Industry 4.0: German logistics service provider's perspective

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Abstract:
Industry 4.0 is the application of Cyber-Physical Systems in the domain of manufacturing/production. The purpose of this paper is to investigate how German logistics service providers perceive and implement the concept of *Industry 4.0*. Primary data from the German logistics service providers were collected following an online questionnaire survey to understand the challenges and opportunities associated with the implementation of the concept in practice. Multiple regression analysis based on 57 responses attempts to define the characteristics of *Industry 4.0* from practitioner's perspective. Diverse characteristics of *Industry 4.0* were identified, including Internet of Things, Data exchange, Automation, Digitalisation, Big Data, IT Facilities and Cybersecurity. The research seeks to contribute to the Industry 4.0 literature by understanding the gap between theory and practice.

Keywords: *Industry 4.0*, Digitalization, Logistics, Operational improvement

1. Introduction

Globalisation and the associated rise in the outsourcing demands growth in transportation infrastructure while searching for new resources of competitiveness (Viana et al., 2014). Recently, *Industry 4.0* has shown potential in achieving specific benefits for logistics and supply chain management. Bill Rush, the chief digital officer for General Electric, US, said that "*Industry 4.0 is a huge opportunity for all industrial companies*" and "*Data analytics and machine connectivity are the way to get to the next level of productivity*" (Crooks, 2017). Recent studies focus on the role of *Industry 4.0* in fast-changing and competitive business environment, where companies are facing challenges (Lee et al., 2014).

The research seeks to contribute to the *Industry 4.0* literature by classifying how German logistics service providers understand and apply the concept of *Industry 4.0* in practice, and compare it with the theoretical concept, to identify gaps and overlaps between these two viewpoints. The of the study aims to investigate how German logistics service providers understand and implement the theoretical concept of *Industry 4.0*.

2. The concept of Industry 4.0

Industry 4.0 describes the fourth industrial revolution but how is an industrial revolution defined? First, industry represents the part of an economy that produces material goods, which are highly automatized and mechanised. With the beginning of industrialisation, technological leaps have led to the paradigm shift, which we call it as industrial revolution

(Lasi et al., 2014; Zezulka et al., 2016). The first revolution was at the end of the 18th century and was the introduction of water- and steam-powered mechanical manufacturing. The second one started at the end of the 20th century, and the mass production was born due to electricity. The next era was the beginning of automation due to the advent of computers. Robots and machines replaced humans to increase productivity (Marr, 2016). Looking at the keywords such as-mechanisation, electrification and information of the past centuries and compare them, based on the circumstances nowadays, it seems like digitalisation will be the keyword of this century. With buzzwords like smartphones, smart TVs, laptops and even 3D-printers, digitalisation has an integral part of our daily private and business life. In 2011 a proposal for the development of a new concept of German economic policy, based on high-tech strategies, mentioned the phenomenon of *Industry 4.0* for the first time in Germany (Mosconi, 2015).

Industry 4.0 revolution covers the evolution of global networks, which includes storage and product facilities in the form of Cyber-Physical Systems (CPS), which communicates, generates, and controls themselves independently (Maslarić et al., 2016). A new transformation of global networks, which uses digitisation to make all data available and ready to use for communication between human and robots all the time is defined as *Industry 4.0* (Roblek et al., 2016). Real-time data about weather, traffic or track and trace data help to execute decisions and generate competitive advantage (Gorter, 2017). Machines communicate and share their status with each other, they interact with the commercial planning system and make use of Internet of Things (IoT) and the cloud in *Industry 4.0*. This new concept is all around us, surrounded by IOT, system integration, autonomous robots, simulation, additive manufacturing, cloud computing, augmented reality, big data, and cybersecurity (Menawat, 2016). The German Federal Ministry for Economic Affairs and Energy describes *Industry 4.0* with characteristics like IT facilities, data exchange in real time, the IOT, autonomous processes, robots, standardisation, and digitalisation to enable the benefits (Federal Ministry for Economic Affairs and Energy, 2017).

