LOGISTICS CHARACTERISTICS OF GOODS AND CONTAINERIZATION LEVEL

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Abstract: The phenomenon of containerization is a well-researched theme. However, these researches are mainly in the context of new technical and technological issues and challenges, necessary for the realization of such a transport technology, as well as the dynamics of containerization and contemporary business models. The investigation of cargo being carried by containers appears to be underrepresented, which can be a result of thinking that container represents the transport unit (box) that replaces a large number of smaller packages so it is primarily intended for general cargo. Containers could be used for the transport of a large number of different types of goods, and types of packages, whether the level of containerization of particular goods depends on several factors. This paper aims at analyzing these factors in containerized level. It also looks at developing a special diagram showing the compatibility between the particular freight and container types. This paper will demonstrate how this diagram could be used in a simple way in finding which types of container are suitable for specific types of commodity.

Keywords: commodity, freight density, containerization, diagram.

1. Introduction

The containerization was the major change in 20th century transportation technology which has a decisive impact on the world economy. That is, there is a significant correlation between the enormous increase in the world trade and commodity flows, on the one hand, and the development of container transport on the other hand. Therefore it could be said that containerization was a catalyst for the development of the world trade and economy in general. Similar statements could be found in a vast literature on transportation economics, such as Bernhofen *et al.* (2016), which emphasized the containerization

as a logistics innovation responsible for the acceleration of the globalization of the world economy since the 1960s; or Levinson (2006) who noted that containerization had an outstanding impact on production and distribution for 50 years; and finally Rodrigue (2012) who pointed out that containerization has been a major driving force behind globalization. From a transportation technology perspective, containerization is based on the use of containers as loading or transport unit which could be transported by different transport modes and which enable fast, safe and easy transshipment of goods between them without any direct contact with the goods themselves. In such way, eliminating

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sometimes a dozen direct handling of goods, the containers enabled a direct technological connection between the producers and customers, while reducing the total transportation costs (Bernhofen *et al.,* 2016). On the other side, containerization required major technological changes in transportation and handling activities and facilities. These changes started in maritime transportation first (a new form of ships, ports, and handling equipment) and progressed to engulf inland parts of the transportation chains, like rail and road transportation. Container shipping developed rapidly due to the adoption of standard container sizes in the mid-1960s and the awareness of industry stakeholders about the advantages and cost savings (Rodrigue and Notteboom, 2014). All these technological and economic aspects of the phenomenon of containerization are well-researched in literature. However, the investigation of cargo being carried by containers appears to be underrepresented, as Rodrigue and Notteboom (2014) have already stated. This could be a result of a perception of the container as a transport unit (box) that replaces a large number of smaller packages, which makes him primarily intended for conventional general cargo. However, such perception of the container must be expanded to consider the container as a transport unit that could be used for a large number of different types of goods, and types of packages, whether the level of containerization of particular goods depends on their logistics and market characteristics. This paper aims at analyzing the level of containerization regard extraction of the new market opportunities. It also looks at developing a special diagram showing the compatibility between the particular freight and container types. This paper will demonstrate how this diagram could be used in a simple way in finding which types of container are suitable for specific types of commodity.

