IJBES
Business Ecosystem & Strategy

BUSINESS ECOSYSTEM AND STRATEGY

IJBES VOL 1 NO 1 ISSN: 2687-2293

Available online at www.bussecon.com

Journal homepage: https://www.bussecon.com/ojs/index.php/ijbes

The evolving role of automated systems in supply chain management and its cyber-security issue for global business operations in industry 4.0

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ARTICLE INFO

Article history:
Received 13 April 19
Received in revised form 18 June 19
Accepted 01 July 19

Keywords:
Automated Systems
SCM
Cyber-security
Industry 4.0

JEL Classification:
M10
M16

ABSTRACT

Nowadays, effective business performance depends on digital competitive factors and its ability to transform corporate capabilities in the light of digitalization. In this study, the evolving role of automated systems for global business operations in the era of Industry 4.0 has been assessed from a theoretical perspective with a practical approach. It is aimed to demonstrate the role of high technologies in an effective supply chain management system with new technological components and cyber-security issues of automated vehicles in SCM. This study highlights that developments in Artificial Neural Networks, Image Processing, Multi-Purpose Decision-Making, Blurred Linguistic Variables, and automated systems increase the performance of the supply chain management system and boost business performance. It is also shown that the evolving role of the automated system requires capital investments on Research and Development efforts

1. Introduction

Global and local companies are today struggling to employ effective business strategies during digital transformational change. Moreover, advances in Industry 4.0 provide more profound obstacles and significant streams of opportunities to managers in global business. Notwithstanding this, the evolving role of automated technologies and systems in supply chain management improves business performance and requires more investment in R&D.

Today, global supply chain management is evolving with the newest advances in technology and collaborative structures of enterprises having strong relations with international vendors and suppliers. Effective distribution is one of the critical issues, which have arisen from the fact that the enterprises have

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Peer review under responsibility of Bussecon International Academy.

http://dx.doi.org/10.36096/ijbes.v1i1.105

a collaborative structure in their relationships with their suppliers (Say, 2010; Topcu, 2015). If It shows the Concurrent Engineering is in practice with the help of the established model in the SMEs, It will increase the vertical professionality of the companies, the costs of their products will decrease, and all R&D and production operations will be realized more rapidly and at higher quality (Ucler and Vayvay, 2018; Sanli 2018; Canli and Aplak, 2016). Global Supply Chain, with the integration of Automated Vehicles and Smart Automated Systems, will boost the company's efficiency as operating costs are anticipated to be decreased in Industry 4.0. Oztemel and Gursev (2018) illustrated the fact that the inclusion of the small and medium-scale enterprises, in general, reveals how the investment plans are essential in the industry 4.0 approach of the enterprises. Their study concluded that the fundamental point of the logistics sector has needs such as superior-quality personnel, making project investment and technology management, analyzing all processes and data in the logistic sector accurately. The integration of logistics planning activities with smart technologies and systems in such a developed Global Supply Chain System requires more in-depth understanding of new technologies including Automated Systems, Cyber Space, Multiple UAVs, OpenMap, FlightGear, IMU, AHRs, Autopilot, Automapping, Smart Traffic Systems and Smart Vehicles (Gokozan & Tastan, 2018; Nørremark et al. 2012; Blackmore & Griepentrog, 2006; Kelep Pekmez, 2018). In the recent literature, studies highlighted that many simulations would be set up by using the multiple UAV simulation infrastructures that are under development and, by this means; it will be ensured that multiple UAV inspections, methods, and algorithms are developed (Bacanak, et al. 2012). When the methods and algorithms to be developed are realized, they will be tested by also including the simulation factors that the people use. It is planned that the Repast factor templates will be expanded by taking the factors in the air combat as a basis, the templates for the tactical image display will be identified for OpenMap and the manned platform libraries which can be used in FlightGear will be established and developed (Topcu, 2015; Kerimoglu, 2011). In these relevant studies, the functionality of the newest technologies is prone to changes in climate conditions. In this study, it is aimed to develop a practical approach to the latest technological components, cyber-security issues of automated vehicles, and their role in effective supply chain management. It is also desired to assess the role of automated systems ineffective distribution while analyzing the evolving role of automated vehicles and its cyber-security issue in supply chain management. From a theoretical perspective to empirical studies, the latest developments in advanced technologies have been reviewed.

The sections of this study begin with a literature review of empirical studies in the field. The following section evaluated Industry 4.0 and developing technologies in the present day. The effects of the advancing technologies on the supply chain in the Industry 4.0 era, finally, the automated vehicles and their role in the SCM were spotlighted. Finally, the study concludes with a conclusion part summarizing the general pinpoint and sparking attention for future studies.

