Industry 4.0 with Supply Chain 4.0 and Smart Logistics

Nevin Aydın

Artvin Çoruh Üniversitesi, İİBF, İşletme Bölümü, Hopa, Turkey

ABSTRACT

Through the change of Industry 4.0, production will become more efficient and cheaper and in this context, logistics activities will be changed in delivering the products to the consumers. The value chains that have been reshaped with Industry 4.0 from the supply of raw materials to the production process and shipment will also affect the logistics transformation. The fact that the machines communicate with each other over the Internet with Industry 4.0 will make the logistics services more efficient on timely delivery and thus ensure more efficient use of resources. New modes of transport, less fuel use, new energy resources, new infrastructure and new employment areas will affect all kinds of logistics activities, especially transportation logistics. As a result, the logistics sector will be shaped by Industry 4.0. In the future communication between man and machine will bring a different dimension. Efficiency will increase with intelligent walkways and smart warehouse management. Energy and cost savings can be achieved by using heat and illumination sensors in intelligent warehouse processes

Keywords: Industry 4.0, Supply Chain 4.0, Smart Logistics, Intelligent Transportation Systems, Internet of Things (IoT)

1. INTRODUCTION

Industry 4.0 is the evolution of cyber-physical systems that represent the fourth industrial revolution on the road to industrial IoT and production, production, logistics, and decentralized intelligence in the industry and the end-to-end value chain [11]. As e-commerce markets evolve, consumer expectations regarding deliveries are greatly improving. Consequently, consumers' expectations for shipment are increasing. For instance, in 2016 Deloitte survey, "fast shipment" was considered shipment within two days, while it was considered within three or four days a year before. The state of its properties and the transparency of control over the place and timing of delivery confronted increased demand [18].

Logistics, an integral part of supply chain management, has evolved with changes in the business world. Until the 1980s, logistics was seen as an area of little importance. In the 2000s, the introduction of mobile devices and the globalization of online sales started a new process. Logistics is a developing market with an information technology component. The future of logistics is shaped by innovation and technology. Today, the industry is adapting these technologies to deliver faster, cheaper, more reliable and sustainable ways while not wasting time for its customers, manufacturers, and retailers. The Internet of Things (IoT) enables devices to communicate with each other in an existing internet infrastructure without human intervention. Logistics is expected to increase the speed of future implementation, reduce waste and reduce overall costs [3].

The large companies such as Amazon and AliExpress are shifting to new logistical measures and business areas. Amazon is creating its own logistic chain to deliver the day before; makes investments in aircraft, ships and trucks. In order to shorten the delivery time, it aims to transport unmanned aerial vehicles (drone) by using the ships as a warehouse. The main players serving worldwide have taken action to carry out their logistic services within their organization. In the face of these developments, the logistics sector is actively moving towards different product characteristics and new business

processes that will be determined by new technologies. Processes will change in logistics, one of the processes of the supply chain. In the future, logistics will be replaced by large drones in logistics.

2. SUPPLY CHAIN 4.0

The supply chain includes inbound/outbound logistics and the management processes required to deliver the products to the right customers in the right place at the right time [7].

Figure 1. Supply Chain Management [14]