2. Containerization

Containerization represents a system of freight transport using standard shipping containers to unitize cargo, and which could be loaded and sealed intact onto ships, trains, planes or trucks. Container logistics thus incorporates transportation, packaging, handling, storage, and security together with visibility of container and its content into a logistic chain from source to the user (Bhattbhatt and Verma, 2012). There are various container types (dry cargo containers, refrigerated, open top, open side, platform, insulated, tank and silo containers, etc.) aims for caring different types of goods (general cargo in boxes, cartons, pallets, bales; bulk, heavy machinery, semi-finished goods, perishable and fresh goods, bulk liquids, grain, bulk chemicals, livestock, etc.). According to Bernhofen *et al.* (2016), container adoption in international trade which occurred between 1966 and 1983 accounted for dramatic growth in world trade (Figure 1). The growing importance of containerized trade is still evident through the increasing number of containers (of all sizes) in export/import freight flows, which is in case of US almost doubled between 2000 and 2007 (www.evisionfreight.com). After the weak performances of 2008/2009, containerized trade has continued to increase in the following years. In 2017 containerized trade accounted for 17.1% of total seaborne trade with an increase of 6.4% in comparison with the year before, which represents the fastest rate since 2011 (Review of Maritime Transport, 2018).
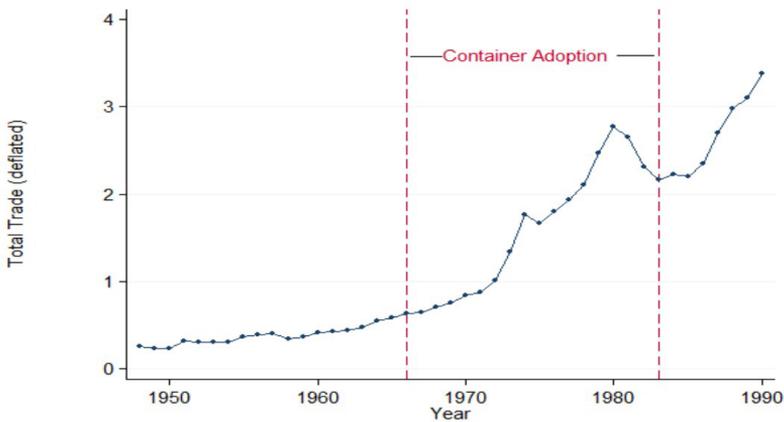
Fig. 1.
The Growth of World Trade: 1948-1990
Source: Bernhofen et al., 2016

2.1. Waves of Containerization

According to Guerrero and Rodrigue (2014), there are five waves of containerization (each of them lasts about 8-10 years), from container port traffic point of view, where each wave is represented by specific temporal growth pattern of containerization. The first wave of containerization was started in the late 1950s by shipping 58 Malcolm McLean's 35-foot containers (actually aluminum truck bodies) and last till mid-1970s and re-opening of the Suez Canal. During this first phase, container's dimension was standardized by International Organization for Standardization (ISO) in the forms of 10, 20, 30 and 40-foot length, with a width of 8 foot and a height of 8.5 foot. Two dominant types of containers are 20 and 40 footers (ft), where standard ISO 20ft shipping containers with dimensions 6.06m (length) x 2.44m (width) x 2.6m (height) has a capacity of 33.1m3, while ISO 40ft containers with 12.12m length have twice the capacity of 20ft containers. ISO 20ft container can each load around 22 to 26 tons while an ISO 40ft container, because of structural integrity issues, has a loading capacity of about 27 do 30 tons. Hence, 40 footers have only 15% more load capacity even the shipping volume is doubled in comparison to 20 footers. Cost effects of the five year's adoption of such standardized sizes of containers (from 1965 till 1971) are provided by Bernhofen *et al.* (2016). According to them productivity of dock labor had increased from 1.7 tons per hour (in pre-container era-1965) to 30 tons per hours (in 1971), while insurance costs have decreased from 0.24£ per ton to 0.04£ per ton, as well as capital locked up as inventory in transit from 2£ per ton to 1£ per ton.

The second wave represents an expansion of containerization in the period from the mid-1970s till the beginning of 1980s. In this period several ports had increased their container throughout and became the world's leading container ports (till the 2000s and the appearance of large Chinese container

ports). This phase was characterized by global diffusion of containerization achieved mainly by entering the containers into the break bulk trades. This containerization's phase was with greater speed and size in comparison to the first wave, but still being costly to operate in some broad sense. The third wave concerns the largest number of ports and captures the massive diffusion of containerization (Guerrero and Rodrigue, 2014). During that period (the mid-1980s till mid-1990s), containerization had become a routine for not only manufacturers but also distributors and retailers. Technological advancements influenced the types of container carrying ships: container/bulk carriers, container/ro-ro, and fully cellular containerships (Nurosidah, 2017). Containerization in this phase assumed improving ship's productivity (less time-consuming container handling) and reducing of total transportation costs. According to Guerrero and Rodrigue (2014) this wave is statistically the most distinctive and assumes an acceleration of containerization, probably because of full internationalization in world trade which has stepped into the scene based on the entry of China and other countries from the Far East in the global sphere of production (Notteboom and Rodrigue, 2009).

