SECTION 1 – IMPLEMENTATION OF THE WCO STANDARDS

JEL Classification: O18, R40, R42

ANALYSIS OF THE WORK OF UKRAINIAN SEA PORTS AND PROSPECTS OF THEIR DEVELOPMENT BASED ON THE CONTAINER TERMINAL "TRANSPORT INVESTMENT SERVICE"

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Abstract

This paper provides an analysis of the Ukrainian sea ports administration work. Particular attention was paid to container terminals, as being much-in-demand to date. As a result of the statistical analysis of the operation of container terminals in Ukraine, it is specified that one of the most promising terminals having a sufficiently high development potential and increasing volume of container traffic handling is a container terminal "Transport investment service" ("TIS").

This container terminal has all the necessary resources and environment for the development and successful competition with other ports of Ukraine. In this regard, the authors propose a "TIS" container terminal modernization model and make an assessment of its performance in view of this modernization. The outcomes show that the implementation of the proposed terminal operational model will enable the company to become one of the leaders in container handling in Ukraine. Based on a systematic analysis of the documentary clearance of goods at the port, the authors suggest designing a new document workflow model.

The proposed approaches are modular in nature and can be generalized for their use as a standard project decisions while modernizing similar container terminals.

Keywords: container shipping, ports, container terminal "TIS" dry port, "Single Window".

Introduction

The current stage of the global transport sector to a great extent determines the level of economic development of countries. Almost all the major sectors of economy can not exist without transport. For example, ports can not work without ships as all kinds of control would not be carried out in ports, and thus shipment would become impossible. Therefore one of the main driving forces of the global economy dynamic development is transportation.

Today transport plays a very important role in the life of mankind. The most important feature is the movement of people and goods around the world. In the meantime

an important factor is a geographical location of a country in the world and an access to the sea. This significantly influences on a country economy. In this respect Ukraine takes a leading place throughout Europe, as firstly, it has an access to the Black Sea, secondly, it borders on the European Union, Eurasia and the Russian Federation. Located between the world centers of production facilities, the transport infrastructure of Ukraine has all chances to become a locomotive of the domestic economy development, which requires its urgent modernization in accordance with the international standards.

Transport infrastructure is a kind of infrastructure, a complex of all industries and transport companies both performing transportations and ensuring their implementation and maintenance (https://ru.wikipedia.org/wiki). Therefore, to ensure the efficient transportation of goods it is necessary to make a lot of construction and maintenance work to support infrastructure. This list includes all kinds of roadway and transportation support facilities (logistics transport and customs facilities, transportation hubs, stations for all types of transport, airports, depots, container terminals, passenger and freight stations, etc.).

It is necessary to underline that today one of the most common and efficient goods transportation technology is container shipping. An annual container turnover growth in the world is increasing, and eventually, majority of goods will be shipped in containers. Transportation hubs for such goods handling are container terminals being built and renovated in virtually all the world's leading ports.

However, experience in the use of container systems reveals two main problems (Pasechnik 2011):

1) if supporting documents go behind the movement of containers or vehicles wait very long for the fulfillment of formalities or there are delays connected with a container search, all the benefits will be nullified;

2) the second problem is the lack of balance between volumes of direct and reverse traffic when the there is cargo being carried to a destination, but there is no cargo being carried to a backward direction, consequently there is a problem of empty runs of containers .

Based on the abovementioned, we can argue that the transport infrastructure is a web connecting enterprises, container terminals, stations, cities and countries. In short modernization should mandatory concern all units of transport infrastructure, and especially container terminals, due to the fact that container transport is getting more and more popular.

1. The system analysis of the Ukrainian ports engaged in export-import freight flow handling

In Ukraine there are 13 sea ports, in particular Berdyansk, Belgorod-Dnestrovsky, Izmail, Illichivsk, Mariupol, Nikolaev, Odessa, Oktyabrsk, Reni, Skadovsk, Ust-Danube, Kherson, Yuzhny. These ports are located along the coast washed by the Black and Azov seas. Despite this variety, each of them has its own handling infrastructure, which allows handling a certain range of goods. From the abovementioned ports not all are engaged in container shipping due to the lack of container terminals. The comparative characteristic of the volume of cargo handling in Ukrainian ports having container terminals is shown in table 1 (Official statistics of the administration of Ukrainian sea ports during January-June 2015; http://www.ukrstat.gov.ua).

