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DISRUPTIVE TECHNOLOGIES IN LOGISTICS INDUSTRY AND THEIR POSSIBLE EFFECTS ON INTERNATIONAL TRADE

Cansu KARABULUT* Mustafa Emre CİVELEK**

* İstanbul Ticaret Üniversitesi, ORCID: 0000-0003-3634-3630 cansu-karabulut@hotmail.com
** Assoc. Prof. .Dr. İstanbul Ticaret Üniversitesi, ORCID: 0000-0002-2847-5126 ecivelek@ticaret.edu.tr

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Abstract

The concept of disruptive technology is used to describe the development and evolution of innovative products or services that destroy, destruct and replace existing products and services that already exist. Production methods have changed radically with the rise of digital economy in recent years. Thus, the need for people continues to decrease significantly. Jobs in various sectors have become fragile due to accelerated automation. Advances in artificial intelligence technology, in particular, change processes in many branches. Foreign trade is affected by these developments. Disruptive technologies, especially in international logistics, will accelerate this change. The purpose of this article is to examine the effects of disruptive technologies emerging in the field of logistics on international trade.

Keywords: Disruptive Technologies, International Trade, Logistics, 3D printers, Drones, Warehouse Robots

1.INTRODUCTION

The volume of international trade is rising with globalization, technological developments and foreign investments as the rapid movement of labour, services and capital between countries. The growth in international trade has brought the fastest and most affordable prices to the agenda of the international trade, leading the growth of the logistics sector. These two sectors, which grow each other positively, are also interconnected. Each investment in logistics infrastructures reduces transit times and logistics costs, while increasing efficiency and competition. Increased productivity and competitive environment contribute to the development of international trade (Navickas, Sujeta, & Vojtovich, 2011). Logistics operations, which cannot be executed efficiently without having a strong logistics infrastructure, become a factor that restricts the development of foreign trade (Devlin & Yee, 2005). Therefore, there is a positive correlation between both sectors (Gani, 2017). A good logistics strategy for sustainable international trade should be established and adapted to technological developments.

Disruptive technologies produce a new value by offering a service or product that did not exist before compared to existing technologies (Charitou & Markides, 2003) and it is radical discoveries that will upset existing competencies and change the business environment (Bower & Christensen, 1995). Disruptive technologies render entire industries obsolete, giving a new dimension to existing competition led by new technologies (Christiensen, 2003) which offers cost advantages by improving work flow processes and increasing efficiency (Bengtssın & Wang, 2016). The main criteria of

disruptive technology are being cheaper, simpler, smaller and more convenient (Christensen, 1997).

Consumers will create the personalised supply chain of the future with 3D printers that offer access to personalized products instead of standard products provided by mass production, robotic technologies and drones that provide delivery opportunity to the customer at the nearest point by shortening the production and logistics processes.

As a new Industrial Revolution, 3D printers will change the dynamics of the supply chain, the concept of the geography in which the industry is spread, the strategies and competition of companies (Sasson & Johnson, 2016) and will make logistics processes efficient and increase productivity overall (Civelek, 2018). Deliveries with drones, robots used in warehouses as well as 3D printers are today's disruptive technologies that positively affect the development of one another reciprocally. With these technologies, the ownership of the product (the ability to produce customized products with 3D printers), production locations (getting widespread of robots cause the movement of the production facilities from the countries where labour is cheap to the rich countries that can allow robot employment) and the importance of logistics for these products in international trade will completely change. In the light of these developments, it should be evaluated what products will be needed for trading in the future, where the products will be produced and how they will be transported.

2.POSSIBLE EFFECTS OF 3D PRINTERS

3D printers are devices that produce raw material in three dimensions according to the specified digital design, which is also known as "additive manufacturing". The term additive is used for defining the products that are produced in three dimensions by adding two dimensions onto each layer in the different material (Petersen, Laplume, & Pearce, 2016). This is the process of "printing" each layer until the three-dimensional product is created. 3D printing was invented in 1986 by an American inventor named Chuck Hull (Abeliansky, Martinez-Zarzoso, & Prettner, 2015).

