

## IMPACTS OF INDUSTRY 4.0 ON LOGISTICS SECTOR: A THEROTICAL RESEARCH MODEL PROPOSAL

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### **Abstract**

*The last industrial revolution, so called Industry 4.0, has started to affect manufacturing industries and expected to shape entire supply chain in the following years. Not only manufacturing organizations but also different service sectors need to alter their processes in order to remain their competitive advantage. Briefly, Industry 4.0 is based on using advanced technologies including Cyber Physical Systems, Internet of Things, Cloud Computing, Big Data etc. in horizontally and vertically integrated supply chains. As a significant part of the industries, logistics sector also needs to adapt to the new changes. To avoid inaccuracies and human to have repetitive tasks, and have rapid process by using technological applications, it is expected that job profiles, technology utilization and processes will be altered in the logistics sector. However, to the best of our knowledge, there is little or no research which focuses on solely to the impacts of Industry 4.0 on job profiles, processes and technology in logistics sector. This study is a primary attempt to investigate impacts of Industry 4.0 on job profiles, logistics processes and technology usage. To do so, in this study, a theoretical research model is presented for future investigation and related literature is discussed in detail for strengthening theoretical background. This study can be seen as the first part of the research, and model is planned to be tested by a survey implementation in the following research.*

**Key Words:** Industry 4.0; Logistics Sector; Theoretical Model

### **1. Introduction**

In world history, there are some requirements for all people to maintain their conditions and lives. Especially for industrial view, with the help of new inventions, significant changes are shown up throughout the centuries. Chronologically, the invention of water and steam powered machines at the end of 18th century, using of electrical powered production lines in 1870's, and about 100 years later, transformation of manufacturing system from mechanic to automation are the examples of these breakthrough changes called as "industrial revolution".

Technology is one the most popular actor in worldwide and it has steady importance for everyone and have an indispensable position to industries. This raising attention also causes some radical changes for many businesses from SME's to large factories to meet a current requirement. For this reason, fourth industrial revolution breaks a new ground.

Industry 4.0 is a submission for development of a new concept about high technological manufacturing strategies of German Economic Policies and firstly used at Hannover Fair in 2011 (Ermolaeva, 2017). They announced it to clarify their integrated industry idea as part of high-tech strategy with holding popular terms like digitalization, internet of things (IoT), internet of services (IoS) and cyber physical systems (CPS) (Hofmann and Rüşch, 2017). This concept is a paradigm shift that encapsulates transformation of traditional process via the internet and thus more flexible value networks start to supplant rigid value chains (Kagermann et al, 2016).

Industry 4.0 is expected to change not only industrial environment but also all the related sectors including service, and logistics. Logistics sector has a significant role in the entire supply chain of the industrial processes, therefore, altering needs in industrial environment directly affect the logistics sector. From this point of view, this paper aims to reveal impacts of Industry 4.0 on logistics sector by considering logistics processes, job profiles and technologies. In the first part

of study, literature review is conducted and briefly attempt to identify some general terms and definitions about Industry and Logistics 4.0. Afterwards, proposed models are discussed, results and further researches are summarized in ongoing parts.

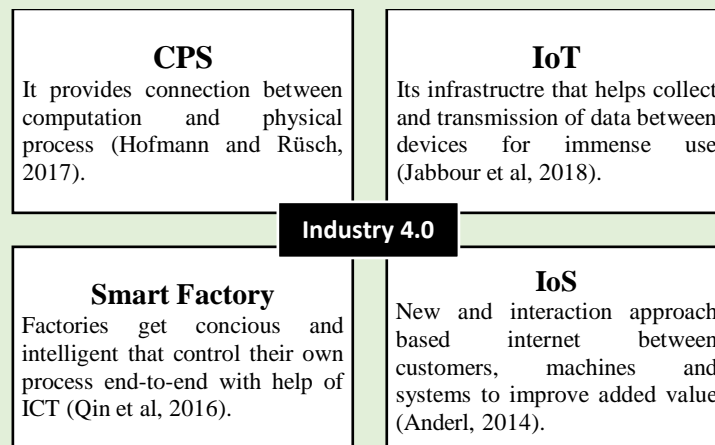
## 2. Literature Review

Literature review in this study is divided into two sections. Firstly, Industry 4.0 related literature is summarized briefly. After that, studies related to the main focus of this study, logistics sector and Industry are discussed.

