Drzazga Michał
Baltic Oil Terminal (BOT), Dębogórze, Poland

Kołowrocki Krzysztof

Soszyńska-Budny Joanna

Torbicki Mateusz
Gdynia Maritime University, Gdynia, Poland

Port oil piping transportation critical infrastructure assets and interconnections

Keywords

asset, critical infrastructure, interconnections, interdependencies, port oil piping critical infrastructure

Abstract

This article aims to analyze the problem of the port oil piping transportation critical infrastructure assets and their interconnections identification. As a result, there are distinguished direct assets, auxiliary assets, flow of people, goods and services, accessibility and capacity of the port oil piping transportation critical infrastructure. Moreover, the interconnections and interdependencies of this critical infrastructure are fixed and described.

1. Introduction

One of the critical infrastructures at the Baltic Sea Region is the port oil piping transportation critical infrastructure (POPTCI) which is a part of the Baltic Oil Pipeline Critical Infrastructure Network (BOPCIN). The POPTCI transports oil between the pier of Gdynia Port and Oil Terminal in Dębogórze and is generally described in [2].

There are fixed assets of the POPTCI and they are hierarchical classified to one of types: direct assets, auxiliary assets, flow of people, goods and services, accessibility and capacity. Moreover, we identify interconnections and interdependencies of the assets in dependence on the type: physical, systems, geographical and logical.

This article gives us a wide knowledge about the POPTCI, its assets and interconnections between them and may be used as an example to determine assets and their interconnections of some critical infrastructures.

2. Critical Infrastructure assets

A CI asset, according to the taxonomy included in [2], is any person, facility, material, information, or activity that has a positive value to the critical infrastructure. We may categorize assets in many ways, including people, information, equipment, facilities, and activities or operations. In this article we distinguish and describe four types of POPTCI assets:

a) Direct assets,
b) Auxiliary assets,
c) Human resources,
d) Flow of goods and services, accessibility and capacity,

and four kinds of the interconnections and interdependencies of these POPTCI assets:

a) Physical interconnections,
b) Systems interdependencies,
c) Geographical interconnections,
d) Logical interdependencies.

3. POPTCI assets

We divide the POPTCI into four parts: the pier placed in Gdynia Port (the breakwater station called the Fuel Reloading Post), the terminal composed of Part *A*, *B* and *C*, pipelines and the delivery post *PB*.

The location of the four parts of the POPTCI is presented in the *Figure 1*.

In this chapter are described and classified the assets of the POPTCI.

Figure 1. The POPTCI

3.1. Direct assets of the POPTCI

a) Pier located in Gdynia Port
The Fuel Reloading Post in Gdynia Port is connected with Part *A* by the pipeline system. It is able to handle tankers of the length up to 210 m (the minimal vessel length is 100 m because of the dolphins spacing), the draught up to 11 m and the deadweight from 5 up to 35 thousand tons.

Figure 2. Fuel Reloading Post in Gdynia Port

b) Part *A*
Part *A* is a supporting pumping station connected with Part *B* and the pier by the pipeline system.

Figure 3. Supporting pumping station in Part *A*

c) Part *B*
The main part of the terminal is Part B. Tank farms, the central pumping station and tank cars loading the terminal are located here.

Figure 4. Overview of Part *B*

d) Part *C*
Part *C* is a technologically advanced fuel transshipment facility for rail tank cars consists of the on-spot loading device (4 lines with one filling pipe each) and the 34-place discharge rack. Part *C* is connected with Part *B* by the underground pipeline system.

Figure 5. On-spot loading device in Part *C*

e) Piping system
The system of pipelines which build the port oil piping transportation system is denoting by *S*. In this system are distinguished three subsystems:
– subsystem S_1 consisting of two piping lines composed of steel pipe segments of the diameter 600 mm, each composed of 178 pipe segments and 2 valves;
– subsystem S_2 consisting of two piping lines composed of steel pipe segments of the diameter 600 mm, each composed of 717 pipe segments and 2 valves;
– subsystem S_3 consisting of one piping line composed of steel pipe segments of the diameter 500 mm and two piping lines composed of steel pipe segments of the diameter 350 mm, each composed of 360 pipe segments and 2 valves.

Figure 6. Pipelines in the terminal

3.2. Auxiliary assets of the POPTCI

The auxiliary assets are:
a) in the Fuel Reloading Post – one jetty, fire-fighting post and the slop tank;
b) in Part *A* – the supporting station equipped with supporting pumps fortifying tankers pumps, the filter station and two slop tanks;
c) in Part *B* – the tank farms, the central pumping station, a control room, tank cars loading terminal, the fire-fighting post and administration buildings;
d) in Part *C* – the front filling train tankers and slop tanks;
e) in the piping system *S* – technological wells and monitoring systems.