2. Literature Review

In an effective global supply chain management system, the role of automated vehicles and automated systems is assessed by several studies. The empirical studies demonstrate the fact that the development of the technologies used in the smart and automated vehicles at the rate of 20%-25% in average in every year and their production and use increase day by day, it is forecasted that the automated vehicles will become widespread and become widely ordinary within the 2020s with the emerging new technologies. By this means, the traffic accidents arising from human errors will be reduced and even completely prevented and the running of the traffic on the roads will be able to become more regular thanks to the artificial intelligence and deep learning with the communication of the vehicles with both each other and equipment forming the smart traffic system (IoT-Internet of Things). The in-vehicle camera function will be able to be fulfilled as well optionally by recording the images during the travel and also the camera images related to the accidents, and adverse conditions will have been recorded. The commercial examples and the research examples show how the behavioral robotics will be able to operate in various areas from agriculture to aviation industry throughout a global supply chain. (Gokozan & Tastan, 2018; Nørremark, 2012; Pekmez, 2018; Blackmore & Griepentrog, 2006).

Smart transportation systems, Automotive engineering, and Automated vehicles are some hot topics today in emerging literature. The smart systems which are being rapidly developed and renewed in the globalizing world are also examined in the transportation area as well as in all areas, and it is considered that it will take the place of the driverless vehicles on all roads within the upcoming years. The movement planning that is included among the stages of movement detection and vehicle control while the automated vehicles are operating was examined in three different classes as global, local, and behavioral in the literature. The existing studies seem that they have considerably resolved the global and local planning problems (Nennioglu & Koroglu 2019; Dumlu and Ayten; 2018. The latest studies in the field assessed the future of automated vehicles with the developments in the area of Artificial Neural Networks, Image Processing, Multi-Purpose Decision-Making, Blurred Linguistic Variables and Game Theory (Ucler and Vayvay, 2018; Sanli, 2018; Canli and Aplak, 2016). Learning mechanism via new techniques and tools by automated systems depends on its ability to understand human characteristics. An automated ground vehicle is designed to learn human characteristics. For further studies, a more advanced automated vehicle can be created by planning a more comprehensive system. To reduce the errors in the detection, to increase the speed of the vehicle and to ensure that the vehicle functions more effectively may be the subject of other researches (Bingol, et al. 2019; Yetim, 2016). When all findings were evaluated together, and the hypotheses were tested, it was seen that the enterprises which participated in the research have not SCM problems at a significant level. The reason for this might have arisen from the fact that the enterprises have a collaborative structure in their relationships with their suppliers and that they have no problem with the distribution and the transportation of the materials (Say, 2010). As a result of the study carried out by Topcu about the Smart Automated Systems in 2015, it was concluded that "*It is not difficult to foresee that the motility abilities of the systems (and machines) in both military areas and other areas will increase and they will increasingly become smart. Following closely the studies carried out in this field, developing new projects related to the subject and taking part in these studies are considered substantially important in terms of shaping the force structure of the future*". In Oztemel and Gursev's study (2018), it was concluded that the industry 4.0 approach was misunderstood by humans and caused negation in terms of technology. "*When the sectors are researched, the inclusion of the small and medium-scale enterprises, in general, reveals how the investment plans are important in the industry 4.0 approach of the enterprises. As a conclusion, it was found that the basic point of the logistics sector has needs such as superior-quality personnel, making project investment and technology management, analyzing all processes and data in the logistic sector accurately*."

In the study of Bacanak, and his colleagues (2015), it was demonstrated that "*Many simulations will be set up by using the multiple UAV simulation infrastructures that are under development and, by this means; it will be ensured that multiple UAV inspections, methods, and algorithms are developed. When the methods and algorithms to be developed are realized, they will be tested by also including the simulation factors that the people use. It is planned that the Repast factor templates will be expanded by taking the factors in the air combat as a basis, the templates for the tactical image display will be identified for OpenMap, and the manned platform libraries which can be used in FlightGear will be established and developed*".