Secondary data from leading German logistics companies and associations such as BVL, Bearing point, Industry 4.0 summit, Menawat and Federal Ministry for Economic Affairs and Energy were utilised to understand characteristics of *Industry 4.0*. Figure 1 shows the identified fifteen attributes for the *Industry 4.0*.

Characteristics/ Source	BVL	BearingPoint	Industry 4.0 summit	Menawat	Federal Ministry for Economic Affairs and Energy
IT facilities	X	X			X
Data exchange	X	X	X	X	X
Real time data	X				X
Internet of Things	X	X	X	X	X
Autonomous processes	X	X	X	X	X
Standardization	X	X			X
Digitalization		X	X	X	X
Supply Chain Management	X	X			
Simulation			X	X	X
Additive manufacturing			X	X	
Cloud computing			X	X	
Augmented reality			X	X	
Big data			X	X	
Cybersecurity			X	X	X
System integration				X	

Table 1- Identified Industry 4.0 characteristics

The digitalisation of logistics processes leads to '*logistics transformation*' or the creation of '*smart logistics*' solutions (Spekman & Sweeney, 2006). Furthermore, the integration of cyber-physical-systems in logistics and manufacturing is necessary for the production process (Gilchrist, 2016). The logistics sector can benefit significantly from the Big Data and the IoT, as service providers in Logistics already handle a massive flow of goods and data on a daily basis. By making successful use of the data and IOT, untapped potential for improving processes and resources can be realised (Kubáč, 2016). Besides that, *Industry 4.0* could dramatically improve the health and safety of human workers in hazardous working environments. With data available at every level of the manufacturing and delivery process, supply chains could be readily controlled for better performance (Marr, 2016). The absence of a unified protocol for IoT and Big Data is the most significant challenge for *Industry 4.0*. Only when all devices are compatible and connected with each other, this system can work and show their real potential. However, the risk of data leakage scares several companies, and due to that, they rely on unconnected or closed systems (Rüßmann et al., 2015).

The advancement in the digitalisation within manufacturing and electronic data interchange linking supply chains has led to the emergence of *Industry 4.0* (Roblek et al., 2016). It is critical to understand the role of *Industry 4.0* in today's fast-changing and competitive business environment; where companies are facing challenges in dealing with big data and rapid decision making for the improved productivity (Theorin et al., 2017). Academic literature shows that the *Industry 4.0* has remained as a cost-driven initiative and there is limited evidence of real business model transformations (Moeuf et al., 2017). "By 2020, companies will be spending about €250bn a year on the internet of things, with half of all that spending coming from the manufacturing, transport and utility industries, according to the Boston Consulting Group." (Crooks, 2017) This prediction shows and confirms that *Industry 4.0* will play an essential role in the future.

3. Research Approach

The study attempts to understand the viewpoint of German logistics service providers regarding *Industry 4.0* following a deductive approach. An online questionnaire was developed based on 15 identified characteristics of *Industry 4.0*. The survey gathered 61 responses, of which 57 were fully completed and later used for the data analysis. To assess the strength of a relationship between dependent and independent variables, multiple correlations and regression analysis was conducted using SPSS software.

4. Data Analysis

Responses from the questionnaire survey were analysed to understand the perception of German Logistics service providers and what characteristics do they strongly associate with the concept of *Industry 4.0*. Respondents were asked to rank these characteristics based on their understanding, and average scores were calculated. The *Industry 4.0* characteristics such as automation, digitalisation, IOT and big data, received highest mentions. The characteristic with the highest average score was Data exchange with a score of 5.32, and with a distribution of 20 answers (45.5%) for the highest opportunity. A similar survey conducted by Price Waterhouse Coopers (PwC) on nine major industrial sectors showed that 83 % expect data to have a substantial influence on their decision-making in the next five years (Columbus, 2016).