Analyzing the statistical data specified in the table, we can state that according to the overall performance ranks the Southern port takes the first place, Odessky port holds the second place and Illichivsky port takes the third place. Mariupolsky, Oktyabrsky and Khersonsky ports showed much lower results, but nevertheless, they handle the range of goods that are not overloaded in Odessky, Illichevsky and Southern ports. In general, this makes it possible to release large ports from petty work, thereby creating favorable conditions for small ports. Taking this into account it should be emphasized that Ukraine

Table 1. The statistical data on the work of Ukrainian ports during January-June 2015

	Ukrainian ports					
	Ilyichevsky	Mariupolsky	Southern	Odessky	Oktyabrsky	Khersonsky
CARGO	kt					
LIQUID	966,36	41	2279,9	2218,64	7,47	16,77
Oil	11,06					
Petroleum products	106,38		248,73	1693,7	7,47	16,77
Lubricant	848,92	41	454,73	24,6		
Chemical			1576,5	498,6		
Other liquid bulk				1,74		
BULKY	6141,49	2051,86	21659	4433,38	2545,92	1234,73
Coal	77,9	704,7	2836,7		263,45	21,12
Coke	49,4	51,4				7,62
Ore	2407,6	1112,9	13402	380,44		9,44
Building	293,5	52,7	10,22	147,01	515,73	90,88
Cement						3
Chemical			915,85		556,59	77,18
Cereal	2401,49	108,73	4098,2	3535,82	887,32	335,43
of which grain	2401,49	66,93	4098,2	3535,82	887,32	154,46
Other bulk cargo	911,6	21,43	396,18	370,11	322,83	690,06
UNITIZED	1680,3	2406,62	318,33	5717,85	917,84	526,51
Automotive	16,8				0,64	
Timber					3,25	101,43
Ferrous metals	602,3	2400,72	25,68	3147,84	887,34	368,86
of which crude iron	568,4	488,81	25,68	46,04		
rolled steel	1,6	844,81		3008,86	862,41	240,1
scrap		2,6		92,94	24,93	128,76
other	32,3	1064,5				
Chemical	1			10,9		2,7
Food	6,7			6,38		4,08
Containers, t	416,1	3,5	292,65	2529,08	1,23	4,35
Containers, pcs	20829	455	16815	118972	138	418
Containers, TEU	32435	408	25946	181155	238	749
Cars, t	429,2					
Cars, pcs	12828					
Other unitized goods	208,2	2,4		23,65	25,38	45,09
Total:	8788,15	4499,88	24256,9	12369,87	3471,23	1778,01

needs a large number of ports, but a desirable condition for their effective work is their functioning according to their cargo nomenclature. Thus, the goods will be evenly distributed to all ports of Ukraine and give an opportunity for their development.

Studying the container handling statistics in ports, in this regard Illichivsky port has overtaken the Southern port. Moreover the Southern port has been servicing containers since 2009, and today it has become a worthy competitor to Illichesky port for such a short time,

and it is smoothly moving towards the level of Odessky port. But an undisputable leader is Odessky container terminal and only foreign ports on the Black Sea coast can compete with it.

Since the most powerful container terminals belong to such ports as Odessky, Illichivsky and Southern, we'll consider in detail the statistics of each terminal separately in figures 1-3 (Ports of Ukraine 2015).