The former US President Barack Obama describes 3D printers as " the potential to revolutionise the way we make almost everything" in his speech in 2013 (Cnn.com, 2013) and they are considered to be one of the most important disruptive trends in the near future (DHL Trend Research, 2016). With 3D printers, the location of the productions and production inputs will change. Instead of producing at a single point traditionally, it is possible for 3D to perform production at many different points: at home, in neighbourhood hub or city-scale hub (Boon & Wee, 2017). 3D printing promises to transform centralized production and supply chains activities into individual practice (Holmström, Partanen, Tuomi, & Walter, 2010). When considered from this point of view, 3D printer is one of the developments that is expected to shed light on the Third Industrial Revolution (Rifkin, 2011).

Today, there are many productions with 3D printers in many sectors. To illustrate; Nike's performance shoe Flyprint that was produced with 3D printed fabric, Adidas' 3D Runner sneaker, many automobile companies and airline business such as Mercedes, BMW, Boeing and Airbus which produce their spare parts by 3D, dental/aural healthcare products, customized 3D-printed earphones, toy giant Mattel which has partnered with Autodesk to launch ThingMaker&Feetz for kids in order to design, create and print their own toys, the first 3D-printed electric car called Strati, HuaShang Tengda which managed to do 3D print and construct a 400-square meter home in just 45 days, and Russian

company Apis which is capable of producing houses in one single day by 3D printers (DHL Trend Research, 2016). With many positive features they offer and increasing sensitivity among consumers with the attention of climate change and ecological degradation, the notion of 3D printing boosts interest in environmentally-sensitive products and production (Brenton, Edwards-Jones, & Jensen, 2019). Therefore, 3D printers are becoming widespread since 3D printers allow flexible production of personalized products, not requiring the need for any other tools (Kleer, Piller, & Weller, 2015). They also enable production in a single process by reducing complex production times and assembly needs (Kleer, Piller, & Weller, 2015) and eliminate the complex manufacturing process into just 3 steps: scanning, modelling and printing (Sharma, 2013). 3D prints, which enable customization and offer the opportunity to supply products to the consumer at the closest point, have a shifting effect on supply chains that make a difference with their costs of dispersal and expertise (Baldwin, 2013), supply chain sustainability (Ford & Despeisse, 2016), creating new business models (Rayna & Striukova, 2014), customization of product and enabling diversity of designs without cost penalty, reduction of logistics costs (Berman, 2012), providing flexibility in production by producing without the need for any order (Kleer, Piller, & Weller, 2015), enabling the disappearance of inventory costs with production-to-order processes (Mavri, 2015), reducing long delivery times and transportation cost (Holmström & Partanen, 2014). Besides these, product prototypes which are produced with 3D help in the innovation process to see the market and conditions in the new product production process (Romero & Vieira, 2016), changes in the recycling process, and they are easy to use with standard CAD software (Sasson & Johnson, 2016). Other positive contributions can be outlined as such: elimination of the assembly phase and the reduction of labour costs so manufacturer can provide cost advantage, since" mass customisation" is made, the stock levels of the companies will decrease hence the storage costs will decrease, they allow companies to diversify rather than working on a single product and providing an advantage against risks and gaining diversity, eliminating the keep stock for spare parts that need to be supplied even years later, regional production without the need for long logistics since the production is close to the main market so it reduces the costs stem from human error, inventory, transport, prototyping, and help to decrease CO_2 emission.

Considering these positive effects, 3D printers become an indispensable part of our daily lives, but some obstacles slow the rapid progress of this destructive technology. For some products, the existing materials used in 3D printers are not diverse to match the material structure used in traditional production (Berman, 2012). In addition, high production cost occurs due to raw material and energy cost; and hence, 3D printers are not economies of scale yet. Slow adaption and not having the availability of skilled designers, lack of talent training related to the use of 3D printers and concerns about the quality of manufactured products and environmental factors and durability can be considered as the other relevant impeding factors.