Source: http://www.salvesenlogistica.com/en/servicios/logistica-integral

In the past several decades, the logistics have much evolved from typical operational functions that dealt with reporting sales and making sure to have sufficient supply of productions lines and customer delivery to more independent supply chain management function. Due to the recent developments, the supply chain management now deals with much more advanced planning processes based on the data analytics brought by the Internet of Things (IoT) technology. It is worth noting that the operational logistics now have outsourced to third-party logistic service providers [17].
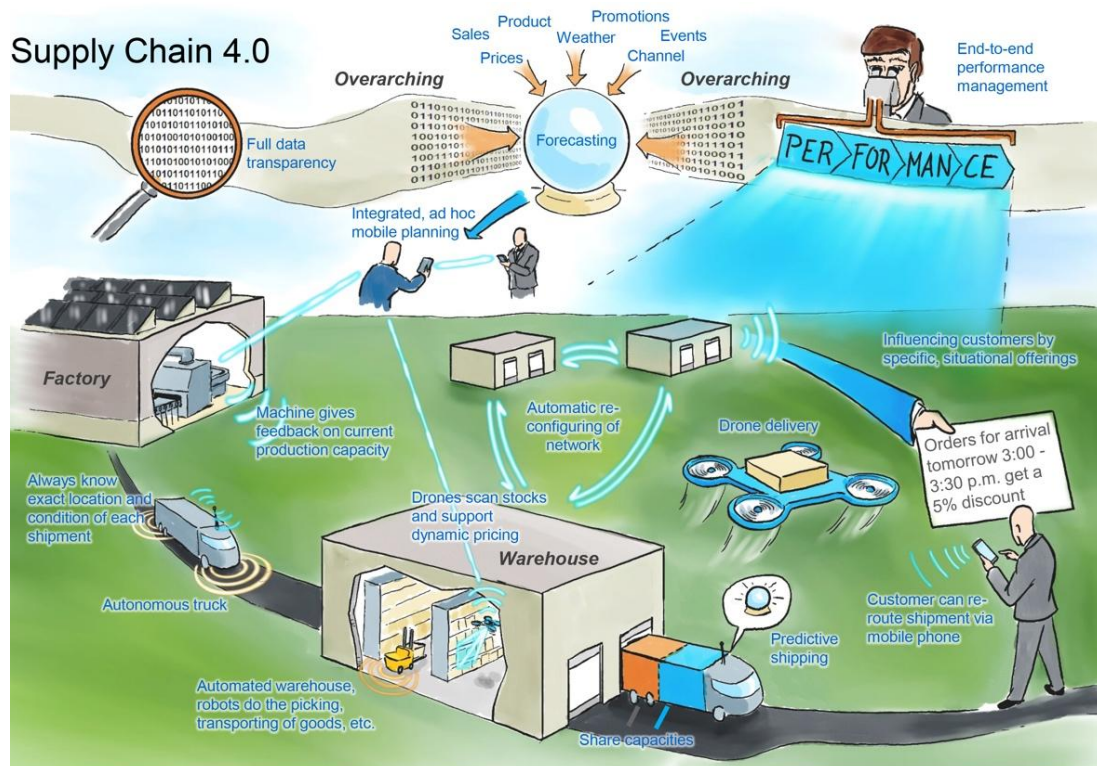
Trends in supply chain management

The companies had to redesign their supply chain due to the drastic changes brought by Industry 4.0. The customer expectations also played a major role in these changes. In addition to adaptation, the supply chains can achieve much more such as carefully looking into digital supply chain business models to alleviate the company to the next level. There are several trends that affect the supply chain management such as continuous growth of the rural areas, pressure to reduce carbon emissions, regulations on socioeconomics, etc. On top all this, the customers' expectations are continuously growing as there is an obvious trend towards customization. Ability to shop online regardless of the physical location of the goods to be delivered give further options to the customers while deriving the competition of supply chains of various companies. In order address these trends, the supply chain needs to be more robust [17].

The digitization of the supply chain allows companies to adhere to the new requirements and the challenges [17]. Through the digitization Supply Chain 4.0 will be

- *Faster:* The delivery time is reduced to few hours based on the new product distribution approaches. Advanced forecasting including predictive analytics and other external factors such as market trends, weather, etc, spare-parts demand assist on improving the customer delivery time. Forecasts are generated on a weekly basis rather than monthly. Large companies such as Amazon is expected to do predict shipping meaning that the product is shipped before a customer order is placed.
- *More flexible:* This is achieved by making planning a continuous process in order to quickly respond to changing requirements. The customers can reroute their purchases to different destinations if needed through improved flexibility in delivery processes.
- *More granular:* As the customers desire for more customized products increase, there is a need for implementing mass customization ideas. This feature allows customers to choose one of several logistic menus that would be the most suitable for them. For instance, drone delivery is used by many companies for the last mile of a single highly valuable packages.

- *More accurate:* The integration of service providers and suppliers in the supply chain management allows everyone to make real-time intelligent decisions based on the accurate information provided. It is expected that the performance management systems will "learn" to identify risks and/or exceptions and as a result, change supply chain parameters accordingly.
- *More efficient:* The efficiency is achieved through automation of planning and task execution. For instance, robots deal with the materials autonomously from the beginning to the end of the process. Cross company transportation is leveraged to optimize truck utilization and increase flexibility of transportation options.

Figure 2: Supply Chain 4.0 [17].

