Container Transport System as a Means of Saving Resources

L Soloviova, O Strelko, S Isaenko, O Soloviova, Yu Berdnichenko

1 State University of Infrastructure and Technologies, Kyrylivska 9, Kyiv, 04071, Ukraine

E-mail: olehstrelko@gmail.com

Abstract. Analysing the transportation of goods as one of the constituent elements of the transport system, it can be argued that container transport today occupies a leading position in the delivery of goods throughout the world. According to statistics, the total volume of container traffic in the first two months of 2018 was approximately 26 million TEU (twenty-foot equivalent unit is a conventional unit of measure for the capacity of freight vehicles, namely, a 20-foot container), which is 6.7% more than the same index last year. Positive growth rates of container traffic indicate the relevance and scale of this type of transport. Also, thanks to the rapid development of intermodal and multimodal transportation, the volumes of cargo delivery in containers are increasing. Resulting from this, the container transport system, the main components of which are containers and container terminals, can be considered and analyzed as a technology for the conservation of resources.

1. Introduction

Container transportation is one of the ways to deliver goods in the transport system of a country, the distinguishing feature of which is the availability of a unified reusable crate – a container [1-7].

According to statistical data of CTS (Container Trade Statistics) for August 2018, the total volume of container flows, taking into account export and import shipments, amounted to 142202779 TEU. The vastness of the use of this type of transport is due to its efficiency, which lies in its main advantages:

- reducing the expenses of container traffic due to fast cargo handling (loading, unloading), which in turn reduces the cost of delivery. As a result of this, the speed of delivery of goods in containers is 30–40 km a day higher, comparing with the delivery of cargo by small shipments;
- the container ensures the integrity of the cargo and protection from various weather conditions, since the container is completely closed and sealed;
- the use of modules of containers and their standardization allows us to automate the entire process of handling container cargos;
- containers are standardized in size and connecting devices, which also unifies the mechanisms for unloading and loading containers;
- the container is a small warehouse module, which reduces the need for storage facilities, and at the same time allows the transportation of goods without crates, in the shop or lightweight packaging [8-17].
Due to the intensive growth of freight turnover, which in turn is associated with the daily increase in demand for various goods, container transportation is a monumental technology in the transport systems of various countries, thanks to which it is possible to save certain resources.

2. Using a container to reduce consumption of a natural resource
Packing of goods is an obligatory stage of preparation of goods for transportation. In freight, the packaging of goods is carried out with the help of crates. Crate is the main element of the packaging, which is a special product to accommodate certain products. For the transportation of goods there are used such types of crates: boxes, barrels, pallets, bags, drums, etc. Most of them are made of sawn timber. As is known, sawn timber is a product of wood processing, the raw material for the production of which is wood of any tree. Consequently, using containers that are made of high-quality alloy steel reduces the consumption of most types of crates. This sawn timber saving is calculated for 1 ton of cargo transported in universal containers and is shown in Table 1 [17].

Table 1. Table captions should be placed above the tables.

| Cargo                              | Volume of sawn timber saving, m³ |
|------------------------------------|----------------------------------|
| Spare parts for automobiles        | 0.45                             |
| Spare parts for tractors           | 0.33                             |
| Attachment for engineering and     | 0.58                             |
| instrument-making                  |                                  |
| Confectionary                      | 0.88                             |
| Canned food                        | 0.56                             |
| Laundry soap                       | 0.38                             |
| Toilet soap                        | 0.69                             |
| Leather shoes                      | 1.07                             |
| Rubber footwear                    | 1.15                             |
| Refined sugar                      | 0.36                             |

3. Container terminal automation as a resource conservation system
Any transportation process of carrying goods begins and ends at special objects, adapted and equipped for the most efficient conversion of cargo flows. In a container transport system, such objects are container terminals [18].

A container terminal (Figure 1) is an element of a container transport system whose purpose is to convert container flows when transferring them from one mode of transport to another [20]. The
The purpose of this conversion of cargo flows is to ensure the most efficient further transportation of freight, goods and materials in containers.

The container terminal is mainly located in the port area. This is due to the fact that for mass transportation of containers there are used special cargo ships – container ships. Modern container ships have recirculation of exhausted gases, which helps to reduce harmful emissions into the atmosphere and saves fuel by increasing the power plant [21].

