ANALYSIS OF PROBLEMS WITH CONTAINERS AS INTERMODAL LOADING UNIT

***Aidas Vasilis Vasiliauskas*[1], *Darius Bazaras*[2]**

[1] *Vilnius Gediminas Technical University*
Plytines Str. 27, Vilnius, LT-10105, Lithuania
Ph.: (+370)-52745076
[1]*E-mail:aidasv@ti.vtu.lt*
[2]*E-mail: dbazaras@vv.vtu.lt*

Current growth of freight flows between world economical regions stipulates increasing growth of the use of containers. They can be assumed as the most versatile type of loading units being in use all over the world.
On the other hand, during the last few decades, all over the world evolved a lot of types of containers with different technological features. This in turn could become a significant problem for interoperability of different transport modes. Moreover, besides of differences in technical standards, the problem with organization of empty containers trips becomes more and more sharp.
Because of these circumstances, this paper presents analysis of current state of the world container market, description of problems related to empty container trips and overview of the latest technological developments of the containers in the EU.

Keywords: *ISO containers, Intermodal Loading Units, empty trip operations*

1. INTRODUCTION

Current growth of freight flows between world economical regions in most cases determines the growing use of containers. This is not only the case of maritime transport. Statistical data shows that nowadays containers are in use in every mode of transport [2].

Containers are the most versatile type of loading units. So it is very important to understand how and why they gain such popularity between transport operators. Also it is very important to highlight their advantages and (if they have such) possible drawbacks, in order to determine its possible development trends in the nearest future. The first step toward this goal can be a brief historical overview of the origin of containers as loading units.

2. ORIGIN OF CONTAINERS AND CONTAINERISED TRADE

The containerisation actually started in 1932 in the USA, when there was designed and developed an aluminium box that could be placed on a truck.

At the beginning people did not understand the purpose of this new development. However, there was a trucking company that was quite serious about this new technological development and used the boxes to transport agriculture products.

Though the real containerisation did not started until 1949, when the company Ocean Van Lines (OVL) got a contract from the USA government to transport military goods from Seattle to Alaska by sea and roads. OVL ordered 300 30 feet long containers that could be stacked by 2 levels onboard the ships. Those first real sea containers could be transported by ship and truck. In the early 50's this concept was quite successful, however there was almost only attention for the concept, but actually nobody bought those containers.

In 1955 a very important man came into this business. His name was Malcolm McLean. He bought shipping company called "Pan Atlantic Steamship Corporation". Soon he found out that the loading and unloading of trucks and ships took a lot of time and many people were needed to fulfil these tasks. McLean came up to an idea that there must be a special box/unit that can contain goods from the shipper's house to the receiving party without unloading and loading again. This must result in less damage and must avoid steeling by thieves. This concept also results in faster loading/unloading trucks and ships and there is not needed so much packing materials.

In April 1956 his idea became a reality. Though it took some time to convince the US Coast Guard that containers have no danger for ship and cargo, in Port Newark, near New York, 58 containers were loaded on deck of the rebuilt tanker "Ideal X" for destination Houston.

However once again it took almost a decade until more and more shipping companies saw the container shipping was a booming business and some companies developed containerships for more competition. This happened around 1968.

After the containerised trade United States – Europe more trades followed. The United States–Asia and Asia–Europe is the most important trades in the world. About 10 years later, in the late 70's/early 80's more trades were containerised (trades to and from Africa, South America and Australia/New Zealand). At the same time shipping companies were developing more and more different container types to satisfy the demands of their customers [3].

3. TYPES, ADVANTAGES AND DRAWBACKS

If we look at the current world container market, we see a great variety of containers. Typology of containers and short description regarding their utilization purpose are presented in the following Table.