Source: https://www.mckinsey.com/business-functions/operations/our-insights/supply-chain-40--the-next-generation-digital-supply-chain

We need to understand the sources of digital waste and aim to provide solutions to reduce it or eliminate it if possible [17]. The categories of digital waste include:

1. *Data capturing and management:* Many times, the data is collected and entered to the system manually and not updated regularly. The received advanced shipping notifications are not always used for process optimization. It is not always clear what additional data would be useful to further improve processes.
2. *Integrated process optimization:* Even though many companies are starting to implement an integrated planning process, it is still far from being useful since not all information is used in the process. In order to achieve integrated process optimization, many entities within the supply chain such as governance, organizational setup, and incentives has to be aligned.
3. *Physical process execution of humans and machines:* These days warehouse operations continue to run on non-real-time and opportunities coming from IoT devices are not taken into consideration in the operation process.

3. SMART LOGISTICS 4.0

Businesses need both virtual and physical structures throughout their entire life cycle from production to distribution to enable them to adapt to global markets. There has also been a change in supply chain processes such as supply and shipment logistics with increasing demand for personalized products and services. In Logistics 4.0, two basic factors are important: labor savings in the time of transport and transport [7].
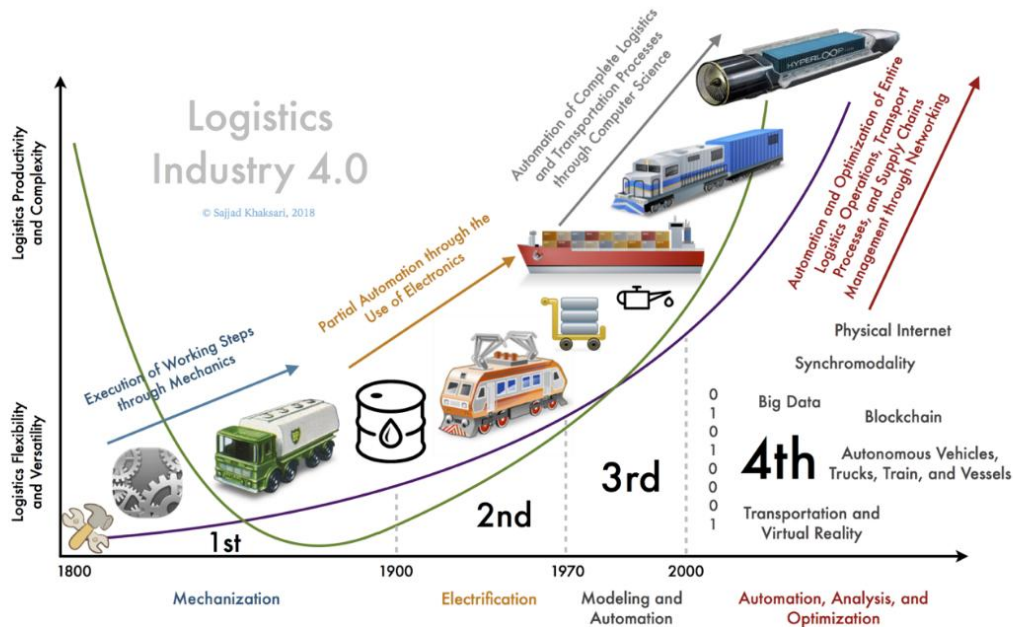
Figure 3. History of Logistics Industry 4.0 [2][13]

Sources**:** https://www.der-wirtschaftsingenieur.de/index.php/industrie-4-0-die-story/&https://medium.com/@sajjad.khaksari/logistics-industry-4-0-b132f0a8f391

Five key elements of Logistics 4.0

The five key elements of Logistics 4.0 includes the following **[10]**

- *E2E visibility:* Increased visibility is consider essential towards improving the current logistics more efficiently than before. The shipping and freight forwarding operations should work together instead of independently to provide additional information to the customers real-time during shipping process.

- *Smart containers and pallets:* Smart container and pallets change the current shipping processes. A smart pallet can signal the user if it is not being filled within the allotted weight. The additions of more smart devices will allow autonomous decision making in the supply chain management. For instance, a warehouse stacking robot can automously make inventory restocking decisions.

- *IoT adoption:* The important question how can a company leverage data, which is collected through smart IoT devices and analyzed through machine learning algorithms, in such a way that the data can provide valuable insights and allows to make decisions towards increasing the profits overall. In Internet of Things (IoT), smart devices are deployed in factories and warehouses and they are generally connected with each other and the data is mostly stored in the cloud. The deployed sensors such as heat and light sensors in warehouses can alert the managers if there is a possibility of the stored items being damaged such that an action can be taken in a timely manner.

