

# Determinants of Operational Efficiency at Chemical Cargo Terminals

T.A. Gülcan, S. Esmer, Y. Zorba & G. Şengönül  
*Dokuz Eylül University, Maritime Faculty, Izmir, Turkey*

**ABSTRACT:** In today's globalized world, one of the requirements of global supply chains is efficient transportation systems. Approximately 80 per cent of world merchandise trade carried by sea and handled by ports worldwide. For this reason, maritime transport has the strategic economic importance. Loading of oil and gas has the biggest share (%30) in commodities carried by sea and 2.9 billion tons oil and gas loaded to ship in 2013. This study is focus on chemical cargo terminals which is a special terminal form where high and international levels of safety and quality elements applied. Unlike conventional bulk cargo and container cargo operations, chemical cargo operations include own priorities, applications, and the evaluation criteria. The aim of this study is to perform a qualitative research to determine the factors affecting the operational efficiency of ship, berth and warehousing operations in chemical cargo terminals.

## 1 INTRODUCTION

The influence of the chemicals, mineral oils and petrochemicals industry in daily life and in industry is well known – chemical and petrochemical products go into the manufacture of soaps, pharmaceuticals, plastics, tires and other objects vital to the onward march of civilization as well as mineral oils are both used by public and industry.

However, before consumers can reap the benefits of these products, a great deal of logistical planning goes into the manufacture, transport and processing (Nath and Ramos, 2011).

Today there are three kinds of terminals; the ones having their own refineries, terminals that only rent storage tanks for their customers only and the ones which include the both. The logistics part of these terminals deal with loading, unloading and also transporting these products via truck, train, pipeline and ships in which operation activities play the most

important role. To become a global and regional terminal, today's ports should always be in improvement process about operational efficiency of their terminals in accordance with the regional and international rules and manuals.

## 2 IMPORTANCE OF MEASURING TERMINAL EFFICIENCY

According to Thomas and Monie (2000), ports and terminals must measure their performance, because port efficiency is an important requirement in order to survive in the competitive world of shipping industry (Esmer, 2008). All ports are unique and measuring and analyzing performance is not simple. Under-utilizations will result in capital loss and higher cost for running the port. However, inadequate facilities result in delays which in turn lead to capital and customer loss (Tahar and Hussain, 2000). For these

reasons, the determination of the technical efficiency of terminals for handling commodities in seaports is an important issue to port manager (Notteboom et al. 2000). As a vital link in the overall supply chain, ports are an important transport infrastructure and, consequently, port efficiency is an important contributor to a nation's international competitiveness (Tongzon, 1989; Chin and Tongzon, 1998).

### 3 IMPORTANCE OF CHEMICAL TERMINALS

Chemical tankers, chemical ports and pipe lines are the main components of the world chemical transportation. Large quantities of liquid chemicals are transported by tanker ships (Arslan, 2009) and chemical cargoes have different properties, and many of them represent a health and safety hazard, which is a critical issue for the tanker industry (Karimi et al., 2002). Also pipelines play another important role for the transfer of the raw materials and products between refineries and terminals, especially located in the same geographical area or where maritime transportation is not cost/effective like Baku-Tiflis-Ceyhan pipeline. And finally truck and railway transportation modes are mostly used domestically for shipping the products from the terminals to the manufacturers.

As it is clear from the description, liquid raw materials and products as well as liquid chemicals are commonly transported by maritime transportation mode because of its lowest cost per ton mile and amount efficiency. All of these facilities require a terminal with its berth or jetties for the ships and also for the barges, railway for the trains, locomotives for the wagons, roads and stations for the trucks, pipelines between the terminals and/or refineries, tank farms for the storage of the raw materials and products, hoses or pipelines between the berth/jetty, wagon and truck loading/unloading stations.

In today's global economic conditions, there are also worldwide storage need for chemical mineral oil and petrochemical industry producers and customers. Chemical cargo ports are facilities which meet that needs. In the world, one of the most important examples of chemical terminals is Port of Rotterdam. Port of Rotterdam offers more than 30 million cubic meter of tank storage capacity for all types of liquid bulk. Products handled include crude oil, mineral oil products such as petrol, diesel, kerosene and naphtha, all kinds of bulk chemicals and edible oils and fats. In Port of Rotterdam region there are now five oil refineries, which process the imported oil, and over 45 chemical companies which have large-scale facilities. There is also 1500 km of pipelines interconnecting oil and chemical companies (<http://www.portofrotterdam.com>).

This paper is investigating the determinants of operational efficiency at chemical cargo terminals. As it is well known that during loading and unloading of the liquid chemicals, operational safety is the most important factor. Spills and accidents can be seen in many ways e.g. (Duffey and Saull, 185:2009); while filling, in storage, during transport, at process and transfer facilities; plus failures of vessels and pipeline. Safe and efficient

operational procedures should include design, control and management with together considering all relevant factors in chemical terminals. Therefore "the operational efficiency of the terminals" is a very important component for handling chemicals cargo.

## 4 METHODOLOGY

In this work "In-depth Interview" method was used face to face with the authorized Operational Manager/Staff of the companies as listed below. Because of all manager and staff do not want to disclose their names, the table do not include name of the participants.

