STANDARDIZATION: BIG OBSTACLE ON THE WAY OF THE INDUSTRY 4.0[27]

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Abstract

Fourth Industrial revolution will beget the disruptive changes in the whole production systems. Smart networks, flexibility systems, individualized production, resource and energy efficiency are some of the changes and benefits of Industry 4.0. Whereas, besides them, there are many challenges such as standardization, complexity, security, reliability etc. which will wait to Industry 4.0. Standardization is the common obstacle of fourth industrial revolution. Various systems, models, methods, languages so on. can be given as examples of areas which require standardization. Universal models and languages should be developed and accepted by different firms. Hardware, software and communication standardization should be invented in order to deal with the different smart devices configurations, systems and networks in smart factory environment. Moreover, a standard protocol should be developed in order to storing, connecting and managing varied connections between devices and systems. Furthermore, standard models to describe autonomous systems, standard performance evaluation systems and benchmarking criteria should be invented. Moreover, data privacy, information sharing policy change countries to countries, firms to firms. Each systems and devices can utilize diverse data privacy, information sharing and security policy. All systems, network, smart product must be contemporaneously planning, coordinating, forecasting and networked environment. So that standard models, systems, languages, models, protocols and privacy policy should be developed, accepted and implemented. The ambition of this paper to identify common standardized required areas of the industry 4.0 and to create awareness and contribute to fastness of revolution through giving possible solutions and advices.

Key words: *Industry 4.0, standardization, challenge*

STANDARDİZASYON: SANAYİ 4.0 YOLUNDA BÜYÜK ENGEL

Özet

Dördüncü Sanayi devrimi, tüm üretim sistemlerinde yıkıcı değişikliklere neden olacaktır. Akıllı ağlar, esnek sistemler, kişiselleştirilmiş üretim, kaynak ve enerji verimliliği, Endüstri 4.0'ın neden olduğu bazı değişiklikler ve avantajlardır. Bunların yanı sıra, Endüstri 4.0'ı standardizasyon, karmaşıklık, güvenlik, güvenilirlik gibi pek çok zorluk beklemektedir. Standardizasyon dördüncü sanayi devriminin ortak engelidir. Çeşitli sistemler, modeller, yöntemler, diller. standardizasyon gerektiren alanların örnekleri olarak verilebilir. Evrensel modeller ve diller farklı firmalar tarafından geliştirilmeli ve kabul edilmelidir. Akıllı fabrika ortamında farklı akıllı cihaz konfigürasyonları, sistemleri ve ağları ile ilgilenmek için donanım, yazılım ve iletişim standardizasyonu icat edilmelidir. Ayrıca, cihazlar ve sistemler arasındaki çeşitli bağlantıları saklamak, bağlamak ve yönetmek için standart bir protokol oluşturulmalıdır. Dahası, otonom sistemleri, standart performans değerlendirme sistemlerini ve kıyaslama kriterlerini tanımlayan standart modeller icat edilmelidir. Ayrıca, veri gizliliği, bilgi paylaşımı politikası ülkelerden ülkelere, firmalardan firmalara değiştirmektedir. Her sistem ve cihaz, farklı veri gizliliği, bilgi paylaşımı ve güvenlik politikası kullanabilmektedir. tüm sistemler, ağ, akıllı ürün, eş zamanlı olarak planlama, koordinasyon, tahmin ve ağ ortamında olmalıdır. Böylece standart modeller, sistemler, diller, modeller, protokoller ve gizlilik politikası geliştirilmeli, kabul edilmeli ve uygulanmalıdır. Bu çalışmanın amacı, Endüstri 4.0'ın standartlaştırılması zorunlu olan ortak alanları tespit ederek farkındalık yaratmak ve olası çözüm ve tavsiyeleri vererek devrimin hızlanmasına katkıda bulunmaktır.

Anahtar Kelimeler: *Endüstri 4.0, standardizasyon, zorluk*

[27] This study is produced from master thesis whose name is "Awareness Analysis of Industry 4.0."

1. Introduction and Literature Reviews

In the 18th century, humankind had started to use water and steam power in the production that caused to first industrial revolution (Kagermann et al., 2013). With this revolution, both production and social lives faced big changes such as productivity increased, cost of production decreased, new social class named as working class occurred (Allen, 2006: 29; Jensen, 1993: 834).