In the fourth wave, from the mid-1990s till mid-2000s, the container became the standard mean for global freight distribution (Guerrero and Rodrigue, 2014) changing the economic geography (the massive entry of Chinese ports in global distribution networks), as well as changing delivery handling from labor-intensive to a capital and time-intensive operation (Nurosidah, 2017). The fifth wave concerns a massive phase of globalization and the usage of containerization to support the wide range

of commodity chains. The last phase of containerization results in a significant increase in the volume of goods transported in this form. The containerization growth trend is still constant, except the world economic crisis in 2008-2009, so that no one can define for sure the final stage of containerization diffusion or its maturity. As Notteboom and Rodrigue (2009) stated the future containerization will be largely determined by interactions within and between four inter-related layers: locational, infrastructural, transport and logistical, where the last one represents the most fundamental. The mix of logistics factors related to containerized goods will determine the future development of the global container transport system (Notteboom and Rodrigue, 2009). One of those factors is logistics characteristics of goods which will have an impact on decision regards identifying and setting of niche markets in future containerization.

2.2. Level of Containerization

Containerization has developed from the specialization to generalization in terms of transported commodities (Yang *et al.,* 2016). That is, all type of goods, such as final manufactured goods, processed food, produce, livestock, intermediate goods, processed materials, and raw materials, which could be packed in different type of packages, such as boxes, bags, drums, pallets, bales, rolls, etc. could be transformed into the form of unitized cargo such as containers. The degree of containerization for particular types of goods or group of types is different. Some goods are almost fully containerized (such as coffee and bananas), while for others containerization is still at its beginning (such as lumber and grain). Level of containerization for a particular type of

goods mainly depends on their market characteristics (value-weight ratio) and logistics characteristics (based on size and frequency of shipments, density, packaging, and perishability). According to Yang *et al.* (2016), containerization is traditionally mainly applied for high-value manufactured commodities, such as electronic device, furniture, toys, apparel, sports equipment, works of art, etc. An example of a high-value commodity where 95% of their imports into Europe are containerized is coffee (Rodrigue and Notteboom, 2014). The top containerized commodities imported to the US in 2004 are from the groups: "machinery, boilers, reactors, parts"; "electric machinery, sound and television equipment, parts"; and "vehicle and parts", with total value of imported goods of 38; 31.7; and 12.1 billion of USD respectively (www.evisionfreight. com). As Karamperidis (2013) has stated, some rough calculation of the average value of contents of the global seaborne container equals 42,000 USD per TEU (Twenty-foot Equivalent Unit). Taking into account the fact that container could be shipped, for example from the Far East to Europe for 1,000 USD it means that the average freight rate equates to 2.38 percent of the value of the container contents. On the other side, the majority of low-volume products like grain, iron ore, coal, and other raw materials are basically transported via bulk shipment. However, many of those segments are in the process of being containerized. In accordance with the previously stated facts, it could be said that containerization is commodity-dependent, which results in a wide variety of existing and potential containerization levels, as it's already noted by Rodrigue (2017). The same author further stated that even within the same groups of a commodity (defined by Standard

International Trade Classification-SITC which is a classification of the commodities being subject to international trade by United Nations Statistics Division), levels of containerization differ (Figure 2).

The logistics characteristics of goods are rather straightforward since ponderous commodities, perishable, and no packable commodities are less suitable for containerization. Taking into account market characteristics, commodities with high value to weight ratio is containerization friendlies. As it already stated the scale and scope of containerized transportation have expanded rapidly, mainly due to the technological advancement in container technology. Many segments of raw materials and food commodity chains are in the process of being containerized (Rodrigue and Notteboom, 2014). For example, food products which have not been containerized initially, through the development of refrigerated containers became containerizable in later years. Similarly to this, according to the number of projects and research papers in the last decades, the trend of containerized shipping for bulk agricultural product (especially soybean) is moving upward (Liu *et al.,* 2017; Clott *et al.,* 2015), mainly within the context of solving the problem of empty container returning back. Hence, the process of containerization of this group of commodities is based on opportunities which have been created by empty container repositioning which assumes an available number of empty containers that can be loaded for backhauls. Apart this, other factors which could have positive impact on further containerization development are (Rodrigue and Notteboom, 2014): a growing number and availability of containers in transport markets around the world; a rise

in commodity prices and growing demand in new markets; fluctuations and rises in bulk shipping rates; relatively stable and even declining container shipping costs.