In spite of all these constraints, the positive effects are evaluated. 3D printer usage is expected to become widespread. According to ING Bank's 2017 report, 50% of trade will be done with 3D printers by 2040, therefore global trade will decrease by 40%, according to the same research 3D sanctions have increased by 29% in the last five years, while investment in traditional production machines has increased by 9.7% (ING, 2017). It is important to consider how international trade and logistics industry will be affected and transform due to the expectation of such a high rate of change. It is clear that reshoring

will take place with the most basic effects, and there will be no need for logistical operations made from the other end of the world for the finished products. However, in order to estimate the size of the transformation, the following questions must be considered: For 3D printer costs and cost savings, competition with international trade is not regulated, but how does competition progress if these costs are reduced? In this case, does the production move from countries where labour and raw materials are cheap to "high-purchasing" countries with "near-sourced" despite the high 3D printer cost? Can customers who want to buy customized products; even if the raw materials are expensive, afford these high costs? With technological developments, can 3D printers and production costs become cheaper or even if it is expensive; is it possible that 3D printer use will spread due to preferences and conditions? In that case many results may arise: how will the market structure change for labour-intensive production? What will happen to the manufacturers that produce intermediate goods because printers produce the finished product directly? Does international trade turn into raw material trading that will be used in 3D printers rather than finished product trading? If 3D printers replace the current form of production and international trade, how will the import and export procedures of products that do not physically cross borders will work? In this case, because the taxes on the finished product are higher than the taxes on the raw materials, governments should prevent tax loss by arranging taxes in the foreign trade of raw materials used in 3D printers. Legal arrangements must be made to protect all users and industries, not just the international trade and logistics sector. Even if the government regulates the sales of the products produced with 3D printers in the domestic market and international trade with certain legal regulations, customs broker companies will not be needed for the products that do not physically cross borders. Or how will the design and patent rights of the products be protected and what will happen in case of infringing? Who will be responsible for the design and product risks, what will be the warranty coverage of the products? How will the legal responsibility regulation of the products be produced with 3D printers, for example, how will it be possible to prevent the production of illegal substances or dangerous vehicles through these products?

With the ease of "on-site production" that reaches the end user's home or the region, the long travel between countries of products will be finished and the logistics sector will have to transform. Logistics companies, whose volumes are falling, will lead these hubs, or they will ship the products manufactured in 3D by serving as "last mile" in areas close to the consumer. Raw materials may still be transported by cross-country logistics activities, but strong local logistics services will be needed to deliver the production in 3D printer hubs located close to the consumer. For example, UPS delivers the products of customers' choice of materials, colours and designs via UPS cargo with the Cloud MDM project which contain 100 pcs of 3D printers. Or, with a hybrid solution, 3D printers are used only for the urgent products or consumers' experience, while preserving the existing commercial structure. The answers to these questions depend on economic conditions, technological developments and the development of 3D printers. But considering the size of the total merchandise trade import and export of the world countries (Table 1.), international trade and logistics industry dignitaries and policy makers should explore the points at which the industry will evolve and ensure efficient transfer of resources by making common sense.

Table 1: Total merchandise trade import and export in 2019

	Export / Million US Dollars	Import / Million US Dollars
European Union	5.813.235,60	5.526.696,10
China	2.499.028,90	2.077.097,10
United States	1.645.625,50	2.568.406,90
Germany	1.489.158,40	1.234.222,20
Netherlands	709.229,50	635.967,40

Source: (WTO, 2020)

3.POSSIBLE EFFECTS OF WAREHOUSE ROBOTS

Even many years ago, robots were seen as technologies that performed repetitive and easy tasks. Today there are robots that learn human movements by copying them as like Robot Sawyer which is the new generation collaborative robot (portofrotterdam.com, 2020). In the future, robots will be able to perform more challenging tasks, being equipped with assessment and decision-making capabilities (Civelek, 2019).

For example, with Kiva Robotics, which Amazon acquired in 2012, investment regarding technology was made in its warehouses, reducing the need for people working in warehouses by 80%, while increasing the storage capacity with shelf arrangements by self-optimise and increasing productivity and collection speed at the same time. And while it provides a competitive advantage with total cost saving, it also provides guidance for logistics companies and other companies (Culey, 2018). The warehouse robots of Alibaba, which can travel 5 feet per second and carry a load of up to 500 kg, are another example of warehouse robots that are of great importance in the logistics of the future.

