Review of Modern Transportation Technologies with focus on Containerization

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Abstract

Modern transportation technologies emerged in the mid-20th century and their appearance changed the current course of the transportation of goods. The use of modern transportation technologies in transport processes results in faster, more efficient and safer transport of goods from the sender/consignor, the manufacturer, to the receiver/consignee, consumer or customer. Container, i.e. containerization is one of the most important transportation technologies with significant impact on the development of international trade and globalization from the 1960s until present time. The aim of this paper is to review the role of containerization, as the most significant transportation technology. The results show an ever growing yet slower trend of containerization during past years that is likely to continue in the upcoming period . In the future, challenges can be expected in the container business especially in the field of digitalization and automation. This paper contributes to the valorization of containerization and points to the important role of infrastructure as a support to the realization of the potential of containerization in future.

Keywords: modern transportation technologies, containerization, container, box

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1. Introduction

Modern transportation technologies play a key role in the ubiquitous globalization process. The globalization process has led to the phenomenon that the whole world can be seen as a single market, and this creates the necessity for daily development of business entities and their business operations. The emergence of the globalization process has further highlighted the need to use transportation technologies. With the emergence of globalization, technological progress and modernization of transport and transport manipulations have emerged as another milestone that has had a significant impact on modern transportation technologies. Business development is necessary in order to maintain the existing level of competitiveness on markets where they operate, but also to achieve new competitiveness through the growth of international trade. The integration of modern transportation technologies into transport processes has contributed to this development. Modern transportation technologies have enabled, and still continue to do so, continuous transport of goods in efficient, secure, fast, and cost-effective manner. Despite the importance of all transportation technologies, the invention of container and the emergence of containerization have had the greatest impact on the economy; therefore, the aim of this paper is to re-open the question of the role of containerization as the most significant transportation technology and its position on the global market. Furthermore, future challenges of container business are discussed such as the adoption of digitalization and automation. The paper consists of five interconnected parts. After the Introduction, the second part of the paper provides a theoretical overview of containerization. The third part of the paper reviews the global role of containerization, while the fourth part discusses the future of containerization. The fifth part is the conclusion, which synthesises the entire paper.

2. Theoretical Framework of Containerization

Modern land-based transportation technologies include palletization, containerization, Huckepack technology, and bimodal technology. In the land and water transport, these technologies include palletization, containerization, Huckepack technology, and RoRo, LoLo, and FoFo technologies. The land-air transportation technologies include globalization and containerization. However, of all transportation technologies, containerization has the leading role in terms of effects on the transport growth and international trade. Namely, containerization is one of the largest commercial innovations of the 20th century that has enabled faster transportation and manipulation, and lower costs enabled the business sector to procure materials and goods from almost all parts of the world [15]. Container was commercialized in 1956 and its simplicity and modularity has made it the mode of choice for the transport of many goods from one place to another Since the 1960s, the use of shipping containers has led to a revolution in ships, freight and maritime transport. Today, 23% of dry seaborne trade

tons is being transported by containers and almost 100% of everyday goods such as clothes, medicines, toys etc. [8]. Namely, until the invention of containers, freight transport was characterized by several intermittent transports with different modes of transport and with several different transport documents, with increased handling costs, frequent damages and cargo thefts, higher packaging costs, higher insurance costs [6]. This has changed in the sense that freight transport has been combining several different modes of transport with a standardized container containing the cargo and taking into consideration the fact that the entire transport, from origin to destination, is covered by one transport document.

Several important factors have influenced such strong development of containerization at the global level [7]:

- technological standardization of containers, container ships, truck trailers, railway wagons, river barges, and ships has enabled containerization to develop uniformly in all modes of transport;
- efficiency and speed of handling operations have resulted in lower transshipment costs and significant reduction in transit time of goods from shipper to consignee;
- stacking of goods in containers has reduced the cost of packaging;
- possible damages and thefts of goods have also been minimized due to the storage of goods in containers;
- the trend of bulding large-capacity ships has reduced the transport cost per container;
- multimodal transport has simplified transport documentation, especially through multimodal bills of lading issued by multimodal transport companies.