Table 1. Types of containers

Type	Purpose
Standard container	All kind of dry general cargo
Reefer container	Temperature controlled cargo
Isolated/ Porthole/Conair	For cargo which must be maintained on a specific temperature, but those containers are isolated and not equipped with mechanically driven engine
Ventilated	Cargo that 'sweat'. This cargo will produce their own heat and moisture which must be ventilated during the voyage to avoid damage to the cargo
Open Top	For cargo height is higher then the roof of a standard container, but not wider then the containers width. Also useful for cargo which is too heavy to handle by normal forklift and which must be loaded from topside
Open Side	Cargo which must be loaded from the side or which needs so many ventilation that the side walls must be opened
Flat Rack (platform with 2 (collapsible) ends)	Cargo which is too big or heavy to be loaded into a normal container
Platform (only the 'bottom' of a container)	Heavy or oversized cargo which cannot be loaded into/onto other container types
Tank	For liquids or gasses
Bulk	For cargo in bulk or in big bags

Despite the different types, containers are used due to some of their features that are as follows:

- are in use worldwide;
- guarantee efficient and safe transportation and handling of the cargo inside;
- are cheap enough, easily maintained and can be stackable onto each other.

However, mentioned above different types is not the only feature that distinct container between each other. Of much more importance is the difference in container dimension.

To keep the transport system running smoothly, the standardization of the container types and sizes is absolutely necessary. The Technical Committee 104 of ISO has developed a series of standards for the dimension and technical characteristics of containers, as well as for their handling.

The kind of containers described by ISO are the 10-20-30 and 40 ft length, 8ft width, and 8', 8'6'' and 9,6'' height. Most widely used are 20 ft and 40 ft containers. Their measurements in metric system are presented in following table.

However, the real problems start because of fact that in order to optimise the use of the rail mode a specialized series of containers has been developed. An example is the 6’4’’ height container, which can be triple stacked on a rail car. The 48’ x 8’ x 6’4’’ unit can carry a payload of around 22 tons. Three 6’4’’-high boxes are equivalent in height to two standard 9’6’’ boxes doubly stacked. These intermodal US domestic boxes are designed to carry heavy and dense commodities and give the opportunity to load the equivalent of three highway trucks on a single rail car.

Table 2. External and internal dimension of the ISO containers

<table>
<tr><th rowspan="2">Freight Container Designation</th><th colspan="3">External dimensions, mm</th><th colspan="3">Internal dimension, mm</th><th rowspan="2">Gross mass, kg</th></tr>
<tr><th>Length</th><th>Width</th><th>Height</th><th>Height</th><th>Width</th><th>Length</th></tr>
<tr><td>1AAA</td><td>12195</td><td>2438</td><td>2896</td><td rowspan="6">Container external height minus 241mm</td><td rowspan="6">2330</td><td>11998</td><td>30480</td></tr>
<tr><td>1AA</td><td></td><td></td><td>2591</td><td></td><td></td></tr>
<tr><td>1A</td><td></td><td></td><td>2438</td><td></td><td></td></tr>
<tr><td>1CC</td><td>6058</td><td>2438</td><td>2591</td><td>5867</td><td>24000</td></tr>
<tr><td>1C</td><td></td><td></td><td>2438</td><td></td><td></td></tr>
<tr><td>1D</td><td>2991</td><td>2438</td><td>2438</td><td>2802</td><td>10150</td></tr>
</table>

Besides these, American shipping companies introduced longer and longer containers. However, most of those containers are not suitable for transport outside the USA. Only the 45’ft container is accepted by non-US countries but still in some countries a truck + trailer combination with a 45’ft container is not allowed. The 48’ft, 49‘ft and 53’ft are not used outside the USA. Those containers are used for intra-US tracks, mostly by truck and rail. Nowadays non-standard containers such as the 48ft and 53ft have annual rate of increase higher than the traditional 40ft ISO container, due to their large use in US domestic market. Non-ISO containers of this kind were first used in maritime trade since the beginning of 1980s.

In Europe land containers have been developed to optimise the loading of the common pallets used in Europe (Euro pallets). This kind of containers has completely different dimensions than the ISO ones. The containers here are wider, and particular care must be applied not to stack them together with ISO ones. Usually warning labels are placed on their sides, showing the effective width.

The UIC fiche 592-2 in detail describes the dimension of land containers (marked as “T” containers) admitted to the rail network. They are grouped into 4 classes:

a) class 1 containers: they have the same width as the ISO containers;
b) class 2 containers: they have a width of 2.500 mm;
c) class 3 containers: they are thermal containers having a with up to 2.600 mm;
d) class 4 containers: they are containers of the classes 1,2 and 3 having maxim gross mass of 4.000 kg.

Another technological development that is to some extent related to containers and widely in use in the EU is the so-called swap bodies.

The swap body derives from a progressive re-shaping of containers in order to improve the commercial and operational attraction for in-land European road freight traffic.