### 2.1. Industry 4.0

The term, Industry 4.0, started to be a phenomenon for many people and organizations including academician, experts, managers, research centres, universities and firms. However, for a clear majority of them, the new industrial revolution is still a complicated station and it should be clarified with the ins and outs (Ghobakhloo, 2018). According to Kamble et al (2018), Industry 4.0 is a reform that changed manufacturing system with adaptation of new technologies to access maximum output with minimum resource. More general, Industry 4.0 is a new step for value chain organizations, and managements with the integration of complex physical machines and internet software/sensor devices to provide prediction, planning and controlling of better business outcomes (Lu, 2017). Its main idea can be summarized as management of business by digitalization to provide real time market and operational information between firms' machinery, supply chain system, production processes and customers (Ardito et al, 2018).

According to the comprehensive literature review, which was conducted by Hermann et al. (2015), four key elements of Industry 4.0 are; Cyber-Physical Systems (CPS), Internet of Things (IoT), Internet of Services (IoS) and Smart Factory. In addition, Machine to Machine (M2M) communication, Smart Products, Big Data, Cloud Computing and Data Services are also considered as subcomponents of these elements (Hermann et al, 2015). These elements are summarized at Figure 1.



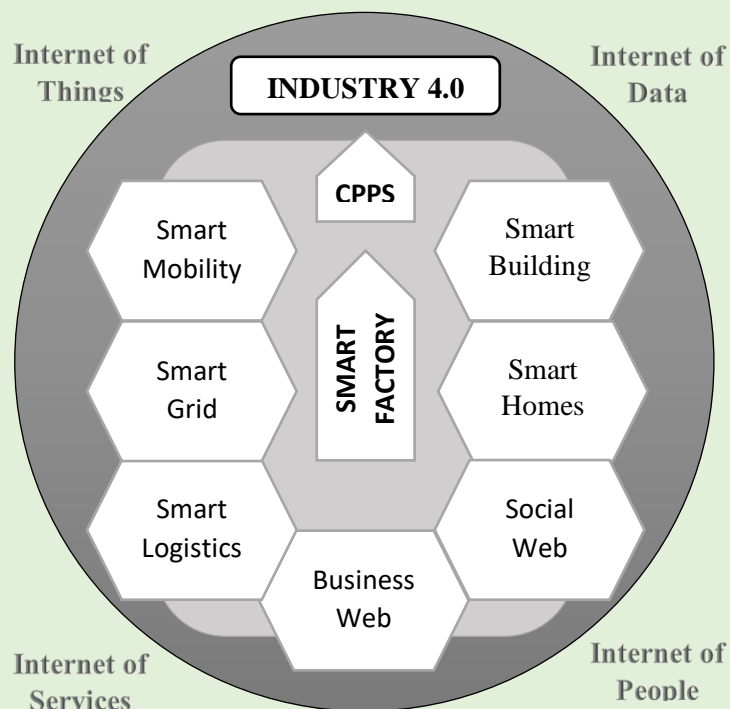
**Figure 1.** Key Elements of Industry 4.0

In addition to these key elements, Pfohl et al (2015) focused on characteristic features of Industry 4.0 and summarized them at the end of comprehensive literature review as; digitalization, automation, transparency, mobility, modularization, network-collaboration and socialization, flexibility, degree of integration, decentral controlling and real time availability.

Furthermore, from the view point of firms and organizations, there are some key features that firms must implement for Industry 4.0, are summarized as following (Oesterreich and Teuteberg, 2016);

- Horizontal integration of information and communication systems (ICT) through value networks from supplier to customers,
- Overall digital integration for all value chain for to succeed simplifying highly customized products with minimum internal operation costs,
- Vertical integration in smart production environment with all process and departments.