Containerization has led to many changes in land and sea transport; one of them being that, once loaded into a container, the goods are not unloaded from the container until the end of the transport process. This has led to deterioration of various ports or to their modifications, because shipping containers would be directly transshipped, either onto trucks, or further shipped via rail to their final destination. Transportation of goods by rail has also faced various technological changes, including those related to HUCKEPACK and bimodal modern transport technology. Although positive, technological progress may prove devastating for the industries that fail to adapt to it. Taking into consideration the changes that have been taking place in road transport, one of them being door-to-door service (which also implies faster delivery time of goods), road transport started leaving railway transport behind [13].

Containers are used in all transport branches and thus can be considered as part of the means of transport, i.e. the space used to store the freight being transported. „Containerization is a set of organizationally interconnected means of work and technological procedures for the automatic manipulation and transportation by assembled freight units – containers, from raw material base to consumers“ [16]. Table 1 provides an overview of the goals achieved by the application of containerization.

Table 1: The Goals of Application of Containerization

1.	Reduction in packaging costs
2.	Better freight protection
3.	Formation of adjustable transport units to achieve fast manipulation
4.	Full use of vehicle space
5.	Optimal utilization of storage space
6.	Reduction in total transportation costs

Source: Authors, based on [6]

From the point of view of transportation technologies, containerization has introduced intermodal freight transport given that multiple modes of transport – ship, rail or truck – can be used in container transport without handling freight when changing the means of transport. By eliminating a large number of separate freight handling, the result of containerization is the direct connection of manufacturers with customers and the reduction in total costs of shipment of goods from manufacturer to customer [2].

Despite the effects containers have produced on businesses and their efficiency, container has also changed the interaction between countries meaning that with the creation of container, the international standardization together with „the principles of mutual reliance and linked supply chains“ have been promoted [11]. In the containerized system, each component must be aligned with all others on the global level. That means that containers themselves together with their locks, the cranes, the ships and the dockyards have to work together and match in order for the system to work. Reid states that „one country cannot independently implement a 33 foot container instead of the modern standard of 20ft or 40ft containers because the cranes, ports, and handling systems around the world could not handle them“ [11].

Finally, a significant amount of time and money of traders, i.e. importers and exporters, is being saved by shipping containers. Containers are making global trade „cheap“ and without them most consumer goods would probably be much more expensive [11]. As one of the modern transportation technologies, containerization has led to significant shifts in the transportation of great quantities of goods. It is fair to say that container traffic is the most important segment of maritime transportation and seaborne trade [10].

3. Global Role of Containerization

It is a commonly accepted fact that globalization would not exist without container [1]. Container has altered global trade by enabling chepear and faster movement of goods around the world. The growth of containerization and container trade has exceeded the growth of the value of exports and the GDP. Guerrero and Rodrigue state that „as the globalization developed, each new individual, GDP or export unit was associated with a higher level of container flows" [4].

The generally used measure of the relationship between container growth and GDP is the TEU to GDP multiplier. It is a significant ratio since it is often used in port traffic forecasting, which tend to be associated with national economic growth prospects. The following table shows the TEU to GDP multiplier in the period from 1985 to 2017 divided into four phases.

Figure 1: TEU to GDP Multiplier, 1985-2017
Source: [12]

The first phase covers the period before 1990. During taht period, the multiplier was between 2 and 2.5, meaning that for 1% of GDP growth there was 2% to 2.5% of container volume growth. The second phase covers the period between 1990 and 1999 and we can see the development of globalization and containerization when the multiplier was above 4. During the third phase, between 2000 and 2008, the multiplier droped to the level of 3 while in the fourth one, from 2009 onwards, the multiplier droped even further, to the level of 2. During the last few years the multiplier fell below 1, thus illustrating the decreasing trend where the GDP growth has lesser multiplying effects on the container shipping growth [12]. Current trade imbalances and transshipment volumes are affecting the ratio and it is expected for the trend to countinue in the upcoming period.