The external dimension of the swap body was set at 2.5 m, in order to take the maximum benefit in road transport, the operational capability was restricted in order to reduce weight and expenses, so originally the swap body was not intended to be stackable one on top of the other. Most recent advances of the market lead to the definition of two series of swap bodies recognized also for marine use under ISO CEN 119.

Currently the CEN committee is discussing the standardization of the smaller series C stackable swap body. Different positions emerged in the discussion. Now it seems that only one measure of length (7.43 m) will be considered among the three that composes the series C, and that the stack ability will be limited to two heights in order to reduce construction costs. The new stackable swap body will have corner fittings that permit it’s handling from the top [1,2].

The fiche UIC n. 592-4 defines a classification of swap bodies. This classification is presented in the following table 3.

From all that was mentioned above regarding technological and constructional differences of containers, some general conclusions can be made:

- in order to meat different requirements from different logistics chains, a lot of container (and related technologies) types were developed;
- the main problem is that all these types have different measurements that not always could meat requirements for transportation by different transport modes in different countries (in most cases ISO containers are too heavy for road transport, besides they are not suitable for Euro pallets). Therefore problems of lack (or idle) of capacities as well as empty trips occur;
- in order to assure interoperability between different transport modes further development of containers, as the most versatile loading unit, is required.

Table 3. Swap bodies types

7.15m length stackable, with roller shutter end door	External width 2.500 mm External height 2.700 mm
7.15m length stackable box end door loading	External width 2.440 mm External height 2.361 mm
13.6m length stackable box swap body	External width 2.500 mm External height 2.703 mm
13.6m length Euro box	External width 2.500 mm External height 2.770 mm
12.2m length Euro liner	External width 2.500 mm External height 2.770 mm
7.15m length Euro box (roller door units)	External width 2.500 mm External height 2.670 mm (Type A)
7.15m length Euro liner (full side access unit, for combined traffic)	External width 2.500 mm External height 2.670 mm (Type A)

4. NEW DEVELOPMENTS ON THE EUROPEAN LEVEL

Back in 2001, Council of Ministers released its White Book, where problems related to future developments of European transport system were highlighted. One of the main problems was mentioned to be the lack of interoperability between different transport modes that in turn leads to insufficient exploitation of existing transport capacities. As a measure to change this situation was mentioned intermodality – transportation of the single loading unit (container and swap body are right examples of ILU) by different transport modes in a single transportation chain. However, intermodality in turn is based on interoperability, which requires that technological barriers between different transport modes were removed. And since containers and other loading units are necessary to assure interoperability, the great attention should be paid to their further development.

European practice shows, that currently ISO containers are mainly used for carriages outside the Europe (in maritime transport), while swap bodies are used in the intra-trade carriages. However swap bodies, though they fit better for the carriages of Euro pallets, cannot be used in inland waterway transport, because of inability to be stacked onto each other. The solution of this problem looks quite easy: the advantages of both loading units should be joined in order to facilitate better interoperability in terms of loading capacities and easy transportation and transhipment.

The first step toward these changes was set in the directive 2003/155 COM. Though this directive is devoted to the promotion of shot sea shipping, it also covers a topic on development of new European intermodal loading unit (EILU), which should combine all the advantages of swap bodies and ISO containers, and could be used in every transport mode.

So far there are several proposals regarding dimensions of EILU:

a) length – such as 11 and 6 Euro pallets would fit in;
b) width – such as 3 Euro pallets by side of 800 mm or 2 pallets by length of 1200 mm would fit in. Such width is (less than 2550 mm) is allowed to carry on the roads;

c) height – 2670 mm (such as of conventional swap body). This height would allow transportation of EILU by rail transport on all railway lines [4].

However the main advantage of the EILU compared to conventional container is increase in loading capacity:

- in case of long EILU (11 pallets in length) – by 32 per cents (figure 1);
- in case of short EILU (6 pallets in length) – by 63 per cents (figure 2).

However, despite the increase of capacity of loading unit, note should be made, that there is also a negative standpoint on such developments.

To begin with, directive 2003/155 COM only repeats standards of swap bodies that are set a long time ago (so actually it's not an innovative solution).