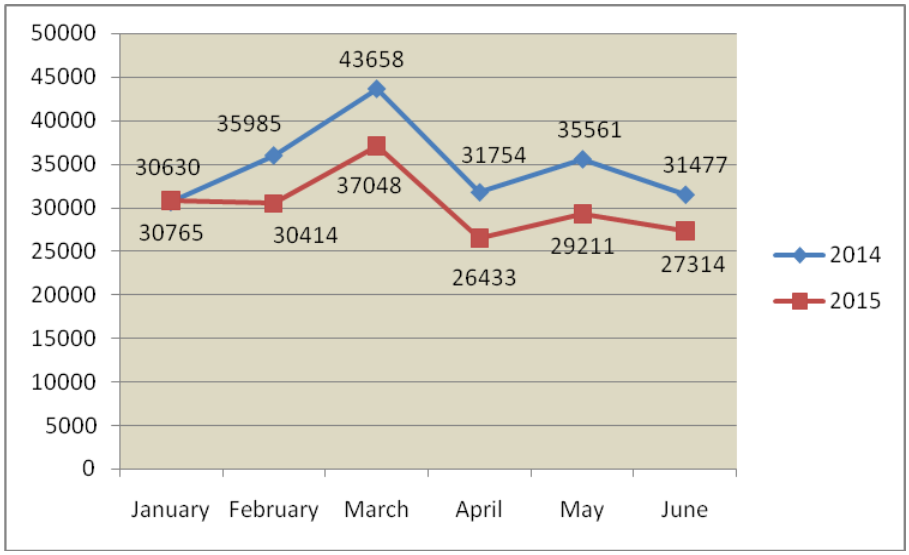

Figure 1. Container flow in Odessky port, TEU

Due to the fact that Ukraine's economy is in recession, the port of Odessa significantly reduced the container turnover in 2015. It is not connected with the port technological process or lack of capacity, but rather with complicated port trade relations with other countries. Thus, for six months almost a steady decline in container handling has been running. A more complicated situation related to the reduction of the volume of cargo handling can be seen in Ilyichevsky port. While the port of Odessa has an average volume of

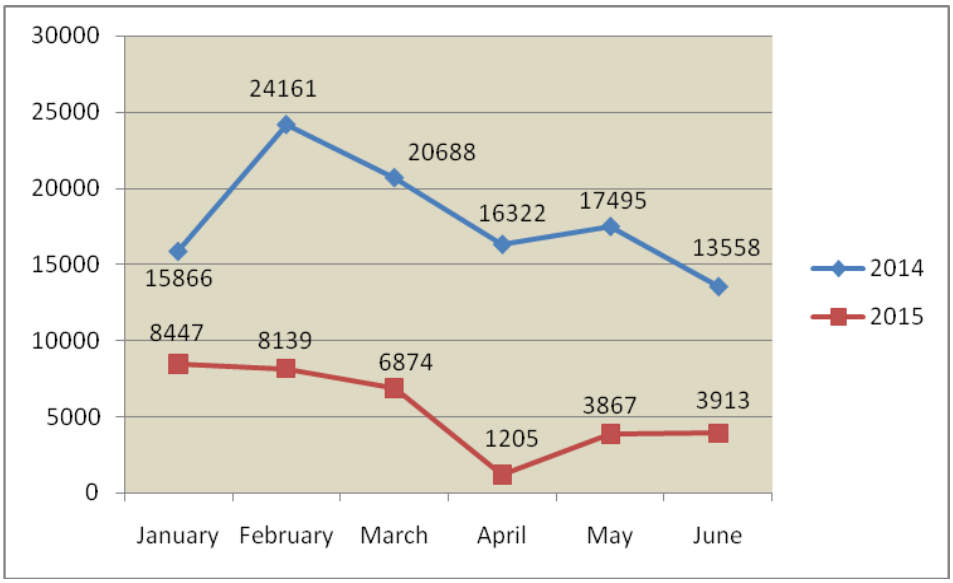

Figure 2. Container flow in Ilyichevsky port, TEU

work up to 86.6%, there is only 30% compared to 2014. The Southern port is the only port that has shown the best results for its six months of work. In January and May 2015 the number of containers being handled was larger than in 2014. The dynamics of the volume of work in this port accounted for 97.43 compared to 2014.

Thus, the container terminal "TIS" virtually retained container handling volumes that characterizes the terminal very positively and creates a good basis for further increasing the volume of cargo handling.