Supply chain operations involve a complex process, as well as the layouts of the warehouses are unique and specific processing may be required to process each order. Therefore, there are many areas where robotic technologies can be used in warehouses. (1) The correct placement of the products in the warehouse and the fact that they can be found with less effort provides a cost advantage by increasing operational efficiency (Tinelli, Vivaldini, & Becker, 2013). (2) Robots are able to collect and place orders from the shelves continuously and without interruption, and perform accurate inventory counting. (3) By calculating the usage of human and forklift, the shelves placed far away from each other can be redesigned according to the processing area of the robots, and the space between the shelves can be shortened and space is saved in this way. (4) By eliminating dangerous jobs with robots, more efficient and stronger operational management is possible, especially in repetitive jobs.

The use of robotic technologies is particularly important in warehouses, which constitute an important part of logistics activities. This technological change also manifests itself in ports which are one of the most important service providers of international trade and logistics sector. A logistic activity is carried out in the port of Rotterdam at the automated RWG terminal, where almost everything is handled automatically. Rotterdam port is also becoming a smart port with 125 meters long robot cranes and automated guided vehicles that serve completely unmanned and proceeding new projects such as self-driving ship (drones ship), which is considered safer, cheaper and more efficient than ships under human management, and Smart containers can measure parameters such as vibration, location, sound, air pollution, humidity, temperature, and communicate with other

equipment (portofrotterdam.com, 2020). According to the Review of Maritime Transport 2019, 793.26 million TEU were loaded in 2018 and global container port traffic increased by 4.7% compared to the previous year. The annual average growth of 2019-2024 is expected to grow by 3.4%. (UNCTAD, 2019). In line with the increase in international trade and port traffic, it is necessary to accelerate and facilitate operations at ports, increase efficiency and reduce costs; therefore, automation of port operations appears to be inevitable.

4.POSSIBLE EFFECTS OF DRONES

Drones, originally used for military purposes and known as unmanned and remote control aircraft, are used both in military and commercial activities today for a variety of purposes. To illustrate, drones are used in crop and livestock monitoring, irrigation management and fertilization activities in agricultural sector. Given that, it is possible to examine the regulations that must be followed for the safety of workers in the construction and mining industry with drones and apply them easily. In addition, insurance companies will use drone technology more to provide faster and more accurate assessment of possible accident and disaster situations (Businessinsider.com, 2020). According to a survey, the proportion of supply chain leaders considering investing in drone technology increased from 13% in 2018 to 22% in 2019 (Statisca.com, 2020).

In 2016, the drone industry has grown considerably due to the exemption granted by the Federal Aviation Administration (FAA) to drone operator companies. According to the research of Business Insider Intelligence estimates that the drone services size will rise to $ 63.6 million in 2025, while by 2021, drone use turnover in consumer shipments will have reached $ 29 million (Businessinsider.com, 2020).

According to the survey, it is expected that 7.8 million shipments will be carried out by drones and 3.3 billion dollars will be generated by 2020 and drone technologies' total market size will reach $100 billion between 2016 and 2020 (Goldmansachs.com). In this case, the logistics sector needs to adapt to the transformation both for its sustainability and to meet the demands of its customers. For example, Henry Schein, who provides healthcare solutions in dental and medical practitioners that develop cooperation with UPS, will deliver a drone to its customers in 2020 (Ups.com, 2020). Airbus UTM (Unmanned Traffic Management) has partnered with drone software company DroneDeploy to develop airspace authorization and flight briefings for commercial drone pilots, when a drone pilot plans a flight with DroneDeploy, Airbus UTM will help ensure a safe and efficient operation by evaluating airspace security and regulations (airbusutm.com, 2019). Swiss Post generates an added value for urgent healthcare services by using drone to carry laboratory samples (Post.ch, 2020). Drones are also used in large warehouses with their sensors and special software, making it easy to access instant data, saving time and reducing stocks count errors. (Culey, 2018).