Moreover, transportation services are based on market economy, which is free to accept or reject technological solutions. Many intermodal operators believe, that stackable swap bodies would be interesting only in transport chains where inland waterway transport is used (for road transport they may appear to be too heavy and also stackable units are not of great importance for road and rail transport since there is no possibility to carry loading units by 2 levels).

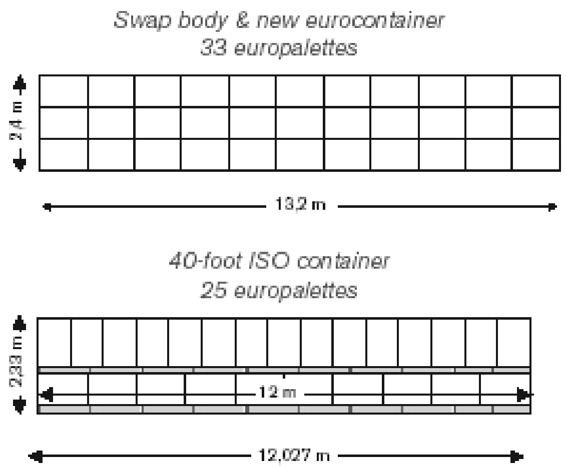

Figure 1. *Comparison of loading capacity between EILU 40 ft ISO container*

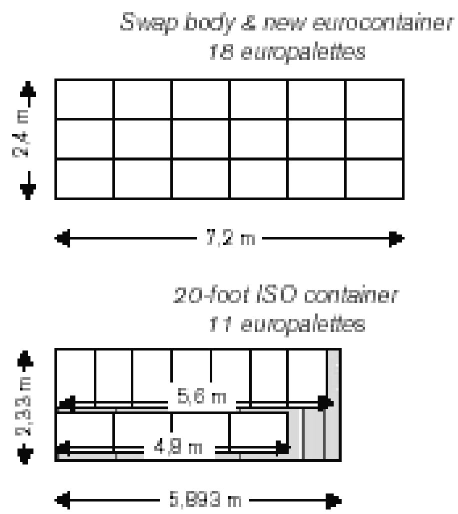

Figure 2. *Comparison of loading capacity between EILU and 20 ft ISO container*

Besides one should think of fact that some cellular ships used in sea and inland waterway transport are equipped with special cells designed to 40 ft container. So these ships would not be able to „accommodate“ longer Euro containers.

So it's not likely that new EILU will find wide acceptance in the intermodal service market.

5. THE LOGISTICS OF EMPTY CONTAINERS

The freight logistics role in the global supply chain is extremely complex, and as illustrated by this typical example in case of transportation in the container, whole cycle has the following main stages:

Delivering an empty container to a depot
↓
Loading the container at a factory or warehouse
↓
Transporting the container to a port by truck, rail or inland waterway
↓
Delivering the container to a container yard
↓
Processing the container at the port and loading the container on a ship at a container freight station
↓
Moving the container over the ocean leg
↓
Unloading the container at a freight station and processing the container at the port of disembarkation
↓
Loading the container at a container yard
↓
Transporting the container to a consignee by truck, rail or inland waterway
↓
Delivering the container to a factory or distribution centre
↓
Return of empty container to depot →↑

Indeed, the supply chain has many interfacing entities, and the freight logistics enterprises are the critical cogs in the cycle. The quality and timeliness of activities and related data becomes a serious matter: if any of the supply chain participants' his performance, the effectiveness and efficiency of the entire supply chain are compromised. This highlights the need to become more and more effective part of the entire supply chain.

We can define, that *Empty container logistics* deals with the movement and distribution of empty containers. As a segment of the whole container logistics cycle, empty container logistics commence where a container is emptied (second to last stage in the provided above scheme), such as at a consignee's warehouse, and ends at the point a container is positioned for reloading [5].

As it is shown, containers cannot move without intermediate stops. These stops can be:

- a carrier's container yard (often located at marine terminal but also at inland depots);
- shipper (exporter) warehouses;
- container leasing company depots;
- intermodal facilities;
- trucking company depots,
- container rail yards.

However in any of these cases, the movement of empty containers is a necessary aspect of the container business. Moving these empty containers efficiently – practically and economically – is a goal of all parties involved in the container business. The question is what should be done in order to reach this goal?

As an example of search for the solution we can review the situation in Lithuania.