In the 20th century, electricity was started to use in the production which triggered to second industrial revolution (Atkeson and Kehoe, 2001: 3; Kagermann et al.,2013; Rosenberg,1998: 8). Assembly line, division of labor and mass production terms introduced to the production areas (Blanchet et al., 2014: 7; Drath and Horch, 2014:1; Mokyr, 1998: 228). Moreover, migration increased from rural to urban areas in order to find the job in factories. New communication machine such as telegraph and telephone were invented that brought opportunities people to more communicate each other (Mokyr, 1998: 225).

In the 1970s, programmable logic controller invented. Production became more autonomous and programable by people (Kagermann et al., 2013). Furthermore, the third industrial revolution like the other first two ones, was not only affect the production systems but also affect the whole society and human lives. Invention of high-speed railroads, internet, fiber optik, cellular phone were the examples of results of the third industrial revolution (Jänicke and Jacob, 2009: 5; Jensen, 1993: 842-843).

In 2011, German goverment announced the fourth industrial revolution that called Industry 4.0. (Kagermann et al., 2011). With this new revolution, cyber physical system technology will started to use in production process, real and virtual world connected each other (Kagermann (2015), more autonomous and remotely controlled production system will dominate in the production (Rüßmann et al., 2015: 3). Also, almost all products will made by robots, that mean unemployment will increase (Stock and Seliger, 2016: 539). However, with this new revolution, new business models will come to exist, different and flexible career routes and more comprehensive training will be possible for workers (Kagermann, 2015: 37; Stock and Seliger, 2016: 540). Though, there are some obstacles in implementation and application phases of Industry 4.0. Standardization is one of the obstacles of Industry 4.0. This study aims to contribute to business world and academicians towards revealing standardization required areas of new technologies that Industry 4.0 brings. In the following section, which areas or fields should be standardized will be clarified.

2. Standardization Issue

Cyber physical system (CPS) is acting as a bridge to interconnect the digital and real environment (Jazdi, 2014). With this system, when changes happened in the production systems these changes can be observable at virtual environment at the same time. Digital and physical production process networked each other, when some changes happened the other side immediately observe them. (Schmidt, et al., 2015, p. 17). Goods and systems can connect to the internet with the internet of things (IoT) technology and cps give them to monitoring, coordinating, controlling and integrating abilities to physical and virtual world (Rajkumar et al., 2010, p.731).

Moreover, firms cannot only control, manage and communicate their own systems but also other systems (Kagermann et al., 2013). Moreover, goods and systems can acquire communication, coordination and autonomy abilities with CPS. (Jazdi, 2014; Schmidt et al., 2015: 17). Besides these advantages, CPS has some challenges such as; CPS will be applied at various businesses and fields which located to different geographic area, thus each of them use different models, languages and methods (Lee, 2008: 364-365; Zhou et al., 2015: 2151).So that standard language, methods and models should be developed based on the businesses needs and they should be accepted by the firms. Moreover, various systems, goods, machines etc. will be connect and communicate each other, but, they are located to various countries and used different time schedule (Baheti and Gill, 2011: 161-162; Rajkumar et al., 2010: 734-735). So that, time is the other constraint should be solved in order to get all benefits of CPS, may be standard and common time schedule can be developed.

Smart factory is the other technological revolution, which Industry 4.0 brings. It is application of CPS and IoT technologies into factories. Each machines, goods and systems will have unique identity that gives them to connection internet abilities, with CPS, each of them connect, and communicate synchronously. Production systems will become more flexible and agile (Wang et al., 2016: 159) which give chance to produce better specialized products and services to delight customers (Zhou et al., 2015; Shrouf et al., 2014: 698). New abilities of production system beget individualized production which is totally unique product based on needs and wants of customers' demands. However, each individualized product requires different smart devices configurations, systems and networks (Kagermann et al., 2013). So that, hardware, software and communication standardization should be developed (Lucke et al., 2008: 2; Zhou et al., 2015; Zuehlke, 2010). Which hardware and software should be used in products and how they can communicate each other are some challenges should be solved by firms. With the standardization, firms do not only save time and money but also make better planning and reutilization of the components (Zhou et al., 2015)