- *Industry 4.0 integration:* Logistics 4.0 can be integrated with Industry 4.0 systems allowing the manufacturers and shipping companies to get connected to achieve increased efficiency and reduced costs. This integration will help the creation of global supply chain which is more agile and smarter.

- *Better living through analytics:* One of the most essential aspects is to leverage big data through predictive and prescriptive algorithms in a such a way that supply and demand can be balanced, reducing wasted time, Money and resources. The prediction can even go further as to companies could potentially predict and ship the purchases for the customers before they place their orders.
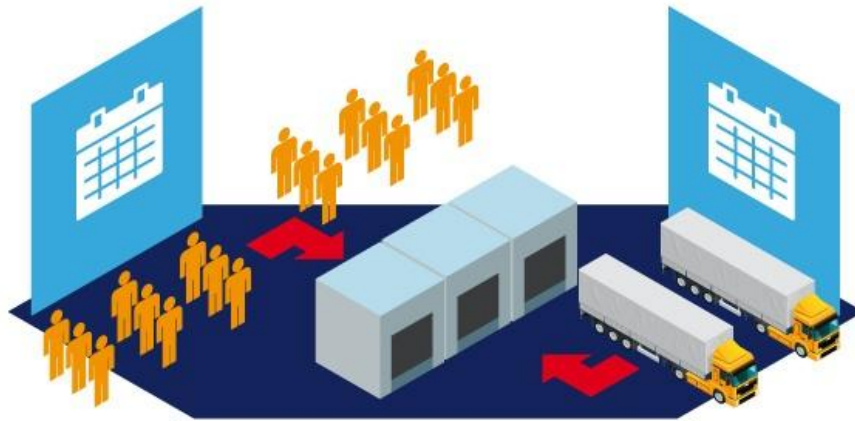
Figure 4. Five Key Elements of Logistics 4.0 [10]

Source:https://blog.flexis.com/5-key-elements-of-logistics-4.0

Intelligent Technologies which are considered computer-aided systems that fully control all business processes are increasingly entering into transportation areas They can work independently and be able to manage the entire process independently [12].

When Industry 4.0 is formed, transport logistics is expected to play an important role in addition to data logistics. This refers to all the elements in the transport chain. In larger areas, this is already in place and used in a number of various applications such as flexible route planning based on traffic situation or weather forecasts, software-assisted management of traffic flows and so on. The introduction of intelligent, self-driving vehicles in a traffic infrastructure based on the Internet of Things will open up new dimensions and bring more automated and flexible logistics solutions.

Intelligent transport systems include autonomous vehicles that can independently detect their environment using laser scanners, infrared sensors, and RFID chips, and can go independently to their chosen destination. These devices, which do not have a central control system, are concerned with the transport orders between them, set the rules governing the right of way and share information about the position of each vehicle in the warehouse. Since each shuttle processes information in a decentralized manner, the entire control system spreads through a series of virtual shoulders.

4. TECHNOLOGIES SHAPING THE LOGISTICS

3D Printing

3D printing (3DP), also known as additive manufacturing, is one of the most important links of digital transformation and evolving supply chains. It has the potential to dramatically change the traditional production and logistics sectors [1]. 3D printing is essentially a technology that allows an individual to take a digital image and turn it into a physical object. These printers use an additional process to place layers of consecutive materials until an object is created. Many industries are using 3D printing for different purposes. Technology, architectural models, movie scenes and so on. The use of 3D Printing for fast manufacturing in the manufacturing industry allows shortening of supply chains, lowering transportation costs and minimizing the need for security stock. 3D printing technology enables manufacturers, other businesses and even individuals to print full copies of parts and products using metal, plastic, composite materials, and even human tissue. The impact on logistics will be important. A car produced in a factory has about 30,000 tracks, a 3D car with only 50 tracks. Instead of supplying parts from all around the world, 3D printing can achieve consolidated production in one place, leading to a reduction in shipping and air cargo volumes. Mass customization of products will mean less stockpile management is needed as inventory levels are reduced and products are manufactured according to order.

