Chapter 18
Data Analytics in Industry 4.0:
In the Perspective of Big Data

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ABSTRACT

The new form of future generation machines and automated systems could be synchronized by IoT adaptation. By this way, a very large size data can be carefully stored in data repositories and have to be analyzed for extracting knowledge. Thus, optimization techniques are becoming invaluable tools for finding patterns from parallel distributed machines. On the other hand, statistical methods and optimization models could not be utilized efficiently due to excessive dimension of data. Additionally, data analytics should be applied and results should be gathered by using practical approaches especially for security, access control and fault detection issues. In this study, optimization techniques are evaluated in the perspective of big data analytics and both mathematical and statistical methods will be extensively analyzed for different versions of problem solving and decision making in Industry 4.0 era.

INTRODUCTION

Manufacturing management paradigms have been increasingly applied all over the world because of the global competition of trade organizations and rapid changes in technology. In recent years, thanks to the communication improvements, customers have become more conscious about purchasing goods or services. Naturally, customer requirements are changing day by day, increasingly high expectations of customers are appeared - and these changes force companies to be speedier to satisfy customer orders with more qualified products in acceptable prices. Furthermore, organizations have to be customer oriented and more flexible against the dynamism of manufacturing environment which increases uncertainties in critical parameters. Besides flexibility, this customer oriented attitude helps organizations to have a better chance of making more profit but also brings pressure to take risks such as inventory shortages,

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decreasing demand, late shipments, quality loses etc. Within this context, manufacturing management applications are sought after following dramatic losses by some world re-known companies. Many organizations try to cope with this continuously changing environment only with decision making tools such as ERP, CRM etc. Generally, these tools are not sufficient enough for detecting faults and making adjustments according to these new realities. In this context, Industry 4.0 was first declared by German government in terms of interaction between intelligent and communicative machines that enable self-organizing and centralized structure for sustainable manufacturing.

The transformation process from steam engine to Industry 4.0 is realized by the improvements in both information technology and industry. The first conversion was the mechanical production as seen from textile looms. Second transformation occurred in assembly lines in terms of division of labor and mass production. At the end of 1970s, automation and industrial robots were introduced and finally, cyber-physical systems, which are the combination of digital and physical systems, and digitalization of industry has emerged using smart machines in production processes.

The improvements in information technology also provide the infrastructure of Industry 4.0. The initial development is in the management of essential business processes such as financial analysis, order placement and production planning via digital platforms. The progress is continuing as the increasing usage of Internet and penetration of personal computers in daily life. The final complement in the digitalization is the integration of products with digital systems such as the adaptation of digital sensors, software and wireless devices. With these revolutionary changes, new business models are emerged in order to maintain the fierce competition and value creation.

In this study, we focused on explaining advantageous properties and critical issues of Industry 4.0 in the context of manufacturing environment. Furthermore, opportunities and threats are defined from the operational perspective. The evaluation of intelligent cross linked machines (Cyber- Physical Systems), end-to-end engineering (product development) and digitalized control systems are analyzed. Finally, some of the business models, value creation networks and changes that should be adapted to organizations and sectors are briefly explained.

The rest of the paper is organized as follows: a literature review of Industry 4.0 is presented in background section. Optimization techniques for data analytics are explained with respect to business need and methodology. Additionally, big data and fuzzy techniques are interpreted for the extraction of valuable solutions. Finally, conclusions and recommendations are provided in the last section.

BACKGROUND

The main idea of Industry 4.0 is first declared by Kagermann in 2011 and supported by German National Academy of Science and Engineering in 2013. The context of Industry 4.0 was introduced by Industrial Internet Consortium (ICC) and wide range of applications could be found in Bosch, Siemens, Apple etc. (Stock and Seliger, 2016). The main idea of Industry 4.0 is the installation of smart products and smart services with smart factories using Internet of Things, Cyber-Physical Systems in order to provide communication of each objects and decentralized systems. (Weyer et al., 2015) The four design principles are listed as follows:

Interoperability: The connection and communication of machines, devices, sensors, and people using Internet of Things (IoT) or Internet of People (IoP).