Cyber security is the other pillar of the industry 4.0. More systems will connect each other, connection nodes increases and protect each node will become harder. Furthermore, systems will use internet to create connection and communication each other (Xie et al., 2010: 213). It is the other reason increasing cyber-attack risk (Byres and Lowe, 2004: 1; Rüßmann, et al., 2015: 4). Financial skills, reputation, image and abilities to controlling processes of firms will affect negatively from the cyber-attack. (Byres and Lowe, 2004: 4). Thus, protecting data and systems be compulsory for firms. Moreover, data and systems will hold private personnel and companies and business know-how information. However, right know there is not standard corporate and competition laws about data protection. These laws should be developed both cooperation of all companies, trade unions and countries. (Kagermann et al., 2013: 51-53).

With the new revolution, systems will become autonomous which can act independently, take decision based on their sensors and artificial intelligence (Redfield and Seto, 2017:103), and regulate themselves to various situations (Kagermann et al., 2013: 20). Moreover, they can act more flexible in the production area, and work more cooperatively with the others systems and humans (Blanchet et al., 2014: 8; Kagermann et al., 2013; Rüßmann et al., 2015: 3). Autonomous systems can take decision or help people when making decision with using decision parameters and some rules which are formed by algorithm designers (Gal, 2017: 6) However, algorithm designers can be uploaded uncorrected parameters intentionally or unintentionally to autonomous systems, or sometimes all possible results can be filtrate by algorithms and when people make wrong or bad decision based on these algorithms results, who will become responsible of decision results, people or designers. This is very crucial question, so that standard laws and regulations should be developed and accepted by countries in order to prevent intentionally deceptive algorithm systems and form new laws to clarify to obligations of people and designers. (Gal, 2017).

Furthermore, autonomous systems have not any standard models to describe them, not standard performance evaluation systems, not standard mathematically models to analysis of empirical observation, not standard technic and tools to categorize task, objectives, environments (Redfield and Seto, 2017) and any standard international regulation or laws protecting security and privacy (Gal, 2017: 5).

Internet of things which are a kind of embedded systems give to products, goods, systems abilities of recording, storing, processing data and communicating the others. (Kagermann, 2015: 26). More efficiently coordinating logistic systems, remotely controlling and managing factories (Kagermann, 2015: 30), more effectively allocation of resources and energy at home, offices (Gubbia et al., 2013: 1649-1650 ; Kagermann et al., 2013) and factories (Miorandi et al., 2012), controlling the home machines remotely (Atzori et al., 2010; Evans, 2011: 4) are some advantages of the IoT. On the other hand, each of products, goods and systems that used IoT technology can use different communication styles, so that internationally accepted communication styles should be developed to form standardization. Moreover, these systems always collect detailed information about people private lives or factories production systems. So that, protecting both data and private lives information of people are very important. (Atzori et al., 2010; Evans, 2011: 9-10; Miorandi et al., 2012). So that, firms,

governments, organizations, and academicians should work cooperatively (Evans, 2011: 10) to form standard laws and common communication protocols to protect both personal and business data.

Big data is the result of the new revolution and technologies. Huge volume (Blanchet et al., 2014: 8), complicated and heterogeneous data (Chen et al., 2014: 171; Wu et al., 2014: 97) are collected from different sources automatically by smart systems, goods, sensors etc. (Rüßmann et al., 2015: 2-3; Wu et al., 2014: 97). Companies can obtain some benefits with using the big data that can be classified as; making more precise decision with using more enriched data source (Manyika et al., 2011: 13), collected more detailed information about consumption of goods such as how much time consumed, when consumed . (Manyika et al., 2011: 6). However, companies face some obstacles when using the big data, because many data will be collected automatically but there is not any standard systems to integrate data that collected from various sources. Without standard data integration systems, reaching global optimization is not possible (Manyika et al., 2011: 12). Moreover, there is not any evaluation and benchmarking criteria (Chen et al., 2014: 202). Lastly, this data holds lots of both private information about people and businesses, so that this data should be protected from cyber-attack. But, data is collected from different countries which have different laws about protecting data. So that, common standard and formats should be created in order to integrate whole data comes from multiple sources (Manyika et al., 2011: 12).