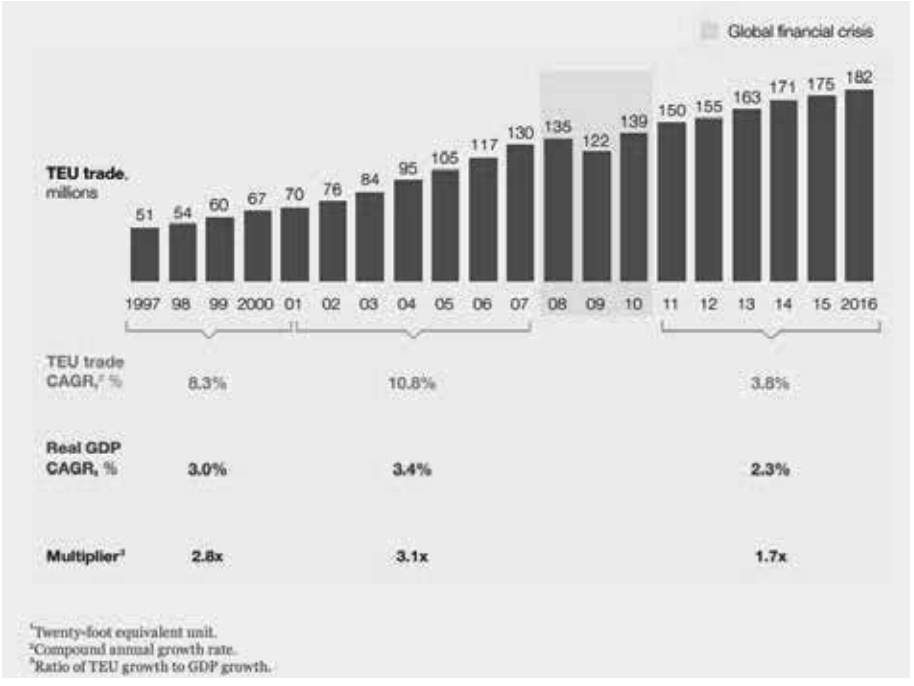

Figure 2: Global TEU trade and real GDP growth
Source: [9]

Figure 2 also illustrates the slowing trend of the container trade growth since the global financial crisis during the period 2008 to 2010. The global role of containerization is seen in the effects the world events produced on container business. We can expect that in the future the container business will continue to be affected by events on the global market.

The global economic role of containerization is also seen in the growth of container fleet [5]. As the surface, i.e. the size of ships, has increased, the space that a container ship can use to transport the required freight has also increased. The enlargement of ships refers to the ships using FoFo, RoRo or LoLo modern transportation technology. The capacity of container ships has grown significantly over the decades, which is shown in Figure 2. In 2018, the world fleet of merchant container ships had a capacity of as much as 246 million metric tons.

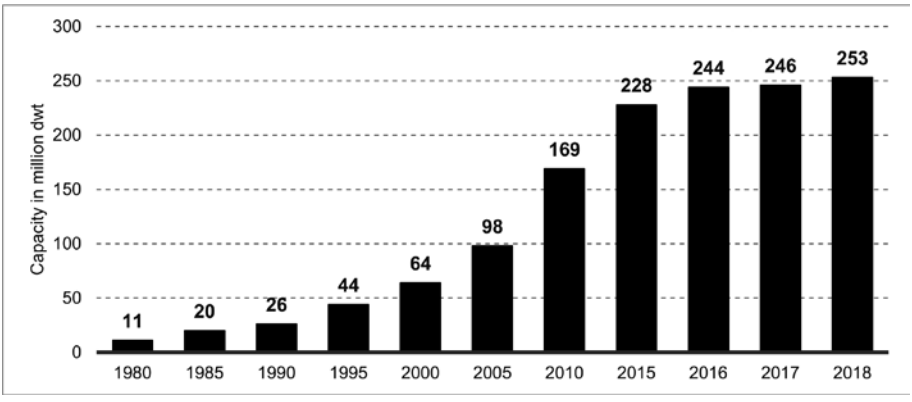

Figure 3: Capacity of Container Ships in Seaborne Trade from 1980 to 2018 (in million dwt)
Source: [14]

The demand growth in the global container market was growing at an oscillating rate between 2008 and 2019; however, it is projected that between 2016 and 2019 the demand growth in the global container market will increase by approximately 4.7 percent.