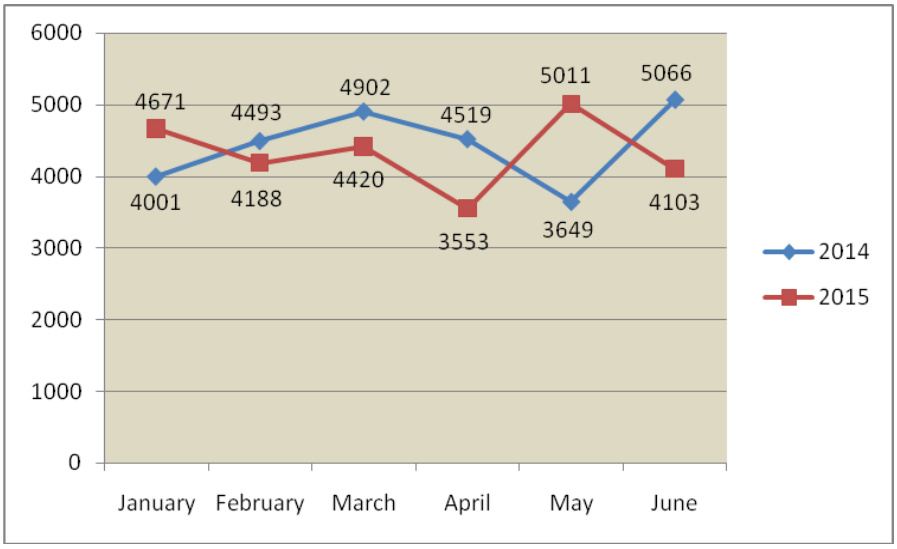

Figure 3. Container flow in the Southern port, TEU

2. The container terminal "TIS"

The container terminal "TIS" is the newest container terminal in Ukraine, which has been modernized to receive and process the largest vessels that can only enter the Black Sea, and can not be accept by any other port in Ukraine. The container terminal "TIS" has a 470 meter long and 16 meter container deep wharf, which is the longest and the deepest in the country (http://www.tis.ua/main_ru.html). Also, the terminal is able to unload bulk cargoes.

While designing and constructing the Transport Investment Service (TIS) (Pasechnik 2012) the latest technical and technological solutions were used and all the basic requirements for modern container terminals were met.

The structure of "TIS" includes 5 terminals: TIS-Grain, TIS-Fertilizers, TIS-Ore, TIS -Coal, TIS-Container Terminal. Each terminal has its own specific function and is engaged in a certain type of cargo turnover. Though the terminals function within the same port area, they are separate and independent.

The container terminal "TIS" is considered now to be the most modern in terms of technologies and technical equipment being used. In comparison to all other container terminals it is primarily a private company, which allows it to operate independently of the spheres of influence. Therefore, despite the competition with Odessky port, which is a container transportation leader in Ukraine, "TIS" is gradually gaining pace, regularly modernizes and builds new wharfs and is becoming a very serious competitor for the port of Odessa.

The biggest reason why Odessky port can't develop significantly is its location almost in the center of the city. The area around the port is already built up and placement of any additional wharf or technical equipment is almost impossible. Consequently, a period of

dynamic development of the Odessa port is completed, and in order to further develop the only way out of this situation is to use the technology of "dry port". This technology has been implemented under the name "Euroterminal". It has relieved the port from extra work and enhanced the economic performance. Due to it a container turnover is constantly growing and therefore the larger capacity vessel begin to enter the port.

"TIS" is an enterprise located outside the city, which has enough own territory and a good transport junction situated between Nikolaev and Odessa. Since there is a drive to two roads, cargo transportation does not impede the movement of public transport, which positively affects the port activities.

In Odessa, in this regard, there are difficulties, because cargo vehicles in order to transport goods need to travel through the city center. Today, carriage is permitted in summer only at night, at elevated temperatures. Thus, there is a possibility that vessels will remain off the harbour waiting for containers being unloaded. Therefore, in terms of geographical location the Transport Investment Service has a convenient location and good prospects for further development.

3. The proposed terminal modernization model

As it has already been mentioned, the "TIS" terminal has all the capacities for further non-stop container handling. However, in order to become a serious competitor to Odessa container terminal, it is necessary to introduce a model for the modernization of the container terminal "TIS".

The administration of the Southern port gradually implements the sea port development plan. For example, last year about $ 3 billion was raised, with $ 2.7 billion directed to the development of the port infrastructure and $ 0.3 billion aimed at the development of the rail and road infrastructure (Ports of Ukraine 2015). Accordingly, such funds are spent on improving the technical conditions of the equipment and its development since the economic condition of the enterprise allows for these costs. In order to improve the performance of the container terminal, it is offered at the same time to take measures in order to renovate the "TIS" container terminal (figure 4).

This model was developed in order to achieve two results: the first is to increase a container flow, the second is to create a simplified procedure for the interaction of all structures within the enterprise, combining them all into a single unit. This terminal should have a programmed working scheme without any failures.