Digitalisation was the second most critical characteristic with a score of 5.23 on average. Digitalisation is followed by IT facilities with a close score of 5.05. The investment in support for enterprise-wide integration and greater digitisation is predicted to increase 118 % by 2020. On the fourth place was autonomous processes with a mean ranking of 5.0;

followed by Cybersecurity with a score of 4.73 on average. Second from the bottom is the IOT with 4.55 points on average. At the bottom of the ranking was the *simulation* with an average score of 2.93, which indicated the lowest importance for the respondents. It was observed that the participants have a different understanding regarding this concept.

Multiple regression analysis was conducted to comprehend the perception of logistics service providers. Table 1 shows the mean score for each characteristic separated by the age of the participants. Both younger age groups (26-35 and 36-45) were below the mean, and the two older groups (45-55 and 56+) were mostly above the average in ranking the characteristics.

	Internet of Things	Data exchange	Autonmous processes	Digitalization	IT Facilities	Cyber Security	Simulation
Age 26-35 (avg score)	4	5.28	5.14	5.14	5.29	4.43	3.15
Age 36-45 (avg score)	4.85	5.28	5	4.86	4.43	4.43	2.14
Age 46-55 (avg score)	4.67	5.5	5	5.67	5.17	5	2.83
Age 56+ (avg score)	4.75	5.25	4.5	5.5	6	5.75	5.25
Overall avg Score	**4.55**	**5.32**	**5**	**5.23**	**5.05**	**4.73**	**2.93**

Table 1- Average Score of characteristics by age

Multiple regression analysis shown in Table 2 examined the ranking related to the current position held by the respondents in the logistics sector.

	Internet of Things	Data exchange	Autonmous processes	Digitalization	IT Facilities	Cyber Security	Simulation
CEO	4.5	5	5.5	5	5.5	5	1.5
Managing director	5	5.5	5.25	5.25	4.87	4.75	3
Management level	4.33	4.33	5	5.66	5	4.33	3.33
Department head or team leader	4.25	5.5	4.63	4.88	5.25	4.63	3
Employee without managerial responsibility	4	6	5	6	5	5	4
Overall avg Score	**4.55**	**5.32**	**5**	**5.23**	**5.05**	**4.73**	**2.93**

Table 2- Average Score of characteristics by current position in Logistics sector

Analysing understanding of the diverse characteristics, most of the participants relate different characteristics to the concept of *Industry 4.0*, and there is no precise and widespread definition. Attributes such as the internet, data exchange, automation, digitalisation, big data, SCM, IT facilities, Internet of Things, and Cybersecurity were reoccurring. The multiple regression analysis shows that the younger (26-45 years) participants and the ones with a lower educational qualification (apprenticeship or university entrance diploma) rank the diverse characteristics lower than the average, while the two older age groups and participants with a bachelor or master degree rate the importance higher in general. Unfortunately, the ranking of characteristics by different age groups and positions did not provide any clear trend, and there was no substantial diversity in the ranking of relevance.

The distribution of the current position in the company of the participants was captured. Most of the respondents are currently a managing director (36.4%), work on management level (18.2%) or act as a department head or team leader (31.8%). Two participants are currently a CEO of a company, and just one participant is an employee without managerial responsibility. Based on that distribution the responsibility of the participants in their business and their impact can be described as high and influential.

Out of the 57 participants, just 15 apply the concept of *Industry 4.0* in their company already. Reasons for implementing the concepts revolved around *to be competitive*, *to prepare for the future* and *Globalisation*. *Preparing for the future* can be interpreted similarly *to be competitive* because every company aims to be competitive in the current volatile global environment. *Globalisation* was only mentioned by five respondents but is found to be a relevant factor. On the other hand, 20 respondents do not apply *Industry 4.0* right now. Varying reasons were provided for not implementing the concept of *Industry 4.0*. Common reasons were *not necessary for the firm, too costly to implement, not familiar with the concept or firm too small*.