3.3. Human resources of the POPTCI

The OLPP company, which owns the BOT (Baltic Oil Terminal), maintains an appropriate level of security by developing an appropriate organizational structure. It is consisting of the security posts which ensure safety work of the POPTCI.
In the structure of the company is operating an agency which is responsible for ensuring the security of the organization and the attorney assigned to protect the CI, who is subordinate directly to the Management Board in the organization chart. This reflects the importance of safety rules for the organization and ensures the management of the security and his team independence from the other cells of the company.
Employees are highly qualified with the necessary powers to conduct operations on the technological installation of the terminal in order to ensure the required standard of services in the BOT. Moreover, key personnel of the BOT have the appropriate competence, which allows implementation of both preventive tasks and rescue. There is developed an effective system of the notification and communication in crisis and emergency situations. The alarm point manned by an operation employee is operating in the continuous mode. There is an alarm point which operates in the continuous mode and is manned by an operation employee. For the duration of higher states of the national defense is created the Standing Duty.
There are trainings of the raising awareness and cyclic exercises of the protection of the CI for all employees of the terminal. Physical protection of the BOT is provided by specialized formation SUFO (specialist armed security). Also pipelines are protected. There are designated security areas and moreover, the whole area of the CI is monitored and patrolled by security personnel.
The technical safety of the area is ensured by having their own water supplies and power generators, what allows sustain all key installations for a long period of time. Protection of the data communication is

carried out by a specialized unit at the head office of the company, which provides continuous monitoring of the industrial systems, identification and protection of the critical systems and devices in the field of industrial automation and supervision of the security software.

3.4. Flow of goods and services, accessibility and capacity of the POPTCI

The terminal of the POPTCI is designated for the reception, the storage, loading and sending the oil products such like petrol and oil, both from rail cars to tankers and from tankers to tank cars or tank trucks. The maximum capacity of this terminal is equal 3.5 Mt per year.

Figure 7. Tank farm

The tank farm consists of four groups ground based fuel storage tanks with total capacity of 195000 m^3:

- I group: 2 x 5000 m^3 (floating roofs),
- II group: 3 x 13000 m^3 (floating roofs),
- III group: 3 x 18000 m^3 (floating roofs),
- IV group: 2 x 30000 m^3 (floating roofs);
  1 x 32 000 m^3 (the fixed roof).

The operating capacity is 180300 m^3 including 43500 m^3 (I and II tank groups) capacity for fuel products of all fire protection classes (petrol) and 136800 m^3 (III and IV tank groups) capacity for diesel fuel. All operations in the tank farm are centralized and controlled from one united control room.

The maximum speed of unloading cargo from tankers is 2000 m³/h, and the maximum loading rate is 1200 m³/h. The terminal is equipped with the on-spot tank cars loading device with 4 lines with one filling pipe each with the maximum loading rate of 300 m^3/h per each line. The terminal accommodates oil products discharge rack with 34 places that can unload a block train in 6 hours**.** The tank trucks loading terminal is equipped in with 4 loading racks, with the maximum loading rate 1600 l/min for each rack.

4. Interconnections and interdependencies of the POPTCI

4.1. Physical interconnections and interdependencies of the POPTCI

As we can see in *Figure 1* and *Figure 9*, the pier is connected with the terminal part *A* through the port oil pipeline transportation subsystem S_1, Part *A* is connected with Part *B* through the port oil pipeline transportation subsystem S_2 and Part *B* is connected with Part *C* through the port oil pipeline transportation subsystem S_3.

4.2. Systems interconnections and interdependencies of the POPTCI

The port oil pipeline transportation system *S* consists of three subsystems S_1, S_2, S_3 which structure is described in a subsection 3.1. Its general and particular scheme is presented respectively in *Figures 8-9*.

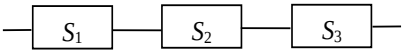

Figure 8. The general scheme of the port oil pipeline transportation system *S*

The system *S* is a series system composed of two series-parallel subsystems S_1, S_2, each containing two pipelines and one series -"2 out of 3" subsystem S_3 containing 3 pipelines. The subsystems S_1, S_2 and S_3 are forming a general series port oil pipeline system safety structure presented in *Figure* 8.

