Application possibilities of the Big Data concept in Industry 4.0

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Abstract. Nowadays the flexibility and specific cost of manufacturing have a relevant role in the competitiveness of the companies. In our opinion, the most important objective of Industry 4.0 is the realization of intermittent manufacturing at mass production’s productivity and specific cost. This aim can be only reached by creating more complex manufacturing systems. We can collect new types of data that enable the improvement of product and process service quality. Due to the big amount of collected data’s is essential to have an application possibilities of the Big Data to be able to evaluate and transform the data’s in usable information. This paper introduces the essence of Industry 4.0, as well as the new application possibilities of the Big Data for increasing the efficiency of logistics processes. Possible research directions for overcoming challenges are also presented.

1. Introduction
The satisfaction mode of the unique customer needs (quality, deadline, cost) significantly influences the competitiveness of companies. In production area, the most important objective of Industry 4.0 is the satisfaction of unique customer needs with the specific costs of mass production [1]. Complexity of manufacturing processes significantly increases with expansion of the product types, which requires elaboration of new solutions in the fields of development and quality assurance of processes. This provides several basic research topics [2,3]. This objective can be seen futuristic, but with the continuous improvement of the technology we get closer and closer to the target. The presence of cyber-physical systems and the big data conception have created new possibilities in the improvement of product and service quality [4]. We can collect and process data for the manufacturing processes that has not been gathered so far. We can determine the correlations among data, in order to make several conclusions regarding failure forecast of products, material handling equipment or the technological equipment. In addition, rationalization of production system operation can become more effective. To be able to reach the mentioned efficiency increase, we have to reveal the data types to be recorded and determine the technological consequences for data recording, as well as elaborate possible methods and procedures for evaluation and encroach of the data. This paper introduces the characteristics of the industrial revolutions development and covers the most important tools of the 4th industrial revolution. Afterwards possibilities of the Big Data practices will be presented, also their advantages to be expected.

2. Development of industrial revolutions
Basically, industrial resolutions are related to social, economic and technological changes since the appropriate economic and social environment is necessary for the invention and spread of technologies.
We can define the beginning of the first industrial revolution from the invention of modern steam engine. The biggest novelty of the second industrial revolution was the invention of electricity. Nowadays, cyber-physical systems have been formed as result of the increase in the cohesion of the information technology and automation. This new technology has induced the beginning of a new time period, so called Industry 4 [5, 6]. Figure 1 introduces several important characteristics of the industrial revolutions.

![Figure 1. Development of industrial revoluations [5]](image)

3. Introduction of most important tools in Industry 4.0
Several tools have been appeared in connection to industry 4.0 Their application enables new opportunities for the production and service companies [4, 2]. The section presents an explanation of these tools. Most important tools of the 4th industrial revolution:

- Internet of Things (IoT): The term: „Internet of Things” was used first by Kevin Ashton in 1999 [7]. Several Hungarian expressions were created in the translations, but „dolgok internete” might be the most eligable to point out the concept behind. IoT enables the access of different equipment (car, fire place, safety system, parts, material handling equipment etc.) through the internet/some networks, as well as the communication between tools in certain cases. In the past decades people have recorded the majority of the data can be accessed on the internet, which has significantly limited the type and quantity of available data. To enhance the system efficiency operated by humanity, date recording and manipulation in the operating system are essential based on the collected data.

- Cyber-physical systems [8]: The development of informatics and automation, as well as their increasing cohesion, have enabled the application of cyber-physical systems (if an electronic device contains a control and network connection then we can call this system a cyber-physical system). These systems are able to collect data from their environment by using sensors and act based on the analysis of their situation. Cyber-physical systems are connected through a network, and their significant parts are also connected with each other; because of this we can apply swarm intelligence, which can result in more efficient work.

- Big Data concept [4]: The amount of data in the world approximately doubles every two years, which results in huge amounts of data in the different areas of life (astronomy, logistics, trade, stock exchange, etc.). We can create useful conclusions and new services based on the huge amount of data by analysing data correlations. An example for such a service is a software, which
forecast flight prices based on ticket purchase of a previous time-period and determines the adequate purchase time without letting us know the calculation method behind. Big data’s essence is forecasting, which means operation with huge amount of data by using mathematical methods and procedures to gain probabilities. Big data will significantly change the future in many people’s opinion, because we can make adequate decisions very likely based on the huge amount of data without knowing the causality. Expressions explained above are strongly connected to each other. Therefore, without IoT we cannot speak neither about cyber-physical systems, nor about big data.