In general, with the view of Industry 4.0 environment, according to Deloitte report (Schlöpfer et al, 2015), the importance of Industry 4.0 starts with smart infrastructures including mobility, grid, logistics, homes and buildings, and business / social networks connections. These elements have a great importance for digital transformation under the influence of IoT, IoS, Internet of people and data. In Figure 2, Industry 4.0 environment is summarized.



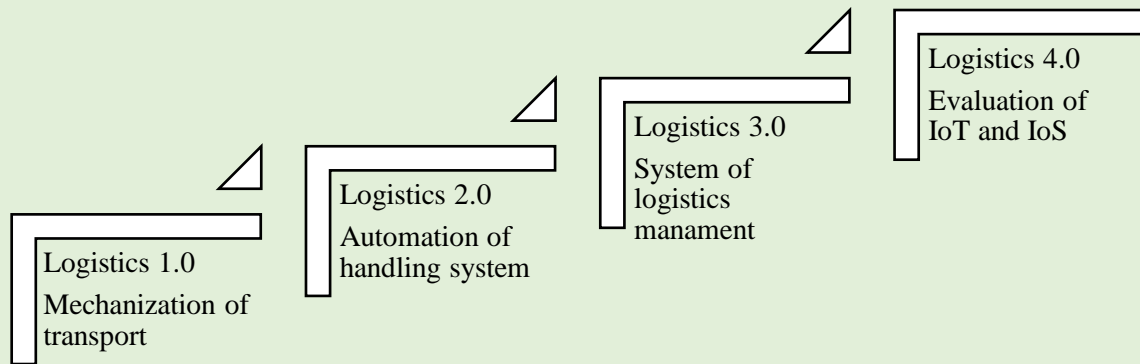
**Figure 2.** Industry 4.0 Environment (Modified from: Schlöpfer et al, 2015)

Thus, Industry 4.0 paradigm is not limited to just manufacturing, and it is related to many dependent and supporting sectors that are the actors of supply chain organization like logistics. This study solely focused on logistics sector in industry 4.0 environment. Hence, in the following section, literature related to logistics sector in Industry 4.0 is discussed.

### **2.2. Industry 4.0 and Logistics Sector: Logistics 4.0**

As explained in the previous section, Industry 4.0 not only affects production environment but also affects all the processes and services related to the industry. As one of a key element of industrial and service activities, logistics sector also need to alter according to the new industrial revolutions' technological developments. On the other hand, current literature is still lacks in knowledge in terms of investigating logistics sector under the light of Industry 4.0 technologies.

Evaluation of logistics sector was summarized by Galindo (2016) in line with industrial revolutions and modified in this study as Figure 3. The key word for the first stage of logistics sector evaluation is the mechanization of transport since this stage represents the move from manual tools and animal force to railway networks and steamer/aircraft shifts. The second stage, logistics 2.0 was the beginning of using logistics equipment e.g. automatic warehouses, mechanization of port cargo, automatic sorting etc. The third wave of the logistics sector evaluation was shaped by numerically controlled machines and industrial robots. Therefore, key statement of logistics 3.0 can be systems of logistics management. Finally, the current stage in the timeline of evaluation of logistics sector is highly affected by Industry 4.0 and it is mostly based on evaluation of IoT and IoS technologies. The term Logistics 4.0 was defined by Baretto et al. (2017) as the integration of logistics with CPS based innovations and technologies.



**Figure 3.** Evaluation of Logistics Sector (Modified from: Galindo, 2016)

In order to deal with Industry 4.0 challenges in terms of transformation to advanced technologies e.g. IT communication, use of big data, IoT, automation and robotics, digitalization, CPS; logistics sector needs to be altered in terms of job profiles, processes and used technologies. It is expected that this alterations would have both positive and negative impacts. While higher standardization, lower manual workforce, more transparent processes, and better communication are the potential positive impacts of logistics 4.0; need for higher investments, infrastructure costs and adaptation costs can be seen as the challenges of logistics 4.0 (Szymańska et al, 2017).