In regards to studying given by Rodrigue and Notteboom (2014), commodities such as grain, chemicals, wood products, as well as temperature-sensitive products, such as food, represent a niche for containerization. In chapter three, some challenges in further containerization of stated commodities based on their logistics characteristics will be discussed in more detail.
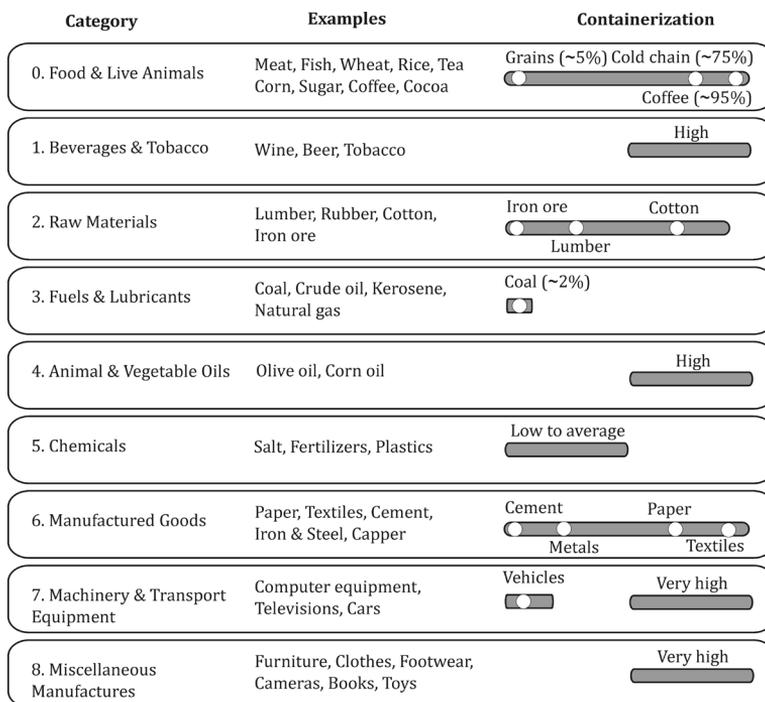
Fig. 2.
Commodity Group and Containerization Level
Source: adapted from (Rodrigue, 2017)

2.3. Level of Containerization: a Case of Serbia

Based on the available data, provided by the Customs Administration of the Republic of Serbia, Table 1 shows which category of goods came into the Serbia in containers in period from 2015 to 2017. Before we provide a brief analyze of presented data, the couple obstacles and assumption related to the method of data collection and keeping of Serbian Customs Administration should be mentioned.

Table 1
Serbian Containerized Imports: 2015-2017

Commodity category of import	2015		2016		2017	
	Number of containers	% of total containerized imports	Number of containers	% of total containerized imports	Number of containers	% of total containerized imports
Category 0+1	933	2,29	795	1,74	815	1,58
Category 2	3004	7,39	3082	6,75	4154	8,05
Category 4	645	1,59	543	1,18	571	1,12
Category 5	*4695*	*11,56*	*5300*	*11,58*	*9115*	*17,67*
Category 6	*23464*	*57,76*	*26436*	*57,77*	*25350*	*49,15*
Category 7	3795	9,34	*4870*	*10,64*	*6925*	*13,43*
Category 8	*4091*	*10,07*	4733	10,34	5160	10,00
Total	**40627**	**100**	**45759**	**100**	**51576**	**100**