There are still significant uncertainties and problems in the mobile map production with the low-cost uncrewed aerial vehicles. Principally, it might be necessary to make regulations related to the commercial flights which are not for hobby purpose. In the areas where flights are performed concerning the use of UAV in the local civil aviation, it might be necessary to make the permissions and regulations related to the navigation control and flight limits (Coskun, 2012). In our present day, the uncrewed aerial vehicles are actively used not only in the military area but also in the public area. In this study, one application of quadrotor, which is one of the uncrewed aerial vehicles in the most appropriate form for civil usage, was performed. Quadrotor can be used in many different areas, thanks to its small structure and ultimate maneuver capability. In the application performed, the ″Arduino Uno,, board and "AeroQuad" software were preferred. The most significant factor in the preference of the Arduino platform is that the platform is very flexible and has the open-source code (Merc and Bayilmis, 2011). As a result of the studies carried out by Gokozan and Tastan, it was concluded that the development of the technologies used in the smart and automated vehicles at the rate of 20%-25% on average in every year and their production and use increase day by day. It is foreseen that automated vehicles will become widespread and become widely ordinary within the 2020s with the emerging new technologies. By this means, the traffic accidents arising from human errors will be reduced and even completely prevented and the running of the traffic on the roads will be able to become more regular thanks to the artificial intelligence and deep learning with the communication of the vehicles with both each other and equipment forming the smart traffic system (IoT-Internet of Things). The in-vehicle camera function will be able to be fulfilled as well optionally by recording the images during the travel and also the camera images related to the accidents, and adverse conditions will have been recorded (Gokozan and Tastan, 2018). In Blackmore and Griepentrog's study on automated vehicles, it was concluded that the automated vehicles cover some of the rapid developments within the recent years in the vehicle automation at the variety from the vehicles having different equipment controlled as semi driver-assisted to the wholly automated vehicles. The commercial examples and the research examples show how behavioral robotics will be able to operate in various areas (Blackmore and Gripentrog, 2006)

The smart systems which are being rapidly developed and renewed in the globalizing world are also examined in the transportation area as well as in all areas, and it is considered that it will take the place of the driverless vehicles on all roads within the upcoming years. The movement planning that is included among the stages of movement detection and vehicle control while the automated vehicles are operating was examined in three different classes as global, local, and behavioral in the literature. The existing studies seem that they have considerably resolved global and local planning problems (Nennioglu and Koroglu, 2019).

Today, the newest and the most different periods between the cycles have started to be experienced. The internet has started to enter into every moment of life, which has become an essential part of technology and has started to lead the Digital Industrial revolution. The latest empirical studies on Turkish companies in the transition process of Industry 4.0, demonstrates that digitalization is the central pillar of the transition process. In this regard, Cagle and her colleagues managed a content analysis on the transition process of Turkish companies quoted in Borsa Istanbul (BIST 100) in Industry 4.0 using of critical keywords, such as; "digitalization," "4.0", "Industry 4.0" and "smart factory." In their study, the population (178 documents) were analyzed, and 20 firms were identified as transitioning towards Industry 4.0. Table 6.2 provides the sub-sector distribution of the identified Industry 4.0 transitioning firms (Cagle, et al. 2019). Table 1 summarizes the list of BIST 100 quoted transitioning firms in Turkey, which are identified under the manufacturing industry

Table 1: Transitioning Firms Identified under the Manufacturing Industry

Industry	**Count**	**Percentage**
Textile, Wearing Apparel and Leather	1	5%
Food, Beverage and Tobacco	3	15%
Chemicals, Petroleum Rubber and Plastic Products	5	25%
Fabricated Metal Products, Machinery and Equipment	8	4%
Wood Products and Furniture	1	5%
Non-Metallic Mineral Products	2	10%
Total	**20**	**100%**

Source: Cagle, et al. 2019.

Industry 4.0, which is the digital industrial revolution, is a joint combination of the information technologies and the industry and represents the fourth industrial revolution in the manufacturing and industry. It ensures that the robotics which can communicate with each other, can detect the environment with their sensors and can make data analysis take over the production, human errors are reduced with the development of artificial intelligence, the production is reduced from the factories to the homes via the three-dimensional printers and a more cost-effective, higher quality product that provides more saving is performed. For the enterprises to be able to have a good command of the markets, the technology should be used in both production and marketing departments (Ertugrul, 2018).

With respect to the remaining studies in the field, empirical studies demonstrated the importance of understanding the evolving role of automated systems in Industry 4.0 for global business operations

3. A path to industry 4.0 and the latest technology toolkits for global business

In our present day, the developments in the information technologies affect the companies and also ultimately adversely affect the countries which cannot adapt to this development. Notably, the development that the companies acquired at the automation level reduces the production costs and provides competitive superiority. The innovation and information technologies constitute the basis of this development, together with Industry 4.0.