Figure 4 shows that such infrastructure objects as a complex of vehicles in-depth inspection, a Ro-Ro terminal, a platform for handling, a station for loading and unloading of wagons, open areas for storage of coal and ore freight and a railway track have been built on the territory of the terminal. All these objects are in far distance from each other.

During operation of the terminal all the objects are used and some of them even work in full loading. The container terminal "TIS" has three mooring bracket-type gantry cranes of Super-Post-Panamax type for the transloading of containers from a ship to the shore as well as ten rear truck-mounted cranes of RTG type for the transportation of containers to the warehouse. Since this equipment is modern, the cranes do not work at full capacity.

The main technical specifications of mooring bracket-type gantry cranes are given in table 2. All these specifications are taken from the official website of the company "Container Lifting Systems" (http://www.topkraftspb.ru/kranyi-sts.html). The mooring crane is very easy to use and takes up little space, being located on the edge of the quay. The main specifications of truck-mounted gantry crane are given in table 3.

The next point is free areas located near the "TIS" terminal (A, B, C, D, E, F, G, H). In these areas buildings, roads and railways are going to be built.

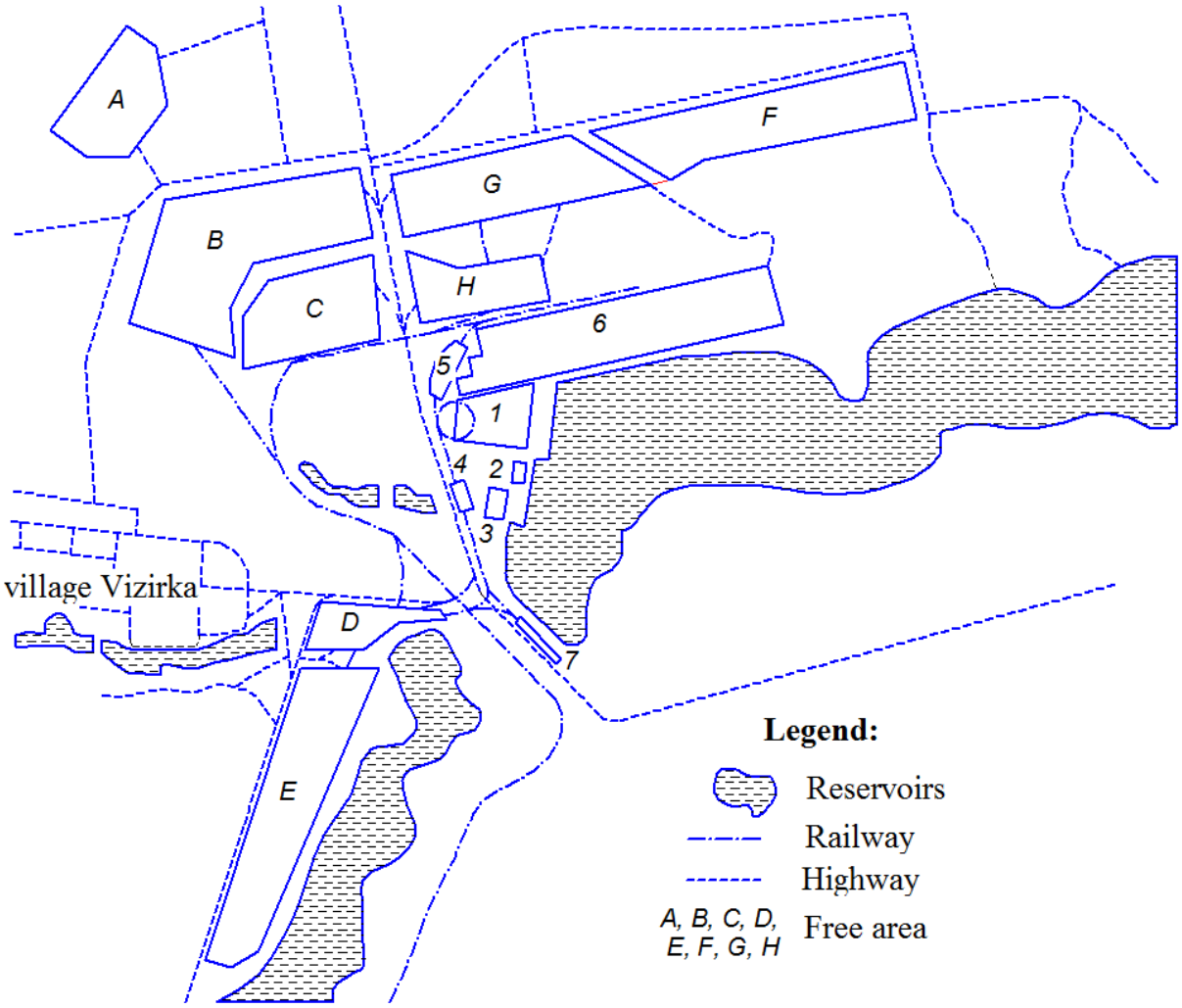

Figure 4. Container terminal "TIS" modernization model:
1 – Container terminal, 2 – Complex of vehicles in-depth inspection, observation ramp, 3 – RO-RO terminal, 4 – Platform for handling, 5 – Station for loading and unloading wagons, 6 – Open areas for storage of coal and ore freight, 7 – Railway track

Table 2. Specifications of mooring crane of Super-Post-Panamax type

Name:	**Crane of Super-Post-Panamax (STS5001,STS5501,STS6501) type**
Rated load capacity under spreader (A)	30, 48-80 t
Maximum reach of marine console (B)	25-70 m
Maximum reach of rear console (C)	8-28 m
Span width (D)	16-42 m
Lifting height over the rail head (E)	10-45 m
Lifting speed with full load	40-90 m/min
Lifting speed without load	70-150 m/min
Speed of the gantry movement	25-60 m/min
Maximum swaying angle	80˚

Table 3. Specifications of truck-mounted cranes of RTG type

Name:	**Crane of RTG type**
Load capacity under spreader (A)	41, 50, 61, 65 t
Span (B)	23; 47; 26,4 m
Maximum lifting height (C)	15,5; 18,5; 21,5; 24,5 m
Lifting speed with load	20-30 m/min
Lifting speed without load	40-60 m/min
Speed of the gantry movement with load	30-50 m/min
Speed of the gantry movement without load	90-150 m/min
Load trolley movement speed	70 m/min
Spreader shifting	+/-250 mm