Source: Customs Administration of the Republic of Serbia

First, they don't make difference between type of containers (20 and 40 footers), they just collect data in form of "containers". Therefore, it is not possible to indicate the import of containerized goods in TEU, it could be just assumed. Second, their classification of goods is somewhat different from the classification defined by SITC, which is used in reviewed papers, so appropriate assumptions regards to this issue is also made, in order to apply SITC classification in this analysis (for example category 0 and category 1 are merged into one group). Taking into account the stated assumptions, it could be said that the top three containerized commodity groups imported to the Serbia in 2015 were: group 6 "manufactured goods"; group 5 "chemicals"; and group 8 "miscellaneous manufactures", with the percentage of total containerized imports of 57,7%; 11,5%; and 10% respectively. The similar situation was in 2016 where commodities from the groups 6 and 5 were again top two, with almost identical share of total containerized imports like in 2015, but with the difference in third-placed groups: commodities from the group

7 "machinery and transport equipment" with share of 10,6% of total containerized imports in 2016. The situation in 2017 was identical to 2016 regards list of top three containerized commodity groups, with the slightly difference in terms of percentage of total containerized imports (shown in Table 1).

It should be underlined the fact that the import of commodities from the category 3 "fuel and lubricants" were not containerized at all, as well as the fact that the commodity "textiles" from the group 6 was with the highest level of containerized import (about 50% of total containerized import), which is completely in line with the statements from Rodrigue (2017), as it is already shown in Figure 2.

3. The Logistic Characteristics of Goods as a Challenge

The logistics characteristics of goods, as a reflection of the good's nature, could create a set of containerization challenges. First, the availability of containers as a load unit

means that containers must be available in sufficient quantities and be of a suitable load unit. What kind of containers is suitable as a load unit for different commodities, such as grain, for example, could be defined according to the diagram presented in Figure 3. The issue of containers suitability is connected to the weight of container loads (loading capacity or payload) as another major issue. The container weight is directly connected to the nature of goods which is carried by. Weight of 10 to 14 tons per loaded 20-foot container is the most common situation (Rodrigue and Notteboom, 2014). The freight nature is mainly represented by density (expressed in tons per cubic meter). At the very beginning of containerization, the 20 footers were the most used. However, due to situation that container loads are much lighter for the commodities with a higher level of containerization (such as retail commodities from the groups food, beverage, and tobacco, etc.), the shipping industry has adapted to this and switched to larger container sizes (40 footers) because of their better suitability for goods with smaller density. The following diagram at Figure 3 put in the ratio container loading capacity and specific container density (expressed by the ratio of container loading capacity and volume), and it allows determination of the possible useful capacity of containers when caring goods with different density. Each container depending on its loading capacity and specific density corresponds to a certain broken line consisting of the line which passes through the beginning of the coordination system and the horizontal part corresponds to the nominal loading capacity of the container. The commodities which have a density higher than specific container density will enable their full weight utilization.

Figure 3 shows diagrams for four cargo types of containers‡: 20 ft (payload: 21630kg, volume capacity: 33.2m3, specific density: 0.65t/m3); 20 ft (payload: 2600kg, volume capacity: 33.2m3, specific density: 0.78t/m3); 40 ft (payload: 26480kg, volume capacity: 67.74m3, specific density: 0.39t/m3); and 40 ft high cube (payload: 26500kg, volume capacity: 76.3m3, specific density: 0.34t/m3), in order to determine their suitability for different commodity groups defined by their estimated average density. As it is shown at Figure 3, the density of each commodity group is estimated on the basis representative goods for each group. For the commodity category 0, the representative good is assumed to be grains with an average density of 0.74 t/m3 (Rodrigue, 2012). The average freight density for other commodity groups are assumed as follows: category 1 (tobacco stems) - 0.24 t/m3; category 2 (lumber) - 0.72 t/m3; category 3 (coal) - 1.13 t/m3; category 4 (vegetable oil) - 0.97 t/m3; category 5 (fertilizers) - 0.96 t/m3; category 6 (textile-blue jeans) - 0.27 t/m3; category 7 (electronic components) - 0.33 t/m3; and category 8 (books) - 0.61 t/m3.