The term Industry 4.0 is widely used in almost all fairs and conferences related to the industry in Germany or in the notices for the projects financed by the public, and it was first used in Hanover Fair in 2011 and many discussions started to arise accompanied with it (Hermann et al., 2016: 3). There is some discussion on the topic in recent literature. Drath and Horch (2014) discussed whether Industry 4.0 is an achievement or an exaggeration between them for an extended period. Roblek et al. (2016) focused on the importance and effect of the internet-connected technologies for Industry 4.0 create added value to the corporations and society. Kocsi and Oláh (2017) examined the possibility for the inclusion of a robotic into the sub-process of panel cutting of the unique furniture production process of a lumber company by aiming at acquiring shorter production periods by taking Industry 4.0 concept as basis and as a conclusion acquiring more reliable processes with lower production costs (Ertugrul and Deniz, 2018:168).

The failure of the EU's effort to catching up and getting ahead of the USA by 2010 in the development of the digital technologies that the EU targeted in its Lisbon Strategy directed German to a new strategy search. It seeks for the exit with the development of the information and communication structure in the manufacturing and production means rather than competition in the production of the information and communication technologies (Fuchs, 2018: 282). The labor productivity of the German manufacturing industry increased to 2.5 folds between the years of 1991-2016, and the average productivity of the economy was exceeded. However, according to Fuchs, the share of the manufacturing industry in the total fees corresponded to a number above the average. The automation to be brought by Industry 4.0 will also reduce the costs based on the workforce. When it is considered from different aspects, the denominational and political reasons of the "Industry 4.0" project are revealed as well. As a conclusion, attempt 4.0 has already gained a significant acceleration in terms of industry and technology even though it caused various discussions. It is clearly seen that 4.0 will provide a contribution to the economies and industries of the countries and indirectly to their technologies regardless of its reason for a start. We hope that the discussions of 4.0 will continue and we will take advantage of the result of the developing technologies. Due to the reason that the German government declared 4.0 as one of the most serious attempts of the high technology strategy in 2011, many academic publications and articles were published, and various conferences were held on this subject.

The term Industry 4.0 is the name given to the next industrial revolution, which is expected to occur now. The first industrial revolution that occurred was the introduction of the mechanical production plants which started within the second half of the 18th century and which continue during the 19th century. From the beginning of the 1870s, the electrification and division of labor ensured the occurrence of the second industrial revolution. The 1970s during which the advanced electronic and information technology developed the automation of the production processes were the third industrial revolution that is also called as "digital revolution" (Hermann et al., 2016: 39).

On Cagle and her colleagues' study, four significant characteristics of Industrial revolution stages are listed: Mechanization, Usage of electric, Automation, and IT, and finally the Cyber-Physical Systems (CPS). Table 2 summarizes the core characteristics of the industrial revolution stages.

Table 2: The Industrial Revolution Stages and Core Characteristics

Industrial Revolution Stages	Core characteristic
Industry 1.0	Mechanization
Industry 2.0	Usage of Electric
Industry 3.0	Automation and information technology
Industry 4.0	Cyber-Physical Systems (CPS)

Source: Cagle et al. 2019

The factor that constitutes the basis of Industry 4.0 was the development of internet technologies and Cyber-Physical Systems. In line with these developments which ensured that the efficiency, especially in the production, increased and the industries expanded, a production structure which is more

rapid, less erroneous, high quality and less costly was established. Moreover, the new generation production technologies caused flexibility in the production and ensured that the fourth industrial revolution started. The products and services have started to be customized much more with the help of the change of the customer requests and requirements caused by the digitalization and the digital technologies which ensure that such requests and requirements are met more quickly and effectively by the enterprises. For the purpose of providing support to the production of customized products allowed by these technologies, it will be useful to take advantage of the big data in making an estimation about the consumer selections by starting from the previous purchase behaviors and in evaluating the new market opportunities. Accordingly, the production of an idea based on information will be obtained at the same time also in the innovation periods. The potentials of Industry 4.0 can be summarized as follows (Ertugrul et al., 2018:9):

- Meeting the individual customer needs,
- Providing flexibility,
- Taking optimized decisions,
- Providing resource efficiency and effectiveness
- Creating value opportunities with the new values,
- Responding to demographic change in the workplace,
- Obtaining the business-life balance.

Industry 4.0 is a new production system, also known as the internet of things, where living and non-living objects are able to be in communication and interaction with each other, smart production is possible, cyber-physical systems are used.

Industry 4.0 is described as a smart production era in which all the living or non-living objects with significant economic value are able to be in communication and interaction with other creatures and the objects through the internet, thanks to the advancements in the artificial intelligence, 3D (three dimensional) printers, robotic and bio, Nano and space technologies fields. In this era in which the production is being digitalized, a production system is discussed where the virtual and physical systems are integrated into each other, and therefore, objects connected to the internet will become smarter (Aksoy et al., 2017:37).