Angle of spreader rotation	-5˚ - +5˚

Dash and axial lines in the figure indicate joint areas of objects planned to be interconnected. Broken lines between objects B, C, G, H, and D, E indicate the road that joins the objects. Currently, these areas of the motorway are not connected. After construction of the road it is necessary to pave the railway track from point 7 to point 5 through point 4 and also connect them with the areas B, C, D, E, F, G, H. In this way, we will create a single transport network between all facilities and free areas in order to make transportation both by road and railway.

"Dry port" will be located at sites B, C, G, H. A dry port is an inland terminal directly connected to the seaport by road or rail (https://ru.wikipedia.org/wiki). In result combining free areas, we have made a platform for a "dry port".

Therefore a "dry port" must meet the following requirements (Pasechnik 2016):

- an inland container terminal is a set of temporary warehouses, other buildings, constructions, roads, railways and other facilities located outside the territory of the seaport;
- it must be equipped with an electronic information system;
- a marine terminal operator (stevedore) must be an owner of an inland container terminal;
- a marine terminal and inland container terminal must be within the area of activity of one Customs office.

A further purpose is a construction of a belt line railway indicated next to point 1. With the help of this railway it will be possible to carry out transloading of containers from the vessel immediately on the train and takes them to a "dry port". This belt line railway is very important when dealing with containers, since a train may enter the territory of the terminal and does not waste time on cars coupling and uncoupling. A train can approach both from the north and west sides, providing simultaneous work of road transport. This scheme will reduce the downtime of vessels during loading and unloading. Also, it will be enough to use only one locomotive as there will be no dead-end station.

On the left hand side figure 4 shows the inscription "Vizirka village", which is a point where the offices of "TIS", stevedoring, broker and other companies are situated. Since there are many branch offices of the company in this area already, it is planned to place "Single Window" here. The essence of this office is that all companies preparing cargo and participating in its turnover as well as in its documenting will all be situated in the same building. This will reduce the time of movement of the company representatives to different cities, as today part of offices is located in Odessa and the other part is in Southern town.