Moreover, according to Baretto et al. (2017), technological applications including warehouse managements systems, transportation management systems, intelligent transportation systems, resource planning and information security are obligation for efficient logistics 4.0 applications. In addition, logistics sector is expected to benefit from one of the most important technology that helps to shape Industry 4.0, IoT (Diwan, 2016).

Hoffman and Rüşch (2017) suggested that logistics processes in Industry 4.0 have two main dimensions, which are physical supply chain dimension and digital value chain dimension. Physical supply chain dimension refers to the autonomous and self-controlled logistics systems, on the other hand digital sata value chain dimension collection of data from physical tools in the entire supply chain and used for any kind of analytics.

There are other studies that are focused on to logistics sector in industry 4.0, i.e. logistics 4.0. For instance Horenberg (2017) investigated the effects of Industry 4.0 applications on third party logistics (3PL) providers and suggested that freight brokerage trends enabled by electronic marketplace platforms, 3D Printing in Nearshoring and production processes, used of truck platooning and drones for transportation efficiencies, warehousing and distribution operations due to autonomous vehicles and robots, and the Blockchain technology for safe and trustful sharing of information are some of the key technologies that 3PL providers may use in Industry 4.0 environment. Moreover, Timm and Lorig (2015) focused on simulation practices in logistics 4.0.

On the other hand, Maslarić et al. (2016) investigated the physical internet utilization in logistics processes in Industry 4.0. Similarly, Lee et al. (2017) proposed an IoT based warehouse management system for smart logistics in industry 4.0. Summary of the literature review related to logistics in Industry 4.0 by including method, aim, and findings are presented in Table 1.

**Table 1.** Summary of the Literature Review for Logistics 4.0

<b>Author(s)</b>	<b>Method</b>	<b>Aim/Focus</b>	<b>Findings/Results</b>
Timm and Lorig (2015)	Overview	Simulating decision makers and logistics processes in industry 4.0 context	Two different approaches were analysed. The first one was based on modifying and extending existing components of material flow simulation Platforms, the second one was based on sophisticated decision-making. Both approaches were found feasible at the end of the study.
Diwan, 2016	Case Study	Internet of Things (IoT) applications in logistics sector	A case was presented where IoT is used for tracking pallets and containers in a collaborative supply chain
Maslarić et al. (2016)	Review	Connection between physical internet, industry 4.0 and logistics	New logistics paradigm including physical internet, is proposed for supporting industry 4.0 as a practical solution
Baretto et al. (2017)	Overview	Presenting requirements for efficient Logistics 4.0 operations.	Resource Planning, Warehouse Management Systems, Transportation Management Systems, Intelligent Transportation Systems and Information Security are presented as key technologies in Logistics 4.0
Hofmann and Rüsçh (2017)	Conceptual research approach	Discussing opportunities of Industry 4.0 for logistics management	Potential Industry 4.0 implications in the context of Just-in-Time/Just-in-Sequence and cross-company Kanban systems were demonstrated

Horenberg (2017)	Semi-structured individual depth interview and complementary secondary research	Examination of Industry 4.0 applications in third party logistics providers	New fields including; nearshoring through 3D printing applications; freight brokerage trends enabled by electronic marketplace platforms; warehousing and distribution operations due to autonomous vehicles and robots; transportation efficiencies due to truck platooning and drones;; and safe and open information sharing technologies are identified for 3PL firms in industry 4.0 adaptation.
Lee et al. (2017)	Case Study and Fuzzy logic technique	Proposing an IoT based warehouse management system for smart logistics in industry 4.0	In terms of tangible and intangible benefits, proposed warehouse management system can help to provide a better performance.
Szymańska et al. (2017)	Systematic literature review	Investigating if the logistics 4.0 is a new paradigm or set of known technological solutions	Logistics 4.0 is not a new paradigm in management science.

In the following section, proposed research model is presented by including potential changes in logistics sector in terms of job profiles, processes and technologies in Industry 4.0.