One of the most important technological features of the Industry 4.0 era is that manufactured technological products which have a certain memory capacity. Chips becoming more affordable and getting smaller with the advancing technology made it possible for even the smallest products to have a memory. It is said that thanks to these smart devices when a chip-product is reached to the manufacturer who controls the process until the production stage at the factory, in case of a failure, a customer will be able to get into contact with the service without an agent and solve the problems in the future. In fact, the term of "Dark Factories" (Dark Factory methodology that, the term of factories where lights out, which first came out in the '80s, is being carried into action by Industry 4.0) which is becoming popular today, implies that in the future, there will be no need for human power in production, human force as a tradition at the factories will be gradually put aside (Altuk & Kablan, 2019; Kablan, 2019)

So, if we address the question of "What is the importance of technology for the factories?", we can see that human force is not enough today. It is also prone to make mistakes, and particular automated technology and speed are necessary for the factories which aim to make mass production. The reason is that the human factor in the production processes is not at the highest points anymore. Manufacturing companies can make faster production with fewer mistakes and wastages without needing human power. It is a time for the companies to dominate the market by advancing their technological developments into the highest segment and accelerating their production speed.

The following developments under Industry 4.0 indicate that they will contribute to business success as decreasing operational costs and human-based risk factors shortly.

IoT (*Internet of Things):* This concept which was first used by Kevin Ashton in 1999 in a presentation that he prepared for a company, had gained a broader vision than the day when it was first coming up with the advancing technology. Internet of things is defined as a network spreading through the world that the things which are addressed uniquely create between each other and things on this network communicating with each other with specified protocols (Zehir & Zehir, 2019)

Blockchain: With the briefest expression, Blockchain is a distributed data recording system that enables encrypted process follow-up. It is not a database because recorded data cannot be changed or deleted. It owes this feature to the keeping the blocks that are accumulated by the data and linking them to each other with encryption algorithm as a chain and sharing this chain dispersedly to numerous people (Cagliyangil, et al. 2019)

Artificial Intelligence: With its lexical meaning artificial intelligence, and its scientific name analysis robot; means the capability of a computer or a robot controlled by a computer perform various operations similar to smart creatures.

Machine Learning: Machine Learning is an algorithm category that enables software programs to estimate the results more accurately without being programmed. Necessary foundation of the machine learning is to create algorithms that are able to receive the entry data and use statistical analysis in order to estimate an outcome while updating the new data as they are being received (Davenport & Kirby, 2015; Brynjolfsson and McAfee, 2014; Shibata and Irie, 1997; Shibata, et al 1997; Carley, 2002)

Big Data: With the technological progress and advancement of the internet, the power of the information came into prominence, and lots of phenomena in the internet environment started to be referred to as "Junk Information." Software companies thinking that technology can obtain meaningful information from this junk conducted their RE-DE studies to this concept and created a phenomenon called Big Data. Although the phenomenon that we call Big Data is associated with data that occupies a considerable space on the disk; it is not like that. Big Data is meaningful and processable form of data that we obtain from different sources such as our social media posts, photograph archives, "log" files which we continuously record (Davenport & Kirby, 2015; Brynjolfsson and McAfee, 2014; Shibata and Irie, 1997; Shibata, et al. 1997; Carley, 2002).

Automated Vehicles and UAVs: Automated Vehicles is the name we gave to the vehicles with the capability of environment detection, navigation, and direction without social support. Automated Vehicles can detect the objects around them by using technologies and techniques such as radar, IDAR, GPS, odometry, computer vision. In light of the recent technological developments, Unmanned Air Vehicles (UHA) became an academic study and engineering application field with increasing popularity. UHA enables to solve and analyze various situations like following-up the military applications, in particular, natural disasters, various sports activities, traffic and illegal housing faster and safer (Alkan, 2018).

3D Printers: Machines that can transform the virtually designed 3-dimensional objects to physical objects in a solid form called 3-dimensional printers. A required apparatus can be printed, and we can print an object that we scanned with a 3D scanner, or personal device drawing can be prototyped.

Robotic Technologies & Human-Robot technologies: It is a technology branch that deals with robotic robots. Robots are programmable machines that can perform a range of operations, generally independently or semi-automated. Robotic Technologies is an engineering branch that designs, manufactures, and operating the robots at the same time. This field works together with electronics, computer sciences, artificial intelligence, mechatronics, nanotechnologies, and bioengineering (Tunc, 2019).

Augmented Reality: Augmented Reality is described as feeling the physical environment of the world live, dynamically, and simultaneously employing a computer and sensory inputs.