4. Most important application fields of Big Data conception

By determining connections between huge amount of data, we can realize advantages in several fields. The most important are listed as following [4].

Astronomy: in 2000, with the start of Sloan Digital Sky Survey program (SDSS), more data were collected during the first few weeks by operating telescope placed in New-Mexico than the amount were aggregated during the entire astronomy history so far. Since 2016, the same amount of data is gained in every fifth day by Large Synoptic Survey Telescope placed in Chile. By elaborating these data, we are able to make more and more precise forecasting regarding changes in our planet environment.

- atmospheric pressure of wheels (influences the duct planning),
- life time of parts (influences the duct planning),
- observation of vibration frequency by determined parts (influences the maintenance planning),
- observation of humidity by determined parts (influences the maintenance planning).

Technological tools: In course of using technological tools, the most important target is to ensure the maximal readiness similarly as in case of material handling tools, and to execute the technological operations on adequate level. Besides that, continuous improvement is expected, which requires continuous improvement of tooling procedures [14, 16], and elaboration of alternative procedures [10, 15]. Big Data conception gives great support to speed up these developments and their physical implementation. Collecting the following data may provide a help to increase efficiency in technological tool operation:

- tyre pressure needed for operation, electricity consumption (influences the ideal operation of a tool),
- environment temperature, humidity (influences the ideal operation of a tool),
- forces to product (influences the product quality),
- forces to the tooling machine [11] (influences the maintenance planning),
- life time of technological tool parts (influences the maintenance planning),
- vibration frequency of determined parts (influences the maintenance planning),
- observation of humidity in case of determined parts (influences the maintenance planning).

Human resources: In case of human resource application, important target is to ensure the maximal readiness and the work according to standards. Supporting this, the following information might be helpful:

- environment temperature, humidity, brilliancy (influences the efficiency of work),
- speed, acceleration, pulse number of movement (influences the efficiency of work),
- data related to the specific work (standard keeping can be supervised).

Collecting so far unknown data makes necessary to introduce new data collecting tool and online data transferring tools. These tools shall be fixed on raw material or their direct carriers. Expectation for data collecting tools [3]:

- recording method does not influence raw material quality,
- damage resistance,
• recycling,
• capability for continuous data transmission,
• insurance of possibility for far distance data transmission,
• availability of in-built carries.

By applying Big Data conception, development of following important services will be possible:

• Product failure prognosis system: By collecting of technological and product data and by determining the relations among data, product failures can be forecasted with a greater probability.
• Technological tool failure prognosis system: The failures can be or casted on a greater probability by collecting different data of technological tools (e.g. temperature, vibration, pressure etc.), and by finding relations between data and failure incidents
• Material handling tool failure prognosis system: The material handling tool failures can be forecasted by collecting different data of material handling tools (e.g. pressure, level of battery charge, vibration data etc., and finding relations between data and failures.
• Application to provide prognosis for stock level in inventory: Impact of demand changes on stock level can be forecasted by collecting data regarding costumer needs and stock level and by finding relations among them.
• Application to support encroaching in logistics processes: We have the possibility to reorganize logistics processes in time based on failure prognosis of product, technological and material handling tool, which results to loss reduction.

Several production and logistics tasks need to be solved smoothly from the beginning till the end of the production process to make the costumers satisfied with the specific product or service provided [12]. Thanks to artificial intelligence, these processes can be even more faster and precise. We can define artificial intelligence as intelligence presented by a machine, program or artificial conscience. common future of Big Data, production and logistics is artificial intelligence, to be more exact the computer/machine learning, which influences automatization and the evaluation process quality. More and more companies see the potential in this technology. Thanks to self-learning algorithm, computers can analyses data on their own, and they are able to tailor-cut models based on changing phenomenon’s and requirements.

5. Summary
The paper has given an overview about the development of fourth industrial revolution, its important tools and challenges. Science fields have been presented, where application of Big Data conception has especially significant role (e.g. astronomy, finance, logistics etc.). It can be stated that we can make remarkable steps in the planning and real production processes to forecast and avoid failures by collecting data which were not collected at all before or just in a limited amount and by determining relations among them with the help of mathematical and statistical methods. Efficiency of earlier applied process optimization algorithm can increase significantly by forecasting the future status more precisely, also new possibilities will arise regarding running supply chain optimization.

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