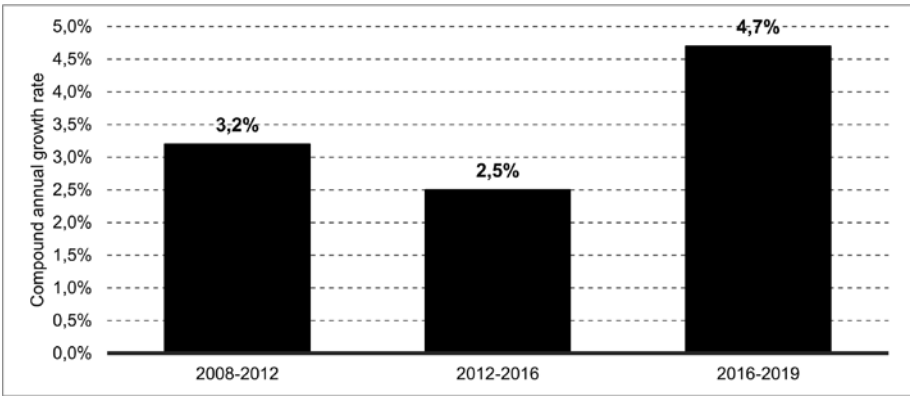

Figure 4: Global Container Market – Demand Growth 2008–2019
Source: [14]

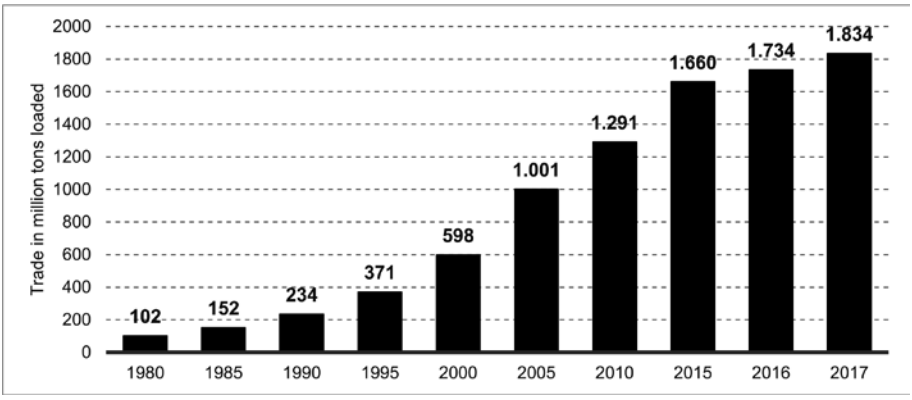

Figure 5: World Seaborne Trade – Carried by Containers 1980-2017 (in million tons loaded)
Source: [14]

Figure 4 shows the volume of the international trade transported by container ships from 1980 to 2017. There is an evident growing trend in the transport of container ships that are also responsible for the growth of international trade and globalization. However, since the financial crisis, the container trade growth has slowed down. Globally, the seaborne container freight accounted for approximately 1.83 billion tons loaded in 2017.

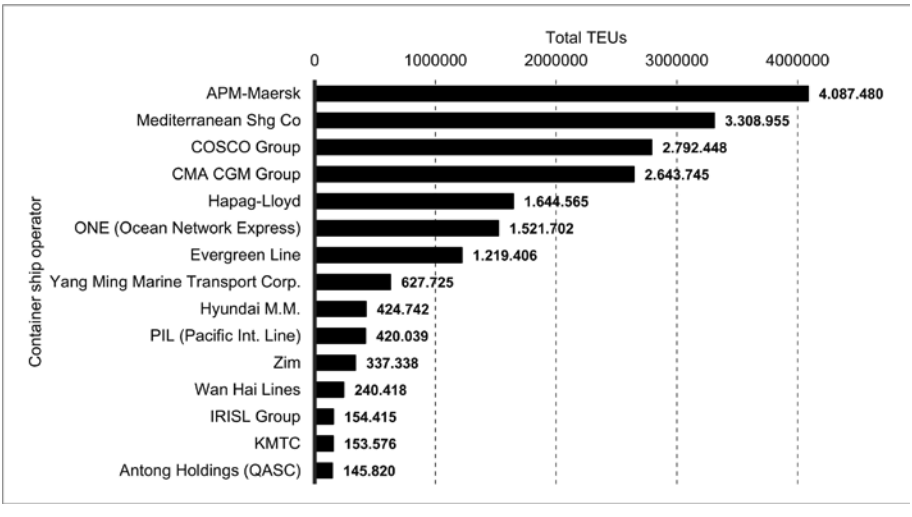

Figure 6: The World's Leading Container Ship Operators as of January 29, 2019, Based on TEU Capacity
Source: [14]

The leading container ship operators in the world are ranked by the number of ships they have in their fleet. According to the latest available data, AP Moeller-Maersk is ranked first with 715 ships. Considering the capacity of the ships, the world's largest container ship operators include the French CMA CGM, the Swiss-based Mediterranean Shipping Company, and the Danish Maersk Line.