The use of drones in last-mile logistics services has gained importance especially with the development of e-commerce, and it is inevitable in the future. Despite this development, it is seen that drones will be included in international logistics activities as well. To illustrate, the Delft University of Technology designed an unmanned containerized cargo freighter, called ATLAS. In order to aiming to shorten the time required for intermodal transportation and road transport, while reducing the cost of air cargo for larger volumes. With the Black Swan drone project, the Dronamics company will be able to carry loads up to 350 kg to a distance of 2,500 km with 50% more cheaper

than air cargo (Mendes de Leon & Buissing, 2019). The fact that drones provide transportation services over long distance shows that it is possible to load with drones in international trade and logistics. It may perform international deliveries in countries close to each other by drone for emergency spare parts or medical medicines at critical times or for critical diseases. Therefore, the security, privacy and use of airfields should be regulated for the use of drones in international trade (World Customs Organization, 2019). The widespread use of drones in international trade will also affect customs and this effect is expected to be twofold: the customs can be an area where drones find use, so they can be used for inspection in areas or borders where it is difficult to control, or they can be the regulatory authority of the product delivery with the drone. In this context, cross-border trade and illegal smuggling of illegal substances should be prevented with measures to be taken at the customs (World Customs Organization, 2019). Concerning the way to prevent smuggling and illegal product shipments, there are different questions: (1) Will the legal responsibilities belong to the owners of the drone or the product owner in the loading made with the drone? (2) How and by whom will the customs declaration of the products carried by drones be made? (3) What kind of arrangements should be made at the customs to monitor the cross-border movements of drones? (3) Will there be a specialized customs application for drones or will a separate customs administrations be established for drones?

However, the concerns do not just end with how customs procedures will be regulated. There are more considerations to be taken into account: who will operate these drones, who will organize the drone delivery of the products from the retailer, how will traffic flow and legal regulation of drones be managed, low value products can be transported by drone but how do customers react to the transportation of high value products such as diamonds?

5.CONCLUSION

Digital transformation is no longer an option, but it is imperative. In order for each company operating in the logistics industry and international trade to continue its activities and maintain its competition, they need to analyse which areas they should transform in their businesses and in which areas they are under the influence of disruptive technologies.

While some industries will not be able to transform with 3D printer technology, some industries have already been affected and some industries will soon be under the influence of 3D printers: natural raw materials such as wood, leather, petroleum, basic metals are not suitable for production with 3D printers due to their granular structure and texture; the industry of these raw materials will not be under the influence of 3D printers. However, industries based on simple products that are small size and contain a single material such as sporting goods, toys etc. are already the areas where 3D printers are used. And some sectors such as food products, wearing apparel, electrical equipment etc. are expected to totally adapt to 3D technology more over time, even though it has started to be affected at a minimum level (Petersen, Laplume, & Pearce, 2016). For this reason, businesses should question themselves and their future in terms of which products and parts can be produced in 3D and what ones are not possible to be produced in this way. While the growth and targets are being designed, the digital transformation of the industry and market trends should not be ignored.

In today's production world, where production has evolved from mass production to individualized mass production, it is impossible for our business patterns to remain the same. Robots should be used in production areas and warehouses for production suitable for each different customer preferences without stopping the production line. Increasing and activating the use of robots will also change management promotion in businesses, and in businesses where fewer people work, managers will not need to develop skills such as directing, motivating their employees, and solving problems between the employees (Civelek, 2019). In this case, it will also lead to a decrease in unethical events such as theft, harassment and corruption in businesses (Civelek, 2009). For these reasons, the definition of management should be reconsidered considering human and robot employees (Civelek, 2019).

The individualization of production through the impact of disruptive technologies, the importance of delivering the easiest and fastest delivery to the consumer offers a variety of opportunities and changes for logistics and international trade companies.

All these disruptive technologies need to be considered as technologies that affect each other and enable them to thrive, rather than separating them from each other. Although these technologies do not completely replace existing technologies today, they are used alongside traditional production and logistics activities with a hybrid modelling. Especially in critical times, it is possible to prevent possible problems by using these technologies together with existing processes as a hybrid model. For example, during the Covid-19 pandemic, which has recently affected the whole world, these destructive technologies have combined with existing processes to add value to life. In a hospital that needs respiratory machines in Italy, when the respiratory valves required to connect patients to the machines are insufficient, Cristian Fracassi, the CEO of Isinnova company, responded to the situation quickly and helped save the lives of as many patients as possible by producing 100 breathing valves with a 3D printer within 24 hours (Forbes.com, 2020). The cargo company UPS and pharmaceutical company CVS have developed a partnership to deliver prescription drugs with drones to an area called The Villages where people over the age of 55 live. Thus, while preventing the spread of the pandemic, fast shipment in emergency situations or access to the needy in difficult-to-reach areas were provided (Businessinsider.com, 2020).

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