Table 1. In-depth Interview details

Terminals	Staff Positions	Date
OIL Tanking / Hamburg / Germany	Terminal Manager	Nov. 2012
VOPAK / Hamburg / Germany	Operations Manager	Nov. 2012
DOW International / Hamburg / Germany	Dock Operations Leader	Nov. 2012
SOLVENTAŞ / İzmit / Turkey	General Manager	Dec. 2012
LİMAŞ / İzmit / Turkey	Tank Terminal Manager	Dec.2012

### The research questions were about the following topics:

- Jetty capabilities of the companies,
- The intermodal logistics capabilities of the companies,
- Loading and unloading automatic system/tools they use,
- The software systems they benefit during the operations and their tools.
- The watch systems for the operational staff the companies apply (number of personnel at operation stations, working hours, watch system etc.),
- The training systems,
- The inspections of the terminals,
- The Risk analyses procedures.

## 5 RESEARCH FINDINGS

### 5.1 Jetty capabilities of the companies;

Numbers of Jetties of the terminals are as listed below.

Table 2. Terminal specifications

	Vopak	Oil Tanking	Dow	Solventaş	Limaş
# of Jetties	9	5	3	2	2
Drafts (m)	3.5-12	3.6-12.8	7-14	10-25	11-22

The products handled in the jetties of VOPAK and OIL Tanking are mostly mineral oils and this is the reason why these jetties are convenient for ships between 2.000 and 200.000 dwt. VOPAK is also

handling sulfuric acid as chemicals. In the inside parts of the jetties of these two terminals, handling operations are usually realized with the barges and only hoses are used in handling operations. The mineral oils can be handled up to 2000 cbm/hour in OIL Tanking and also 1000 cbm/hour in VOPAK with loading arms according to the receiving capacity of the ships and to the property of the products. Although, pipelines used in mineral oil handlings are generally produced for a maximum pressure of 12-13 bars, they're usually used under pressures of between 6-7 bars due to safety and material lifetime.

DOW is handling only chemical products in its terminal with its jetties between 155 meter and 270 meter long. The loading arms on the jetties can be remote controlled which prevents the possible delays caused by the ship maneuvers.

SOLVENTAŞ uses one of its jetties for chemical liquids and the other one for fuel and gas oil handlings which are 250 and 275 meter long. There is real-time fuel oil and gas oil blending capability on the jetty as loaded to the barges for bunkering. On chemical jetty, 42 separate products can be handled at the same time with 4 or 8 ships according to their tonnages. LİMAŞ can handle 10 separate chemicals simultaneously on its 165 meter long jetty with two ships.

As described "The Physical Oceanographic" effect, tidal level in the Elbe River reaches up to 5 meter which causes delays in ship operations in connection with the drafts of the ships sometimes.

### 5.2 *Intermodal logistics capabilities of the companies;*

The European railway network is directly connected to the terminals in Hamburg and therefore is a very flexible instrument for transports leaving Hamburg and arriving at the terminals from the hinterland. All three companies in Hamburg have their own locomotives and railway inside their terminals. The yearly average number of wagons handled in OIL Tanking is 20.000. Also this number in VOPAK is daily between 100-200 wagons. As a result, the amount of handled liquid by railway is more than seaborne transports in these two companies 26% of the products leave DOW / Hamburg terminal by railway.

VOPAK and OIL Tanking has pipeline connection between their terminals and also with other refineries in their region. DOW international has a 380 km. long Ethylene pipeline inside Germany to its other refineries.

Tanker loading capabilities allow these three companies serious amounts of product handling and transporting them via trucks inside Germany and Europe. OIL Tanking handles average 65.000 tankers yearly and DOW / Hamburg forwards its 21% of chemical products by road transport by tankers.

The firms located in İzmit/TURKEY use seaborne and tanker transportation modes in common. First of all LİMAŞ has pipeline connections with two companies producing chemical products in its region. The average Tanker loading number in SOLVENTAŞ is daily 250 and has 43 loading stations which allows

a yearly handling amount 1.400.000 tons in average. The loading stations number in LİMAŞ is 16 with a daily average 100 tankers loading capacity.

### 5.3 *The Automatic Loading and Unloading system/tools the companies use;*

All the terminals use automatic handling systems in accordance with their capacities. In this case, VOPAK and OIL Tanking can control all the handling cycle with the help of the software by which they realize the planning and handling that includes from which station and line number the product loading is going to be realized or which tank is going to be unloaded/loaded, in the "Control Rooms" they use. The staff working in these control rooms can control the level of the products in the Tanks and also the physical conditions of the products real time as well. Handling operations with ships and wagons are completed under the auspices of terminal staff.

The three Hamburg located terminals use full automatic loading systems for the tankers. This loading process is realized under the terminal's safety and security rules only by the tanker drivers who pass the tests made at the entrance of the terminal and who are experienced in automatic loading at least for a specific time that the company defines.

If the driver makes some mistakes during the loading process, then the system doesn't let him to go on with loading and warns the staff in the control room for helping the driver with the communication system or personally.