Automation of the container terminal, in the first turn, involves the conservation of human resources. Modern organizations are increasingly dependent on the ability of workers to effectively use their abilities and intelligence for the benefit of production. Due to the innovation period, modern workers are focused not on their abilities to work, but on its result; not on labour, but on consumer value, embodied in certain products and technologies. Automation of the container terminal is an example of the result of the activity of “knowledge workers”.

The operation of the container terminal in an automated mode eliminates the aggressive driving of reach-stackers, the fall of containers to the ground, and provides only a certain order and stability of the movement of automatic machines for rearranging containers on the territory of the terminal. On this basis, one of the first areas of operations automation was the improvement of the horizontal transportation system [22], expressed in the appearance of automated guided vehicle (AGV) machines for moving containers between the operating areas of the container terminal (Figure 2).

In turn, the use of AGV provides:

- continuity of the technological process;
- high terminal throughput due to an increase in the turnover of containers;
- high level of security;
- reduction of operating costs (due to the exclusion of the wages of those workers whose work functions have become automated);
- high positioning accuracy.

![Figure 2. Automated guided vehicle [23].](image)

Automatic equipment also conserves resources and contributes to their sustainability. Significant fuel savings are achieved through optimal movement mechanisms, namely reducing the need for air conditioning and eliminating the systematic engine shutdowns during an idle AGV. The territory of
the automated terminal also requires less lighting in the courtyard, which reduces energy consumption and accordingly reduces the negative impact on the environment [24, 25].

4. Conclusion
The container transport system helps to expand the boundaries of international, transit and home types of cargo transportation. This is confirmed, first of all, by the efficiency of the container as reusable crates. The delivery of goods in containers contributes to the conservation of such a natural resource as wood – this is due to the fact that for the transportation of products without a container requires a crate, which in most cases is made of sawn timber.

Due to the scale of container traffic, there appear container handling points. The mechanism of operation of the container terminal is automated in many countries, such as Norway (in the port of Rotterdam), China (container terminal Yangshan), the United States of America (container terminal Long Beach), Germany (the port of Hamburg) and in many others. Automation of the terminal management system minimizes the work of a person, which saves human resources, and provides staff with the opportunity to use their intelligence to adopt and develop further innovative technologies. Also, the use of automatic AGV machines reduces fuel consumption and significantly reduces lighting consumption. Obviously, the automation of the container terminal management system requires significant capital investments, but it is worth noting that the introduction of this technology has a cumulative effect, which after a time will be supported by positive performance indexes of the terminal.

Thus, the container transport system, ensuring the efficient operation of the structure, can be a real means of significant conservation of human and natural resources.

References
[1] Van Riessen B, Negenborn R R and Dekker R 2016 Real-time container transport planning with decision trees based on offline obtained optimal solutions Decision Support Systems 89 pp 1-16 https://doi.org/10.1016/j.dss.2016.06.004
[2] Kopecky I 2018 Sources of electric energy for logistic means in ISO 1C containers The proceedings of the 22nd International Scientific Conference Transport Means2018 PART III pp 1289-1292
[3] Szczepański E, Jachimowski R, Klodawski M and Jacyna I 2018 GoldaContainers storage strategy at the rail-road intermodal terminal The proceedings of the 22nd International Scientific Conference Transport Means2018 PART II pp 564-568
[4] Song B B and Cui Y Y 2014 Productivity changes in chinese container terminals 2006-2011 Transport Policy 35 pp 377-384 https://doi.org/10.1016/j.tranpol.2014.04.011
[5] Ding Z Y, Wang Y and Yeo G T 2015 The relative efficiency of container terminals in small and medium-sized ports in China The Asian Journal of Shipping and Logistics 31 pp 231-251 https://doi.org/10.1016/j.ajsl.2015.06.004
[6] Almawsheki E and Muhamed Z 2015 Technical efficiency analysis of container terminals in the middle eastern region The Asian Journal of Shipping and Logistics 31 pp 477-486 https://doi.org/10.1016/j.ajsl.2016.01.006
[7] Kyrchenko H, Statyvyka Y, Strelko O, Berdnichenko Y and Nesterenko H 2018 Assessment of cargo delivery quality using fuzzy set apparatus International Journal of Engineering & Technology 7(4.3) pp 262-265 https://doi.org/10.14419/ijet.v7i4.3.19800
[8] Siqueira G, Leal Jr I, Da Cunha L, Guimaraes V and Guabirola R 2017 Analysis of technical efficiency and eco-efficiency in container terminals International Journal of Shipping and Transport Logistics 9 pp 562-579 https://doi.org/10.1504/IJSTL.2017.086351
[9] Efektivnost' kontejnernyh perevozok [online cit.: 2018-11-19] http://www.1520mm.ru/container/efficiency.phtml
[10] Strelko O, Kyrchenko H, Berdnichenko Y and Hurinchuk S 2018 Automation of work processes at ukrainian sorting stations International Journal of Engineering & Technology 7
[11] Li K X, Luo M and Yang J 2012 Container port systems in China and the USA: A Comparative Study Maritime Policy & Management 39 pp 461-478 https://doi.org/10.1080/03088839.2012.705032