At this moment we cannot note inland container depots owed by international ocean carriers in Lithuania. In that way, container owners, rail operators and forwarders would be able to use the storage warehouses at logistics centres in Vilnius, Kaunas and Panevėžys in the short future. Klaipėda has its own container terminal, so this problem is not so actually in Klaipėda region [6].

As Lithuania does not have the ideal situation of an importer and an exporter in approximate geographical region, either the importer is not the exporter in general and uses different types of container, several solutions for empty container reuse should be considered:

1. The most actual problem is a concept of developing four Logistics Centres in Lithuania. These centres could serve as facilities for organization of empty containers trips. When this concept is realized, these four centres will cover strategically not only the whole territory of Lithuania, but also borderline regions of Latvia, Byelorussia and the District of Kaliningrad.

2. The concept of off-dock Empty Return Depots is also beneficial for the regional movements of empty container in Lithuania. Empty Return Depots would be another solution for the following reasons:

- empty container would be directly returned to an off-dock Empty Return Depots, as opposed to being returned to the marine terminals;
- it would serve as neutral supplier of reusable empty containers and facilitation of empty returns when terminal gates are closed (or as facilitation of empty returns when container storage warehouse/depot in Logistics Centre are closed);
- it would help to avoid additional trips with leased containers;
- also it would serve as a capacitors of peak hours traffic returning to marine terminal or Logistics Centres.

3. High-quality empty container logistics will not exist without implementation of Internet-based information systems. We can note a number of third-party strategies, which include Electronic Data Interchange. Some of them should be widely established to facilitate communication between ocean carriers, marine terminal operators, multimodal logistics centres, railway and inland waterway operators, warehouse depots, logistics providers and their customers for sure. Well-organized model Empty container logistics depends on every participant, which shares commerce information timely. Without these basic circumstances, the well-balanced empty container logistics would be rather complicated.

6. CONCLUSIONS

1. Growth of trade between world economical regions stipulates increasing growth of the use of containers that are recognized as the most versatile type of loading units. This in turn led to development of many different types of containers with different technological features. This could become a significant problem for interoperability of different transport modes.

2. Despite the different types, containers are used due to their advantages, the main of which are: worldwide distribution, efficient and safe transportation and handling of the cargo inside, low price, easy maintenance.

3. However, the real problems start because of fact that in order to satisfy requirements of different logistics parts (in order to optimise the use of rail, road and sea transport modes) a series of specialized containers have been developed. These developments were implemented mostly on the national level. Good examples are 6’4’’ height container for the domestic rail carriages in the USA; 45’ft, 48’ft, 49‘ft and 53’ft maritime containers used mostly in the USA; European land containers developed to optimise the loading of Euro pallets (this kind of containers has completely different dimensions than the ISO ones).

Technological developments that to some extent are related to containers stipulate also some confusion. These are widely in use in the EU and re-called swap bodies.

4. The main problem is that all these types have different measurements that not always could meat requirements for transportation by different transport modes in different countries. Therefore problems of lack of capacities in some of the regions as well as increase of empty trips occur.

5. In order to solve the problems of reduction of empty container trips in many cases additional infrastructure capacities (such as logistics centres and depots), properly working models, as well as Internet based information system is required.

6. In order to assure interoperability between different transport modes further development of containers, as the most versatile loading unit, is required. Good example of such activity is a try to create new European intermodal loading unit (EILU), which should combine all the advantages of swap bodies and ISO containers, and could be used in every transport mode across the Europe.

References

[1] Fowkes A.S., Nash C.A., Tweddle G. Investigating the Market for Intermodal Freight Technologies, *Transportation Research Part A*, Vol. 25, 1991, pp.161-172.
[2] http://www.containershipping.nl
[3] Jennings B.E., Holcomb M.C. Beyond Containerisation: the Broader Concept of Intermodalism, *Transportation Journal*, Vol. 35, No. 3, 1996, pp. 5-13.
[4] Proposals for a Directive of the European Parliament of the Council on Intermodal Loading Units: Communication from the Commission. COM (2003) 155 final. Brussels, 2003.
[5] Gateway Cities Study (2002): Empty Ocean Container Logistics Study.
[6] Narbutas V. The Aspects of Empty Containers Logistics. Fachhochschule Erfurt, *University of Applied Sciences*, Vilnius Gediminas Technical University. Erfurt, 2005, p. 61.