4. Effects of the advanced technologies on supply chain activities

By changing consumption patterns rapidly, globalization had forced the business organizations to change their business processes with different applications. Today, business operations are trying to take a significant competitive advantage by decreasing the costs and product delivery time as well as increasing the product quality and range. Properly managing the process steps until the time of delivering the right product to the customers at the right place with the right quantities and price at the right time: provide a significant advantage to the business operations in a competitive environment. Award of these provided advantages can be so high that one can dominate the market. Business operations involved in all processes of the products included in this advantage from their raw material origin points to the consumption point are linked to each other attitudinally. Planning, coordinating, and managing the relationship between the chains or the members forming the supply chain will ensure the success of these processes. After the '90s, computer networks had started to be created with the advancing technology. As a result of this, Supply Chain Management significantly changed and along with it, manually recorded stocks, customer follow-up cards gave their place to the online orders from the internet, and IT-based customer follow-up programs which can be tracked by the manufacturers and the customers together. Hence, companies are able to conduct the processes from their warehouses to the delivery of the products to their customers and/or consumers more easily and fast.

The information has great importance in terms of the general performance of a supply chain. Because the supply chain managers decide on this basic concept. Information technologies consist of tools and materials that are used to gain information awareness. The performance of the supply chain is trying to be increased by analyzing this information and moving on this necessary foundation. For example, while e-Business Management technologies affect the integration of the product information in a supply chain, supplier integration affects the operational function and activities of the company. All of these proves that IT has significant importance in combining suppliers and partners in a virtual business and the supply chain. Numerous technologies can be used to analyze and share information in the supply chain. It is possible to give Electronic Data Interchange (EDI), Internet, Enterprise Resource Planning (ERP), Radio-frequency Identification (RFID) and Supply Chain Management/Planning (SCM/SCP) as an example of the most frequently used technologies (Ozdemir, Dogan, et al., 2010:4). Managers have to decide which technology should they use and how can they manage to integrate this technology into their own and partner's businesses. These decisions are becoming more critical with the increasing efficiency of these technologies.

4.1 Automated Vehicles and their management in the Supply Chain Management

The supply chain is a formation that consists of automated or semi-automated business operations responsible for acquirement, production, and distribution operations on an equal basis related to the one or more product line. A supply chain is a network comprised of a service and distribution options that technically carries out material supply, transforming them to semi-finished and merchantable products and finally delivering them to customers employing the distribution chains. This network enables to perform the operations of providing materials, transforming them to mid-product and finished product, and delivering these finished products to the customers. According to the expression of the supply chain council, the supply chain covers all the works related to the production and distribution of the finished product. The blockchain ecosystem plays a significant role in the efficient supply chain management. In today's supply chain operations, autonomous systems and vehicles provide a cost advantage while providing the interconnection between the components of the SC system. Active tracking, automated vehicles with high accuracy and speed, and predictive maintenance provide a productive and successful logistic activity. The following figure demonstrates the mine of the future factors which are shaping the logistics and SCM systems.

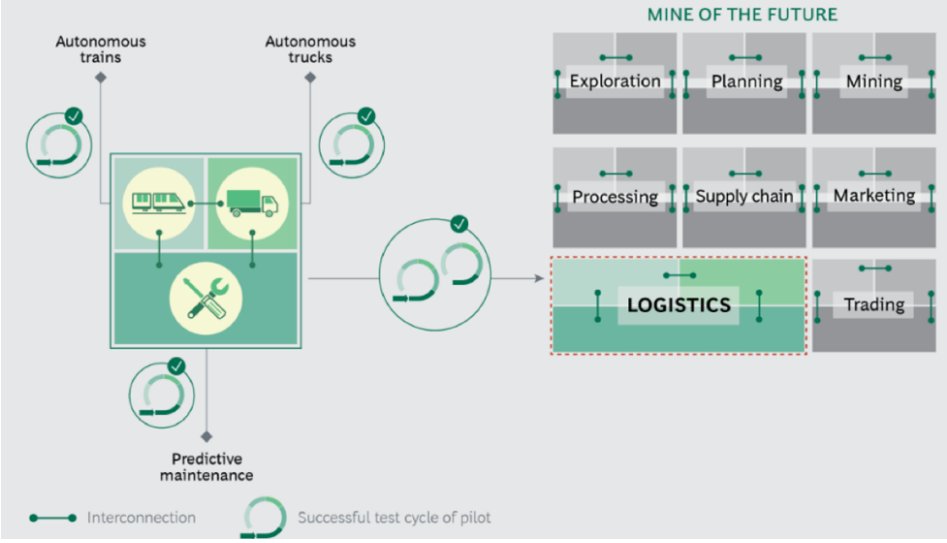

Figure 1: The future of Automated technologies and integration with supply chain activities