Cloud systems is a digital platform that users stored their data and information and reach, manage and control them (Vaquero et al, 2008: 51) within minutes or seconds. Huge amounts of data and information that will gather through smart devices, sensors, systems etc. and they will be held on cloud systems to increase firms' data accessibilities within seconds. But, there is not any standard mechanism that defines how the companies use the cloud systems (Botta et al., 2016). In addition, various service providers ensure services from different countries so that they are responsible different laws and regulations. Standard laws and regulations should be regulated to protect personal and business data and to increase reliability of cloud systems (Botta et al., 2016: 687)

3. Findings and Conclusions

When the literature is examined, it is found that; standard models, languages, methods and time schedule should be developed in order to implement properly of cyber-physical system and internet of things technologies. Moreover, standard hardware and software programs for smart systems, machines and standard communication method are crucial for smart factory. Also, international laws and regulations for data protection, clarify obligations of people and service providers are necessary actions for cyber-security, autonomous system, IoT and cloud system. Moreover, performance evaluation criteria and technic to define tasks, objectives of autonomous systems are the other areas should be standardized for autonomous system. Detailed examination of results is shown in Table 1.

Table 1: Standardization Needed Areas

CPS	Models for smart system and goods (Lee, 2008: 364-365; Zhou et al., 2015: 2151)
CPS	Languages for smart goods and systems (Lee, 2008: 364-365; Zhou et al., 2015: 2151)
CPS	Methods for smart system and goods (Lee, 2008: 364-365; Zhou et al., 2015: 2151)
CPS	Time schedule (Baheti and Gill, 2011: 161-162; Rajkumar et al., 2010: 734-735)
Smart Factory	Hardware and software methods (Lucke et al., 2008: 2; Zhou et al., 2015; Zuehlke, 2010).
Smart Factory	Communication methods (Lucke et al., 2008: 2; Zhou et al., 2015; Zuehlke, 2010).
Cyber-security	Laws and reguations about data protection (Kagermann et al., 2013: 51-53).
Autonomous systems	Laws and reguations to revent intentionally deceptive algorithm systems (Gal, 2017).
Autonomous systems	Laws and reguations to crearify to obligations of people and designers. (Gal, 2017).
Autonomous systems	Models to describe autonomous systems (Redfield and Seto, 2017)
Autonomous systems	Robotics' performance evaluation systems (Redfield and Seto, 2017)
Autonomous systems	Mathematically models to analysis of empirical observation (Redfield and Seto, 2017)
Autonomous systems	Technic and tools to categorize task, objectives, environments (Redfield and Seto, 2017)
Autonomous systems	International regulation or laws protecting security and privacy (Gal, 2017: 5).
IoT	Communication methods (Atzori et al., 2010; Evans, 2011: 9-10; Miorandi et al., 2012).
IoT	Standard laws and common communication protocols to protect both personal and business data (Atzori et al., 2010; Evans, 2011: 9-10; Miorandi et al., 2012).
Big Data	Data evaluation and benchmarking criteria (Manyika et al., 2011: 12).
Big Data	Methods to integrate data that collected from various sources (Manyika et al., 2011: 12).
Cloud system	Models defines how the companies use the cloud systems (Botta et al., 2016).
Cloud system	Standard laws and regulations should be regulated to protect personal and business data and to increase reliability of cloud systems (Botta et al., 2016: 687)

After the analysis, the results categorize the under three concepts which are methods, models and laws and regulations is shown in Table 2. International laws and regulation is mentioned 6 times under the literature, standard laws and regulation should be required data protection and explains obligations of users and producers. Second mostly mentioned topic under the literature is common language. Each systems and machines, which located different geographic areas and use various languages. So that, common, internationally accepted languages should be developed.

Table 2: Categorization of Standardization Needed Areas

models	define smart systems	1
	define communication sytle or comman language	3
	define autonomous systems	1
	define data evaluation and benchmarking criteria	1
	define usage of cloud systems	1
methods	usage of smart systems	1
	hardware and software	1
	performance evaluation systems	1
	to integrate data that collected from various sources	1
	regulate time differences	1
	analysis of empirical observation	1
	to categorize task, objectives of smart goods and robotics	1
laws and regulations	data protection	4
	clarift obligations of users and servive providers	2

Standardization is the big bottleneck for the implementation and usage of the Industry and scientists, governments, academicians and engineers should work together to solve the challenges on the way of the implementation of Industry 4.0.

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