The leading logistics providers, including 3D printing technology, need to be more efficient, more locally focused and more connected globally. The relationship between the 3D printing and logistics industries is growing each day, and in some ways, the integration of 3D printing into the field of logistics and supply chain management seems to be an inevitable development, so 3D printing has proven itself as a revolutionary innovation to production, so researching potential applications in the distribution process seems to be an important step [8]. Logistics providers should adopt the change and anticipate the impact of 3D printing on global supply chain dynamics. This will require changes to strengthen their role in the broader value chain and offer new solutions to their customers [9]. Large logistics companies such as UPS are also investing in technology. UPS wants to take orders from the customer, print them on 3D computers and deliver them [21].

Internet of Things (IoT)

The Internet of Things (IoT) enables devices to communicate with each other in an existing Internet infrastructure without human intervention. In logistics, it is expected to increase speed, reduce waste and reduce overall costs. IoT increases the logistics infrastructure and transportation of the companies to the next level. Transportation and logistics, whether by air, by road or by sea, are the most fundamental elements of many companies' productivity and access to real-time data [15]. Companies need fast data flow about these networks when making decisions. As a result, transportation and logistics companies are quick to see the benefits of new sensor and connection technologies, and they are at the forefront in the transition to the world connected to the Internet. In 2015, a McKinsey survey predicted the IoT to create an economic impact of $11 trillion by 2025. Companies that offer logistics software solutions use more than one IoT for users to increase speed, reduce waste, and reduce costs for their customers. For example, IoT can be used for asset tracking, inventory management, ordering and forecast maintenance among others [21].

Drone

Drone is small unmanned or autonomous aircraft that can deliver products to customers. It will also help reduce delivery time and reduce costs in the long run. After Amazon announced its plan to use drones to deliver its products to its customers, many companies argued that this plan could not be appropriate. According to Amazon, Prime Air will deliver the product within 30 minutes of placing the order. Although this new type of logistics technology is not yet ready for large scale use, big steps are being taken [21] [19].

Driverless Vehicles

Driverless vehicles are capable of navigation without human input. In November 2015, Google presented a proposed design for a self-driving vehicle to the US National Road Traffic Safety Administration (NHTSA). Driverless vehicles can become an integral part of a logistics software solution, can reduce turnaround times and human errors, and ultimately help companies recover costs [21]. In addition, the latest technology in the logistics area is autonomous trucks. Currently, this technology is in testing for most organizations. Vehicles use the combination of camera and radar to remove the human intervention. As a result, lower costs and accident risks will be greatly reduced. In the future, the logistics sector will be a part of our daily lives. In order to remain competitive in the logistics industry, organizations must start learning and developing these new technologies [6].

<div align="center">

CONCLUSION

</div>

Industry 4.0 brought many positive changes while moving towards a technological future – supply chain 4.0 and smart logistics are among the most important ones. The important new sector that will affect the logistics industry is believed to be related to the storage and transport of raw materials that feed the 3D Printers. As 3D printers become affordable to the customer, the home distribution market of these materials will increase. The changing supply chain dynamics will lead to the evolution of a new type of logistics company. The new logistics company will design solutions including demand planning, production, delivery, market monitoring, service part management, and return and recycling services [16]. In a survey study, almost half of online shoppers showed that they left a reseller because of poor order tracking and transparency [20]. Recently, better tools for increased Internet access and online shopping have led to an increasing number of shipments and possible delivery locations for companies delivering goods. For example, in 2016, the Deloitte Holiday Survey revealed for the first time that customers were planning to spend online as much as in stores [4].

Industry 4.0 has many different effects on logistics. Industry 4.0 will affect all of the stages of supplying the right product, in the right amount, in the right way, at the right time, from the right source, at the right price. Logistics promises remote access payment for operators, corporate customers and end consumers. This benefit extends across the entire logistics value chain, warehouse operation, freight transport, delivery to the end user. Thus it will have a significant impact to solve problems in areas such as operational efficiency, safety and security, customer experience, new business models.

Sensors and cameras will be able to calculate the risks, imperfect storage, and calculate the probability of a possible element falling. In the future, employees will integrate with their smart devices and bring a different dimension to communication between man and machine. Efficiency will increase with intelligent walkways and smart warehouse management that will make it easier for workers to work. With active and passive RFID technology that enables mobile localization, we will be able to monitor the movement of objects more easily. By adding heat and lighting sensors to the smart warehouse processes, energy and expense savings can also be provided. Thanks to sensors, you will be able to monitor how often you use trucks and containers. Thanks to fleet management, it will be an important factor in increasing profitability by providing significant fuel savings [5].