### 3. Proposed Model and Further Studies

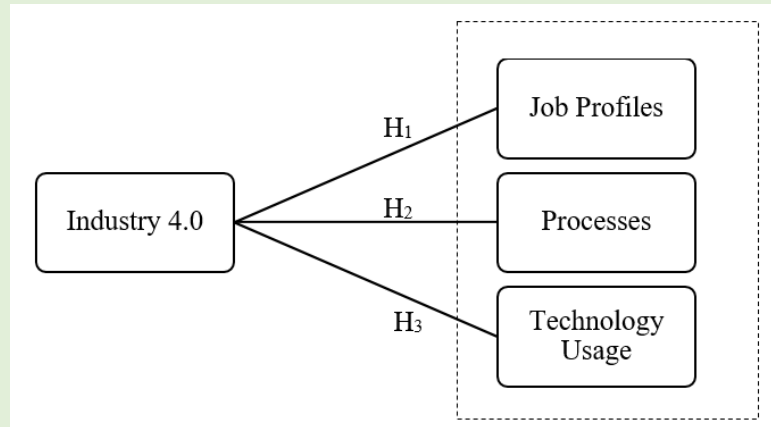
This study seeks to investigate potential effects of Industry 4.0 on logistics sector. To do so, three dimensions of logistics sector i.e. job profiles, processes, and technology usage are going to be discussed.

Logistics sector has a critical role in economy, therefore, skilled workforce is essential, and challenges due to continuous changes should be considered in planning well trained workforce (Thai et al., 2010). Increase in complexity in supply chains leads the importance of well-trained employees and adaptation pace to changes are important specialities. Job profiles are started to alter due to Industry 4.0 transformation, where repetitive and dangerous tasks are conducted by machines, and humans play a more organizing role in the processes.

Moreover, logistics processes and technologies are directly integrated to each other. Therefore, altering in technologies affect the way of implementation of processes. As it was mentioned in the previous section, core elements of logistics processes including warehouse management, transportation, distribution, marketing, and planning are expected to be changed due to technologies such as CPS, IoT, autonomous vehicles, electronic marketplace platforms.

Although there are some general predictions about how Industry 4.0 will affect logistics sector, and also it is started to affect in some parts, to the best of our knowledge none of the studies focused on job profiles, processes and technology utilization separately. To fulfil the gap in this area, proposed research model is structured in this study as presented in Figure 4. Aim of the

proposed research model is to investigate potential effects of Industry 4.0 on job profiles, processes and technology usage in logistics sector.



**Figure 4.** Proposed Research Model

With regards to proposed research model, three hypothesis are structured as follows:

- H<sub>1</sub>: Industry 4.0 has impacts on job profiles in logistic sector.
- H<sub>2</sub>: Industry 4.0 has impacts on processes in logistic sector.
- H<sub>3</sub>: Industry 4.0 has impacts on technology usage in logistics sector.

In order to test these hypotheses, authors are planning to conduct a survey on white collar employees who are currently working in logistics sector. After this study, it is expected to contribute the literature related to logistics sector in Industry 4.0 by focusing on job profiles, processes and technology usage separately.

#### **4. Conclusion**

To sum up, new industrial revolution has impacts, not only on industrial environment, but also on all other supporting sector. As one of the key sector that has a significant role in the entire supply chain stages, logistics sector, needs to alter its processes in order to adapt the Industry 4.0. Thus, both individual and corporate view, they have to gain awareness and knowledge about Industry 4.0 and its requirements and implementations. To do this, every stakeholder in industry from managers to experts/academicians have to do their part. Therefore, academic studies have also significant part to deal with these challenge.

So far, studies related to logistics sector in Industry 4.0 are limited but increasing day by day. Especially, adapting key technologies of Industry 4.0 into logistics processes is a popular topic in the literature. However, broad investigation in logistics sector by covering human, process and technology factors is missing.

This study can be seen as the priory attempt to investigate effects of Industry 4.0 on job profiles in logistics sector, processes in logistics sector, and technology usage in logistics sector. For this investigation, a theoretical research model and hypothesis are presented to test in the future studies.

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