[12] Cullinane K, Song D W, Ji P and Wang T F 2004 An application of DEA Windows analysis to container port production efficiency Review of Network Economics 3 pp 7 https://doi.org/10.2202/1446-9022.1050

[13] Schoyens H and Odeck J 2013 The technical efficiency of norwegian container ports: a comparison to some Nordic and UK container ports using Data Envelopment Analysis (DEA) Maritime Economics & Logistics 15 pp 197-221 https://doi.org/10.1057/mel.2013.3

[14] Demirel B, Cullinane K and Haralambides H 2012 Container terminal efficiency and private sector participation The Blackwell Companion to Maritime Economics pp 571-598 https://doi.org/10.1002/9781444345667.ch28

[15] Singh P, Singh J, Antle J, Topper E and Grewal G 2014 Load securement and packaging methods to reduce risk of damage and personal injury for cargo freight in truck, container and intermodal shipments Journal of Applied Packaging Research 1(6) pp 47-61 https://doi.org/10.14448/japr.01.0005

[16] Huang J and Ren Z 2011 Research on SA-based addressing model of slot in container terminal Applied Mechanics and Materials 97-98 pp 985-989 https://doi.org/10.4028/www.scientific.net/AMM.97-98.985

[17] Kunchev L 2018 Methodology for selection the optimal route and transport for carriage of containers The proceedings of the 22nd International Scientific Conference Transport Means2018 PART II pp 724-728

[18] Malikov O, Korovyakovskij O and Korovyakovskaya E 2015 Container terminal design Tipografiya FGBOU VPO PGUPS (Sankt-Peterburg)

[19] Veletenski terminaly buduvatyme na Zakarpatti ta Volyni “Ukrzaliznytsia” [online cit.: 2019-03-20] http://zl-ua.news/veletenski-terminaly-buduvatyme-na-zakarpatti-ta-volyni-ukrzaliznytsya/

[20] Wang D H 2014 The woes of the container leasing industry International Journal of Shipping and Transport Logistics 6 pp 7-25 https://doi.org/10.1504/IJSTL.2014.057811

[21] Park S, Rakha H, Ahn K and Morgan K 2013 Fuel economy impacts of manual, conventional cruise control, and predictive eco-cruise control driving International, Journal of Transportation Science and Technology 2 pp 227-242 https://doi.org/10.1260/2046-0430.2.3.227

[22] Ushakov D 2015 Organization of container transportation of goods (TransLit, Moskva)

[23] HHLA Container terminal Hamburg Altenwerder [online cit.: 2019-02-22] https://www.bildarchiv-hamburg.de/fotos/16/HHLA+Container+Terminal+Hamburg+Altenwerder+%28+CTA+%29/76_12510_5266+Beladene+und+leere+AGV%2C+Automated+Guided+Vehicles+in+Hamburg+Altenwerder

[24] Alho T, Hickson M and Kokko T 2019 Converting a manual straddle carrier terminal to automation Conversion to automated straddle carrier terminal [online cit.: 2019-03-19] http://www.kalmar.fi/globalassets/equipment/pdfs/whitepaper_conversion-to-automated-straddle-carrier-terminal.pdf

[25] Solovev D B 2017 Improvement of protective relaying efficiency for motor drives at mineral processing plants Industrial Engineering, Applications and Manufacturing (ICIEAM), International Conference on. pp. [Online]. Available: http://dx.doi.org/10.1109/ICIEAM.2017.8076343