SOLVENTAŞ is realizing all the handling operations, including the ones that are completed under nitrogen cover automatically with help of the software the company created. The handling planning should be done by using this program and it doesn't let the planner to do this over the lines or valves that malfunction or under construction which inhibits the accident possibilities by the material. In loading process of tankers, it starts automatically by entering the number of "Loading Conformity Paper" by the staff to the system at the loading station which is brought by the tanker driver and ends automatically when the volume of the product reaches the required amount as it should be.

### 5.4 *The Software systems the terminals benefit during the operations;*

The examined terminals are all using various software according to their capacities during their operational facilities, connected within the framework of delegated limitations to the other departments such as technical and commercial.

After the clients order, handle planning is realized via these Decision Support System software including the variables like ETA of the vehicles or ships, the line numbers going to be used during handling, the necessary tank levels at the beginning and at the end etc. Additionally by the Local Area Network, operators can achieve ship's information, essential manuals, and procedures and check lists for the operations which they're assigned for with these

software's. During the operations if operator does something wrong than the program automatically stops the handling process and informs the control room or quality management departments of the terminals.

Further the stated tools, some terminals like SOLVENTAS enable tank leaseholders, owners of the products and freight forwarders to achieve with in competence of they are allowed to its software database to check out the real time information about their products, the bureaucratic works status etc. This software tool capability enables the freight forwarders make their loading and shipping plans by entering all the information about the tanker and also the drivers to the system.

After the freight forwarders' handling planning are loaded in the system, if traffic or other issues don't let the plan get realized at the terminal then the related staff inform the forwarders about the situation and guide them.

#### 5.5 *The operational staff working systems;*

In the Hamburg terminals, the handling process continues 24 hours for ships, barges and wagons. Tanker operations are 24 hours only in OIL Tanking terminal. In SOLVENTAS and LİMAŞ terminals ship handling processes are also 24 hours. Tanker operations in this two terminals are only daytime available.

Although, all terminals have various watch systems according to their personnel numbers, they apply daily 8 hour working with 3 watches (LİMAŞ has 2 watches). Some of them support the day time watches with staff who works only at day times on working days. Every watch except DOW has Watch Leaders. The watch leaders at SOLVENTAS should be ship engineers in principle.

The watch leaders assign their watch staff to the stations according to their skills and experience after they analyze the Planning Department's daily operational plans. Except operational problems, OIL Tanking doesn't assign any staff to the tanker loading area.

According to the GERMAN rules, during the handling operations at jetties, one staff should always be on duty on jetty. Additionally on jetties, in all terminals in HAMBURG there are always enough numbers of staff at train loading stations and in tank farm area. The terminals in Hamburg and also IZMIT principle about their staff are their having the skills to work on every station inside the terminal. In DOW and OIL Tanking terminals in every watch there are a few locomotive drivers who are trained and licensed by Deutsche Bahn.

#### 5.6 *The training systems for the Operational staff;*

All operational staff both in Germany and Turkey are well trained by internal and also external trainers as well. According to the international and national rules, all of the staff should be trained in specific issues like IMDG Code, ISPS Code, Fire Fighting and First Aid. These trainings are generally given by

licensed internal trainer in the terminal. SOLVENTAS and LİMAŞ are also trains it's staff about "Emergency Response Against Marine Pollution".

Additionally these trainings, simulators are used in some terminals for training the operators especially to build up their visual memories. OIL Tanking is using a wagon simulator from an external training company to train its staff and is planning to do this with a ship simulator next year.

#### 5.7 *The inspections of the terminals;*

Today's global economic circumstances, safety and security rules forces the terminals to have certificates which are valid worldwide to subsist in the market. All terminals in this work have the technical and quality (ISO) certificates according to their capabilities and are inspected frequently to keep these standards.

Today, intuitions like CDI or SGS imposed themselves worldwide and the terminals which work with their standards and have their certificates are always one step forward to the others in the competition.

Some companies like OIL Tanking creates an inspection team with its employees who work at the other terminals worldwide an inspects it's terminals with this teams.

#### 5.8 *The risk analyze procedures to minimize accidents during the operations activities;*

Analyzing all risks, accidents and taking precautions principle is implemented by all the terminals in this work. Although the analyzing methods are various, the managers and watch leaders determines the possible risks during the operations and after analyzing them with coefficients, bring out measures to minimize them.

## 6 CONCLUSION

Almost all terminals included in this work primary subject is to convert the manual handling systems to full automatic systems by the time to prevent the accident possibilities caused by human mistakes and to save up from labor force and leeway.

Especially railway intermodal mode affects the operational efficiency positively in terminals and doesn't require labor force like road mode. Investments on upper structure in this case by Eastern European countries and Turkey and integration with Western European countries would increase the capacity seriously.

Determining the specific criteria for the tanker drivers to enable them to do loading operations in automatic stations without terminal staff and applying them widely would affect the operational efficiency positively.

Making use of simulators by training the operational staff would give the personnel a visual

memory which would be helpful them during the operational activities.

Allowing the customers to enter the terminals software within the framework and to make their own handle plan with the terminals planning department can help the planning department in making operational plans.

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