The increase in the size of container ships has led to certain problems. For example, between 2013 and 2015, Maersk delivered about twenty ships with a capacity of about 18000 TEU. However, because of their size, these ships could not pass through the Panama Canal. Another problem that has arisen lately is the lack of adequate infrastructure in some ports. It is fair to say that the ports were surprised by the emergence of container ships of larger capacities and that only a few are able to cope with the size of the ships and the amount of freight they carry. This is why it is necessary to increase investments in the infrastructure of the existing ports so that, in the near future, they can accommodate ships of larger dimensions and larger freight space.

4. The future of containerization

Despite the changes on the global market, such as political unstability, trade wars, technological development and environmental issues, the container transport will not stop, millions of containers will continue to move around the world; however, it is likely that the industry behind the container transport will change. The transport industry is faced with new opportunities and challenges from the rise of digitalization, big data, and analytics to robotics and automation. This industry has traditionally been focused on physical assets and the digital era presents new challenges which might disrupt current business models and create new value streams [8].

At this point, we can only assume the future of containerization. According to the opinion of the transport industry specialists, containers will remain the same, because customers prefer frequency, not bigger containers [8]. That means that the physical characteristics of the industry will not significantly change. Both the container itself and the container ship will still exist. Cranes will be used for terminal loading and unloading operations while yard operations will continue to be connected to rail and trucks. However, we can expect changes in the field of automation. Automation is expected to be implemented through the whole supply chain and to be adopted in ports, terminals, rails and trucks and automation should bring a higher level of business efficiency. In the next couple of decades terminals should be completely automated and self-driving trucks for the transportation of containers to inland distribution centers will be used for inland operations. The digitalization of the container business will also bring new challenges, especially to service providers and container ship operators, because the customers will expect „a higher degree of reliability, transparency, and user-friendliness" [9]. Regarding container ship operators, the container-shipping industry will continue to concentrate and we expect that shipping companies will merge and only a few companies will hold the whole industry.

For container shipping stakeholders, in order to achieve the goals of applying modern technologies, it is also necessary to provide infrastructure support. Without developed infrastructure, it is impossible to develop modern transportation technologies or carry out transport processes in a safe, fast and cost-efficient way and to achieve trade growth. With modern infrastructure, it is also necessary to develop personnel structure and carry out job distribution in all parts of the transport chain. The last preconditions to be fulfilled in order to achieve the development of modern transportation technologies are „…stimulative measures of economic instruments and economic policy, adequate quality, structure and volume of new transportation technologies among all entities in the 'door-to-door' transport chain system" [3].

There are several reasons why it is desirable to fulfill the above-mentioned preconditions for the development of modern transportation technologies; for example, with a direct impact on the reduction of the country's transport costs when importing or exporting goods, it is possible to „... attract large concentrations of goods and very intensive foreign exchange inflows as well as achieve competitiveness of national goods and national carriers in the world market" [3]. The fulfillment of some of the above-mentioned preconditions over the years has enabled the development of transportation technologies. The very development of modern transportation technologies is closely linked to the selection and use of different procedures and methods when organizing transport as well as transshipment of freight via modern transportation technologies.

5. Conclusion

Since the emergence of modern transportation technologies, the invention of containers and the development of containerization in particular, many of the above-mentioned changes have taken place. These changes have emerged under the influence of the environment in which these technologies were developed, but also of the globalization process. Despite the fact that almost all of these modern transportation technologies have progressed in certain ways, further progress and development of transportation technologies is possible, as well as of means necessary for successful freight handling within these technologies. Therefore, it is also possible to make a greater contribution to optimal manipulation of freight between branches of transport as well as optimal development of the transport process. This will be achieved if we take into account the current shortcomings of the technologies and if we try to consider these shortcomings in more detail in the future and turn them into advantages. Investments into infrastructure used by modern transportation technologies can also contribute to their development, but also to improvement and modernization. In this way, other modern transportation technologies will also reach their maximum applicability in goods handling, transport processes, but also the international competitiveness of countries.

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