Source: BCG Analysis

These works consist of four basic processes as *(The Supply Chain Council, 2009)*:

- *Planning (Managing the Supply and Demand)*
- *Sourcing (Providing Raw and semi-finished materials)*
- *Production (Manufacturing and Assembly)*
- *Delivery (Warehousing and Stok Tracking, Receiving and Managing the Orders, Distribution through all the channel and Delivery to the Customer)*

In the technology-based physical logistics processes; transformation into software-based practices from hard-ware based practices have started with the effect of Industry 4.0, increase in calculation and communication capacities were achieved and sharing all the necessary information with every shareholder get easier (Hompel and Kerner, 2015: 177; Timm and Lorig, 2015). It means that traditional devices (old generation) with no flexibility give its place to the software-based devices with the flexibility of gaining new functions according to the users' needs when necessary. While users' hardware-based devices can be used only at certain places and until their technology obsoletes; devices can be improved and changed based on the advancements in computer technologies, and their performance and lifecycles have started to increase thanks to this software-based system. It should be mentioned about Logistics 4.0 while it is about supply chain management. So, let us look over to Supply Chain Management Logistics 4.0. Logistics 4.0 consists of automated subsystems in which the behaviors of an individual actor depend on the other actors. These automated systems are in interaction with each other in order to achieve their individual goals and also enable other related parties to achieve their own goals (Timm and Lorig, 2015).

In Supply Chain Management, the management of automated vehicles is an important matter. The role of the automated vehicles within the companies are becoming significant, and data shows that this significance will increase in time. Using automated vehicles in the chain properly has significant importance because using automated vehicles affects the supply chain directly. Therefore, opinions built towards Logistics 4.0 are necessary for us to get information, understand the importance of their management and their effect on the chain. Foresights formed on the Logistics 4.0 are of particular concern to automated vehicles and their management. According to Şekkeli, formed some foresight are enlisted in Table 1 (Sekkeli, 2018:29):

Table 1: Future of Automated vehicles and their effect on Supply Chain Management

*The machines will perform every operation process: the robots controlled by a computer will carry production and transportation. Surgeries, spying, waitressing, etc. are being already performed by the robots. It is thought that in 2025, nearly half of the people living in the USA will hand on their business to the robots (*Sekkeli, 2018;*Tarhan;2017:141-142);*
It will be ensured that products will conduct and manage themselves through the supply chain by means of the sensors and smart labels which will be put on the products or the vehicles; by this means, it will be possible to obtain simultaneous information of in which level and how the products are delivered to the customers.
Suppliers will be able to obtain simultaneous information on new orders and automatically arrange the processes by themselves. Therefore fulltime logistics applications will reach the highest level.
Employees will wear augmented reality headsets in which the information on logistics and production are given, and thanks to these glasses, they will be able to see whether all parts are in their right place where they are required to be in the installation or not.
Transportation will take a new turn with smart vehicles like automated lorries, vessels without shipmaster, planes without pilots manufactured in a new style.
Accident risks will be minimized with the improvement of the vision by adding blind spot cameras, forward-looking radar systems, mirror cameras, etc. to the heavy vehicles for safety purposes.
The efficiency of transporting vehicles will be increased by developing modern communication technologies that enable faster data communications and distribute information on traffic conditions.
Stress on the driver will be reduced, efficiency in the freight shipment will increase, and traffic flow will be more proper by creating a partial automatic and semi-dependent driving system.
A digital assistantship system will be formed in order to minimize the mistakes made by driver, this assistant will provide information to the drivers or the automated systems on their own units, their trailers if any, status of the vehicle body, etc., navigation and ordered products; and while driving, it will set the following distance, direct the vehicle by reading the signs on the road, fix the speed of the vehicle according to the speed limits, and arrange the driving according to the lanes on the road.
Vehicle fleets will be increased in order to achieve more efficient transportation; therefore, fuel will be used less, and costs will be reduced.
Commercial vehicles will be ensured to be work on electricity, natural gas or batteries, and fossil fuels lose their importance and value, new fuel and energy sources will be needed. Therefore nature will be damaged less.
Logistics services will be provided more efficiently and operatively with the machines that are interacting with each other through the internet.
During food transportation, carriers will receive warnings on real-time temperature and location of the vehicle utilizing a GPS-based (computer technologies that are independent of each other). Therefore it will be possible to control the temperature convenience consistently.
Logistics service providers will start to launch geostationary satellites, and the space stations will perform supply management.
Because most of the industrial wastes will be converted into primary raw material sources employing recycling, reverse logistics applications will be on the rise.