As it could be seen from Figure 3, for ponderous commodities the 20 footer container is the most suitable, as Rodrigue and Notteboom, (2014) have already concluded. Those commodities have a density that enables the full payload utilization of 20-foot containers, as well as 40-foot containers. However, in the case of 40 footers, the volume capacity utilization is very low, which could have an impact on shipment stability. For example, to load a 40ft container to a payload of 26.5 tons with a grain of density 0.7 t/m3, the height to fill to inside the container would be less than 1.5m (the utilization of the volume is less

than 55%). Therefore, for the commodities which represent a future market potential for containerization expansion, such as grain, coal, lumber, fertilizers, the use of 20-foot containers are more structurally suited. Even the economies of scale are pushing towards the largest container possible, as it implies lower total distribution costs (including both maritime and inland carriers), the containerization of such ponderous commodities will ensure that 20-foot containers still remain on the market.
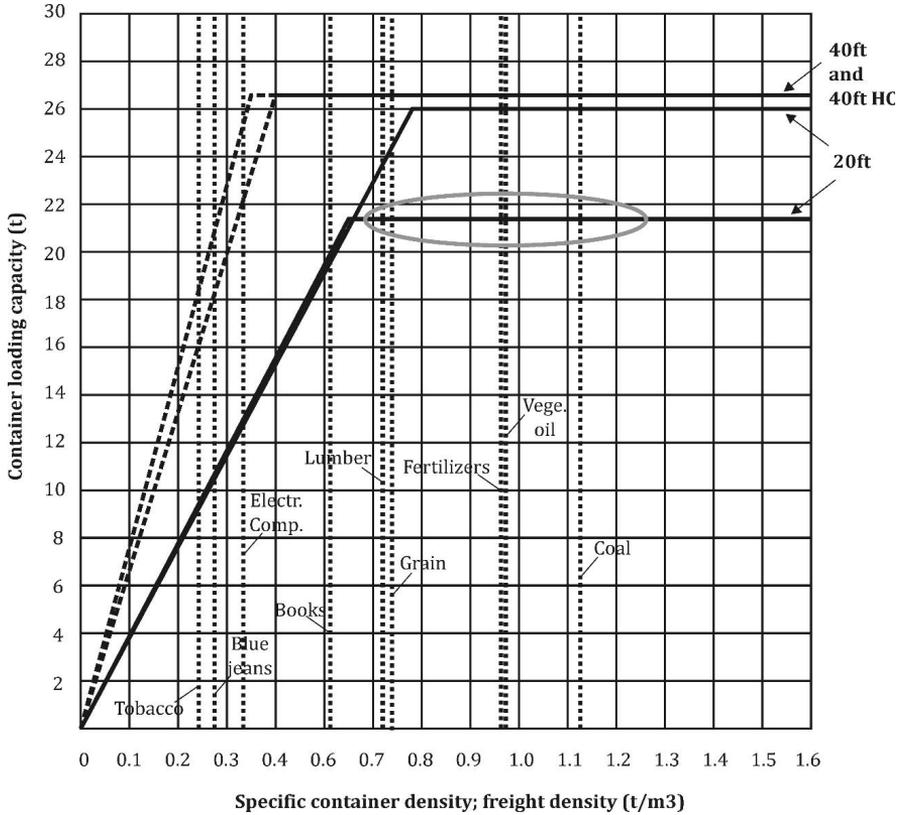

Fig. 3.

Diagram of Loading Capacity and Specific Density Ratio for Different Type of Containers Applied for Different Commodity

Source: adapted from (Topenčarević, 1987)

4. Conclusion

Containerization plays a very important role in freight transport with a constant tendency of growth in the context of world trade. The advantages of container transport have been widely recognized since the 1980s, as a significant tool or technology which could lead to transport cost and time savings, as well as environmental sustainability.

Containerization has forced even the most unavailable countries to import goods from foreign countries that can produce them at a much lower cost. It's very difficult to imagine the future of international commodity exchange without container cargo. Containerization, as one of the biggest technology revolution which hit the shipping industry in the last century, will be replaced by some unknown technology in the future, but which technology we still need to discover. Bearing in the mind the simplicity of the containerization system and standards that apply it internationally, it will probably never be fully replaced by new shipping and delivery system, but rather improved in the context of application information technology solutions. The new phase of containerization expansion in the context of both attracting of new commodity and raising the containerization level of existing ones, assuming the extraction of niche market opportunities, which will be followed by a number of challenges. The fundamental factor in the emerging containerization will be the nature of the commodities represented through their logistics and market characteristics.

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