The implementation of the proposed solutions for the terminal modernization will introduce the following technology of containers handling:

1. A vessel entering the waters of the port moors near the container terminal.
2. A belt line railway allows unloading of containers on railway platforms and at the same time on the road vehicles.
3. Nowadays the mechanism of customs clearance through the "Single Window" has been already launched.
4. Through the mainline railway track there is a distribution of trains directing towards the territory of "dry port", while trucks, after a complete documenting, leave the container terminal and carry cargo to the consignee.
5. Container are carried to the territory of "dry port", where they are stored, sorted, and then also on a train or road transport goods leave the territory and are delivered to the final destination.

Due to this non-stop process the containers handling will be made every minute, in the presence of a vessel with containers.

Further it is necessary to calculate the efficiency of transloading process, which will operate under the new scheme after the modernization.

The duration of the operations related to slinging and unslinging of containers will comply with the standards specified in tables 2, 3. Duration of other operations is determined by calculation.

A cycle duration of cranes of span type at the time of cargo transloading:

$$T^{пр}_{ц}=t_з+t_о+e(t_{п.г}+t_{пер.г}+t_{о.г}+t_{п.п}+t_{пер.п}+t_{оп}), \quad (1)$$

where $t_з$, $t_о$ – duration of cargo capture and unslinging, sec;
$t_{пер.г}$, $t_{пер.п}$ – duration of moving the loaded and empty gripper, sec;
$t_{п.г}$, $t_{п.п}$ – duration of lifting the loaded and empty gripper, sec;
$t_{о.г}$, $t_{о.п}$ – duration of lowering the loaded and empty gripper, sec;
e – rate of operations combining, e = 0.8.

The duration of lifting (lowering) the loaded or empty console during containers transloading:

$$t_{П(О)} = \left(\frac{H_П}{V_П} + \frac{(t_р + t_г)}{2} \right), \quad (2)$$

where $H_п$ – height of lifting (lowering) the loaded or empty gripper, m;
$V_п$ – speed of the crane lifting mechanism, m/sec;
$t_р$, $t_т$ - duration of acceleration and deceleration of lifting mechanism engines.

As the mooring crane has been installed on the territory of "TIS" for vessels with a width of 22 container rows, it is designated to process large amounts of containers. Therefore, we accept $H_п$ as about 10 meters, as containers will be loaded as much as possible.

Lifting speed of a container with full load is 90 m/min, but we accept $V_п$ = 70 m/ min to prevent the use of technical equipment at maximum load:

$t_{оп}=t_{пг}=10/70+(3+3)/2=11,62$ sec;
$t_{ог}=t_{пп}=40/130+(3+3)/2=21,51$ sec.

To determine the duration of the crane movement, the following formula is used:

$$t_{пер} = \left(\frac{l_{пер}}{V_{пер}} + \frac{(t_р + t_г)}{2} \right), \quad (3)$$

where $l_{пер}$ – movement distance of the crane with a loaded or empty gripper, m;

$V_{пер}$ – speed of movement mechanism, m / sec.

The crane movement distance depends on the size of a vessel and in which part of the vessel the containers to be unloaded are located. Therefore, we calculate the distance taking into account 3.15 meter width of a car, 2 meter width of a truck, 2 meter distance between a car and a vehicle, 20 meter width of the crane span and 2.5 meter average width of a container and 22 container rows on the board. So the average console movement distance is 55 meters:

$$t_{пер}=55/40+(3+3)/2=86,33 \text{ sec};$$

$$T^{пр}_{ц}=60+40+0,8(11,62+86,33+21,51+21,51+86,33+11,62)=291,13 \text{ sec}.$$

Technical productivity is calculated by the following formula:

$$W_T=3600\times q_м/T_ц, \quad (4)$$

where 3600 – number of seconds per an hour;

$q_м$ – loading cargo unit weight, t.

Since the container generally has an average gross weight of 24-30 tons, we respectively accept the average value of 27 tons.

$$W_T=3600\times 27/291,13=333,87 \text{ t/h}.$$

In order to determine the specific service conditions, it is necessary to calculate a working capacity. That is, we take into account specific time of the crane usage and lifting capacity of the crane during containers transloading.