Source*:* Adopted from Sekkeli's study (Sekkeli, 2018:29)

As a result of the information above, Industry 4.0 affected the Logistics system first and then the Supply Chain Management directly. Companies are particularly interested in advanced industrial and technological developments; this results in a competitive environment for those who aim to provide the best service. Those who says and express opinions on that there will be "Dark Factories" (Dark Factory methodology, the term of factories where lights out, which was first came out in the '80s, is being carried into action by Industry 4.0) in the near future will bring the terms of "Dark Trucks", "Dark Logistics", "Dark Supply Chain "forward. Also, they will be able to claim that the human factor will be eliminated in the stages of the production process between the manufacturer and the consumer and everything in the system will be handed over to the automated devices. Maybe we are handing over the world to the perfectness of the technology with our own hands and fade from the scene (Kablan, 2019).

4.2. Cyber Security Issue in Supply Chain Management and its effect on Automated Vehicles

According to the cybersecurity principles, only verified users could reach confidential and private information. Attacks against the verification systems are divided into two main topics:

a) Obtaining users' information by means of malware,

b) Attacks towards disconnecting the online channel connection such as "Man in the Middle" attacks may result in sophisticated attacks. On the second attack type, instead of obtaining the users' information, computer and bank servers are tracked without being noticed. Attacker shows himself as a client to the server, and as a server to the client (Hiltgen, et al. 2006).

Various risks come along with the benefits of technological developments for the supply chain; information leakage, stealing customers' credit card information, etc. One of the newest risks today is a cyber risk. Risks that occur in the area involve cyber-attacks, backdoor, replica products and sales, malware and viruses, feedback mechanisms installed in the hard disks, frauds by the employees (Boyson, 2014). According to the report of Allianz Risk Barometer (2015), cyber threats have the most increasing risk in the current period and has reached up to the second place in Germany and third place in

the United Kingdom amongst the most significant risks. In the USA, lines were shut down for three weeks as a result of a virus damaging the turbine control systems of a power plant (Advisen, 2013). It was detected that the reason for this incidence is that a technician unintentionally inserted a corrupted USB driver to the network. If the effects of cyber-attacks are discussed on the automated vehicles; first, it should be said that they pose a significant threat for automated vehicles because the automated vehicles made up of artificial bits of intelligence that are open to the cyber-attacks.

A Danish data analysis company *Autintelligence* shared a report with the public opinion on cybersecurity gaps which may occur concerning the automated vehicles. Cyber-attacks and cybersecurity gaps today have become a global problem for individual users, countries, and private corporations. A report issued by *Autintelligence* company questions how the automated vehicles which are programmed with over 100 million code lines can be safe against the cyber- attacks. It was underlined in the report that in case of a possible cyber-attack, accident risks involving death or personal injury is quite high, and that may cause danger on the roads where the automated vehicles are used. It was highlighted that in the future, these systems might be a target for the terrorist attacks (İmamoglu, 2017)

While expectations are high for automated vehicles, it is not enough to only focus on the innovations in-vehicle technologies in order to prevent accidents involving death or personal injuries. It is required to focus on the innovations in road technologies and their designs at the same time. It would be possible to realize more safe cities and travel by road design and technology to be developed.

5. Conclusion

In today's competitive business environment, digital competitive factors determine the level of business success, and effective business performance depends on a company's ability to transform corporate capabilities in the light of digitalization. The evolving role of automated systems for global business operations in the era of Industry 4.0 seems to be transforming all business practices through the entire business. The role of high technologies ineffective supply chain management system with new technological components contributes to business efficiency while having some doubts and concerns on the cyber-security issue of automated vehicles integrated with SCM applications. This study highlighted the recent developments in advanced technologies in Industry 4.0 and the new topics such as *Artificial Neural Networks, Image Processing, Multi-Purpose Decision-Making, Blurred Linguistic Variables, and automated systems* are evaluated for an effective supply chain management system, and it was demonstrated how they boost business performance. Robotic technologies, Robotic behaviors, Employee characteristics, value creation and sharing via blockchain technologies, risk management of human-robot interactions, accident risks, cybersecurity issue of integrated automated systems in supply chain management are an essential subject for the future studies. Understanding the newest techniques and case studies from practice to theory should be the mainstream of future studies in advanced technologies.

Acknowledgements

This study is dedicated to the Bussecon International Academy's future authors, reviewers, board members and staffs. We also acknowledge this paper is just a starting footstep towards to the future of this journal. Additionally, Dr. Hacioglu has co-authored this paper to hold a memorable place in the history of journal as he has a preeminent role in EB.

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