations in the quality of production, reducing the cost by saving the energy and enhance the equipment’s services. Collecting and evaluating huge data from many sources like production systems will support the efficiency of the decision making process (Jacques, Chui & Manyika, 2011). According to Santos et al. (2012) the big data which flow from different sources like machine controller and sensors in the manufacturing systems has great opportunities for sustainable innovation in factories, but there are also many challenges facing big data exploitation such as collection , integration , storage and analysis and how to integrate all entities and needed data of the manufacturing systems.

Big data as a new concept in the cyber-physical system still confront with many challenges which needed to addressed to get the advantages of big data , these challenges can be classified into two groups (HU et al.2014):

1. Technical challenges like data representation, redundancy reduction, data life-cycle management and privacy security issues

2. Challenges that are related to large-scale parallel system like energy management (energy consumption is very high in large-scale data processing) scalability (the ability to support large data now and in the future) collaboration (big data analysis requires experts from multiple fields to be working together).

5.Conclusions

The era fourth industrial revolution started and it will transform the manufacturing systems by many advanced technologies. In this review paper we discussed cloud computing and big data as a basic elements in industry 4.0 provided a great opportunities to the production systems in manufacturing industry. Some challenges face these technologies need to be addressed.

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