Working capacity is determined by the following formula:

$$We=W_T\times \eta u\times \gamma p, \quad (5)$$

where $W_т$ – technical performance of the crane;

$\gamma_г$ – rate of the crane service by lifting capacity;

η_u – rate of the crane service by time, η_u = 0,8-0,9.

$$\gamma_г= q\phi/q\kappa, \quad (6)$$

where $q_ф$ – actual lifting capacity, t;

$q_к$ – crane lifting capacity, t.

$$\gamma_г=27/50=0,54;$$

$$W_e=333,87\times 0,9\times 0,54=162,26 \text{ t/h}.$$

Working capacity accounts for 162.26 t/h, while the technical performance is equal to 333.87 m/h. Thus, the working capacity is half as much as technical performance, due to incomplete time use and utilization of the crane in a certain mode.

The working capacity of three cranes per year will be equal to:

$$W_e =162,26\times 24\times 31\times 12\times 3=4345971,84 \text{ t/year}.$$

This figure is calculated in conditions of non-stop service. It is difficult to define the number of transloaded containers, since there can be unpredictable situations that happen every day:

- late arrival of a truck for containers transloading;
- late submission of documents for registration by shipping companies;
- breakdown of vehicles in any period of the operation process;
- delay in all types of control.

To achieve a maximum effect it is necessary to organize the working process in such a way that delays and unpredictable situations mentioned above will be as few as possible.

It has been calculated how many containers three cranes can transload from a vessel to another kind of transport and vice versa. Table 1 shows the statistical data of the Ukrainian ports work during half-year of 2015. Semi-annual performance indicator of the Odessa container terminal accounted for 2529.08 thousand tons, i.e. 2,529,080 tons. Annually this figure is approximately equal to 5,058,160 tons. Thus, it reveals that for one year the performance indicator of “TIS” container terminal has become almost equal to the indicator of the port of Odessa.

4. Principles of the "Single Window"

Every year more and more attention is paid to the simplification of Customs clearance of goods. There are many different types of control that are carried out by Customs authorities themselves or in cooperation with officials from the State Fiscal Service of Ukraine. The clearance of cargo is a responsibility of the State Fiscal Service, which controls the goods crossing the border, imposing taxes and bringing them into or out the territory of Ukraine. In recent years, the technologies of electronic clearance and "free practice" of vessels entering a port have often begun to be applied.

According to the International Health Regulations "free practice" means that a vessel is permitted to enter a port, to be embarked or disembarked, loaded or unloaded (World Health Organization 2005). "Free practice" at the container terminal shall be mandatory, with the aim of reducing vessel downtime in the harbour and during the fleet productive downtime. This will create conditions for attracting container lines' interest to the container terminal "TIS".

The essence of a "Single Window" creation is to send all the vessel documents in an electronic form. Thus, a "one-stop-shop" will be set up. This office will receive all the documents and distribute them all other departments. During this process, while a vessel is being moored, full control and clearance of cargo will be carried out. If there are any doubts, clearance is suspended, the commission working at the container terminal is called and within 5-10 minutes its members board the vessel for further investigation. Also observation ramps are mounted on the territory of the container terminal, and in case of suspicion of illegally imported or exported goods, containers are immediately X-rayed by the ramp.

It is also planned to connect the entry and exit checkpoints with the "Single Window", and vehicles will be released only after the permission given be the "Single Window".

Thus, if a clearance is made in the electronic form when the ship workers do not even see the faces of people who are engaged in this process, it will increase transparency of the documentary circulation as well as facilitate all kinds of procedures.

Summary and concluding remarks

The analysis has revealed that the most promising for modernization work is the container terminal "TIS". The proposed model of modernization combines all structures into a single entity, thereby creating a common mechanism of functioning. To achieve best results, the terminal must operate virtually in a programmed mode and don't have any breakdowns.

To obtain such outcomes it is necessary:

- connect all the free areas by roads and railway lines;
- within the mooring area build a railway ring in the shape of an ellipse to be able to make transloading operations at the same time on road and rail transport;
- build a "dry port" near the container terminal in accordance with all requirements;
- create a "Single Window" and implement "free practice" of vessels entering a port.

By means of the abovementioned actions it will be possible to create a universal terminal, which model can be copied by other ports. The long-run objective of this model is not designing specifically the container terminal "TIS", but creation on the basis of this prospective company of a non-stop functioning model with reduction of time spent on paperwork and downtime in the harbour, with increase of the containers storage area, with the ability to simultaneously make transloading on two means of transport.

Endnotes

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