REFERENCES

[1] Additive Manufacturing (3D printing). http://www.panalpina.com/www/global/en/home/products_solutions/logistics /3d_printing.html. [Accessed: 15 December 2018].

[2] Aunkofer, B. (2013) Industry 4.0 – The Story https://www.der-wirtschaftsingenieur.de/index.php/industrie-4-0-die-story/. [Accessed: 16 December 2018].

[3] Coronado, V. (2015). What is the future of logistics (Freight Transportation)? https://www.linkedin.com/pulse/what-future-logistics-freight-transportation-victor-coronado. [Accessed: 15 December 2018].

[4] Deloitte Holiday Survey 2016. https://www2.deloitte.com/insights/us/en/industry/retail-distribution/holiday-retail-sales-consumer-survey-2016.html. [Accessed: 20 December 2018].

[5] Dijital Sanayi Devrimi 13: Endüstri 4.0 ve Lojistik (2017). https://industryolog.com/dijital-sanayi-devrimi-endustri-4-0-lojistik/. [Accessed: 20 December 2018].

[6] Futuristic Technologies that are Reshaping Logistics Now. https://www.clearspider.com/blog-futuristic-logistics-technology/. [Accessed: 18 December 2018].

[7] Galindo, L.D. (2016). The Challenges of Logistics 4.0 for the Supply Chain Management and the Information Technology, Master Thesis, Spring 2016, Norwegian University of Science and Technology.

[8] Goulding, C. (2018). 3D Printing and Logistics – A Natural Progression of Opportunity, https://3dprint.com/212915/3d-printing-and-logistics/. [Accessed: 15 December 2018].

[9] Heutger, M. (2017). DHL: How 3D printing is disrupting the logistics industry, https://www.supplychaindigital.com/logistics/dhl-how-3d-printing-disrupting-logistics-industry. [Accessed: 17 December 2018].

[10] Hoey, B. (2018). Five key elements of Logistic 4.0, https://blog.flexis.com/5-key-elements-of-logistics-4.0. [Accessed: 17 December 2018].

[11] Industry 4.0: the fourth industrial revolution – guide to Industrie 4.0. https://www.i-scoop.eu/industry-4-0/. [Accessed: 20 December 2018].

[12] Kesayak, B. (2017). Endüstri 4.0 ile Lojistiğin Değişen Yüzü. http://www.endustri40.com/endustri-4-0-ile-lojistigin-degisen-yuzu/. [Accessed: 16 December 2018].

[13] Khaksari, S. (2018). Logistics Industry 4.0. https://medium.com/@sajjad.khaksari/logistics-industry-4-0-b132f0a8f391. [Accessed: 16 December 2018].

[14] Logístca, S. (2014). Supply Chain, http://www.salvesenlogistica.com/en/servicios/logistica-integral. [Accessed: 15 December 2018].

[15] Lojistik ve Ulaşım Bazlı Nesnelerin İnterneti (2016). https://ioturkiye.com/2016/12/lojistik-ve-ulasim-bazli-nesnelerin-interneti/. [Accessed: 17 December 2018].

[16] Manners-Bell, J. and Lyon, K. (2014). The Implications of 3D Printing for the Global Logistics Industry. https://www.supplychain247.com/article/the_implications_of_3d_printing_for_the_global_logistics_industry. [Accessed: 20 December 2018].

[17] McKinsey & Company (2016). Supply Chain 4.0 – the next-generation digital supply chain, https://www.mckinsey.com/business-functions/operations/our-insights/supply-chain-40--the-next-generation-digital-supply-chain [Accessed: 15 December 2018]

[18] Nguyen, D.H., de Leeuw, S., and Dullaert, W.E.H. (2016). Consumer behaviour and order fulfilment in online retailing: A systematic review," International Journal of Management Reviews, vol. 20, issue 2.

[19] Rahman, M. (2016). The future of logistics technology. https://www.morethanshipping.com/future-logistics-technology/. [Accessed: 17 December 2018].

[20] Supply Chain Quarterly (2016). Survey: Online shoppers demand visibility as well as speed in delivery. www.supplychainquarterly.com/news/20161004-survey-online-shopper--demand-visibility-as-well-as-speed-in-delivery/. [Accessed: 20 December 2018].

[21] Vacca, H. (2016). Four Technologies Set to Change the Future of Logistics https://www.inboundlogistics.com/cms/article/-four-technologies-set-to-change-the-future-of-logistics/. [Accessed: 17 December 2018].