Participants were asked to provide details regarding how they apply Industry 4.0 in their organisations. The implementation and application of the concept of *Industry 4.0* are described as highly important and necessary in the future to be competitive. The implementation includes a wide range of factors like information, communication, production, connected world, and integration. Furthermore, the participants apply it in connection with different software packages, which aims to spread information and improve communication. Other fields of application are the supply chain management, lead times, JIT/JIS deliveries or stock information, which all supports the production, and also information and communication. Also, the participants apply *Industry 4.0* to secure connection between all processes and make use of big data. Key elements discussing, where and how they apply the concept of *Industry 4.0* were identified. The participants apply *Industry 4.0* mainly in combination with diverse software packages, the Supply chain management, lead times, stock information, JIT/JIS deliveries, big data, and the connection between all processes.

The comparison of the theoretical concept of *Industry 4.0* and the practical application shows that there are some overlaps and gaps between these two. The viewpoint of the practitioner's overlaps with the abstract definition of the importance of IT facilities, data exchange, IOT, autonomous processes, and digitalisation. These characteristics are most of the participants aware, and they evaluate them as necessary. The two-other characteristic (simulation and cybersecurity) can be defined as a gap due to the low amount of mentions from the participants. Reasons for that can be the implicitness of it, at least for cybersecurity, because every company wants to have their data in a safe environment.

In addition to the previous findings, to identify the opinion of the participants regarding the near future. 86,36% respondents believed that the *Industry 4.0* would play a major role in the logistics industry, while, remaining participants were not sure about the future and did not believe it will affect their firms or the industry today or in future.

5. Discussion and Conclusion

The purpose of this study was to investigate how German logistics service providers understand and implement the theoretical concept of *Industry 4.0*. Following the secondary data collection from leading Logistics organisations/associations in Germany, fifteen characteristics were identified for developing and collecting the questionnaire survey data. The investigation found that there is a diverse understanding of the concept of *Industry 4.0* in practice, which results in a wide (dis)agreement with a focus on some core aspects. Typically, *Industry 4.0* is found to be consisting of following characteristics: Internet, Data exchange, Automation, Digitalisation, Big Data, Supply Chain Management, IT Facilities, IoT, and Cybersecurity. The findings also show that the majority do not apply the concept of *Industry 4.0* so far. Interestingly, two out of three participants were found not applying the concept of *Industry 4.0* in practice. However, a majority believes that *Industry 4.0* will play a vital role in the near future. Those who apply it make use of it in combination with different software packages, supply chain management, lead times, stock information,

JIT/JIS deliveries, big data, and the connection between all processes. Interestingly, there is some overlap in the theoretical concept of *Industry 4.0* and the viewpoint from the practice. Both set their focus on the importance of IT facilities, data exchange, IOT, autonomous processes and digitalisation. Also, the characteristics simulation and cyber security lacks priority for the practitioners and are identified as a gap between theory and practice. Study indicates that the implementation of Industry 4.0 has high potential to create multiple benefits for supply chain and logistics management. The theoretical concept overlaps in most attributes of *Industry 4.0* with the viewpoint of the practitioners. On the other side, just every third company of the participants applies the concept, which disagrees with the high ranking in importance of the diverse characteristics and is identified as a gap.

The study had few limitations, a relatively small sample size (57) was used to make inferences. It was challenging to acquire large sample sizes and to achieve high response rates in surveys due to limited time and access to the dynamic industry. Secondly, the geographic context may hinder the transferability and generalisability of conclusions to other settings and countries. Future research can look into different geographic setting could enlarge the applicability of results. Furthermore, this study's findings could be verified and examined in-depth with other research approaches and methods. By linking empirical data with qualitative data, such as interviews, a more comprehensive picture could appear, which would extend the understanding of how *Industry 4.0* is determined in practice. Due to limited studies on *Industry 4.0* and especially the implementation and application, more satisfactory and reliable measurement models would be supportive to be able to relate studies and findings.

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