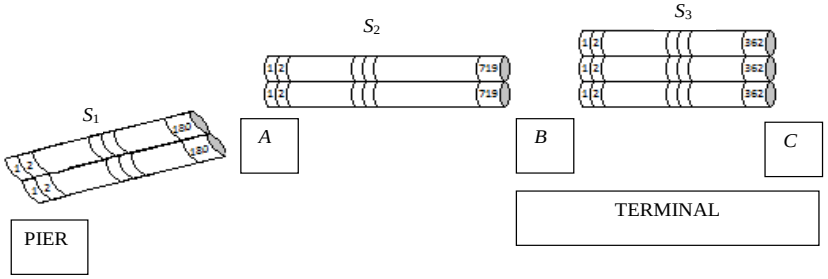

Figure 9. The particular scheme of the POPTCI

However, the pipeline system safety structure and its subsystems and components safety depend on its changing in time operation states.

Taking into account expert opinions on the varying in time operation process of the considered piping system, we distinguish the following as its seven operation states:

- an operation state z_1 – transport of one kind of medium from Part *B* to Part *C* using two out of three pipelines of the subsystem S_3,
- an operation state z_2 – transport of one kind of medium from Part *C* to Part *B* using one out of three pipelines of the subsystem S_3,
- an operation state z_3 – transport of one kind of medium from Part *B* through Part *A* to the pier using one out of two pipelines of the subsystem S_1 and one out of two pipelines of the subsystem S_2,
- an operation state z_4 – transport of one kind of medium from the pier through Part *A*, *B* and *C* using one out of two pipelines of the subsystem S_1, one out of two pipelines in subsystem S_2 and two out of three pipelines of the subsystem S_3,
- an operation state z_5 – transport of one kind of medium from the pier through Part *A* to *B* using one out of two pipelines of the subsystem S_1 and one out of two pipelines of the subsystem S_2,
- an operation state z_6 – transport of one kind of medium from Part *B* to Part *C* using two out of three pipelines of the subsystem S_3, and simultaneously transport one kind of medium from the pier through Part *A* to *B* using one out of two pipelines of the subsystem S_1 and one out of two pipelines of the subsystem S_2,
- an operation state z_7 – transport of one kind of medium from Part *B* to *C* using one out of three pipelines of the subsystem S_3, and simultaneously transport second kind of medium from Part *C* to *B* using one out of three pipelines of the subsystem S_3.

The influence of the above system operation states changing on the changes of the pipeline system safety structure is as follows.

At the system operation states z_1 and z_7, the system is composed of the subsystem S_3, that is a series-"2 out of 3" system containing three series subsystems with the scheme showed in *Figure 10*.

At the system operation state z_2, the system is composed of a series-parallel subsystem S_3, which contains three pipelines with the scheme showed in *Figure 11*.

At the system operation states z_3 and z_5, the system is series and composed of two series-parallel subsystems S_1, S_2, each containing two pipelines with the scheme showed in *Figure 12*.

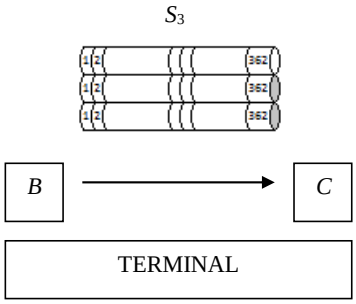

Figure 10. The scheme of the port oil piping transportation system at the operation states z_1 and z_7

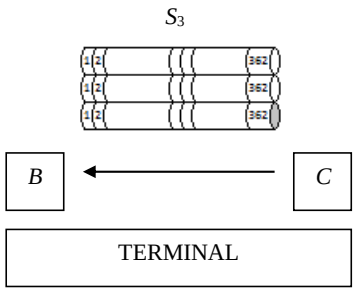

Figure 11. The scheme of the port oil piping transportation system at the operation state z_2

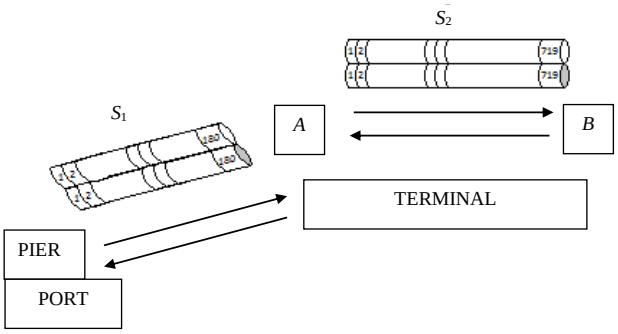

Figure 12. The scheme of the port oil piping transportation system at the operation states z_3 and z_5.

At the system operation states z_4 and z_6, the system is series and composed of two series-parallel subsystems S_1, S_2, each containing two pipelines and one series-"2 out of 3" subsystem S_3, with the scheme showed in *Figure 13*.

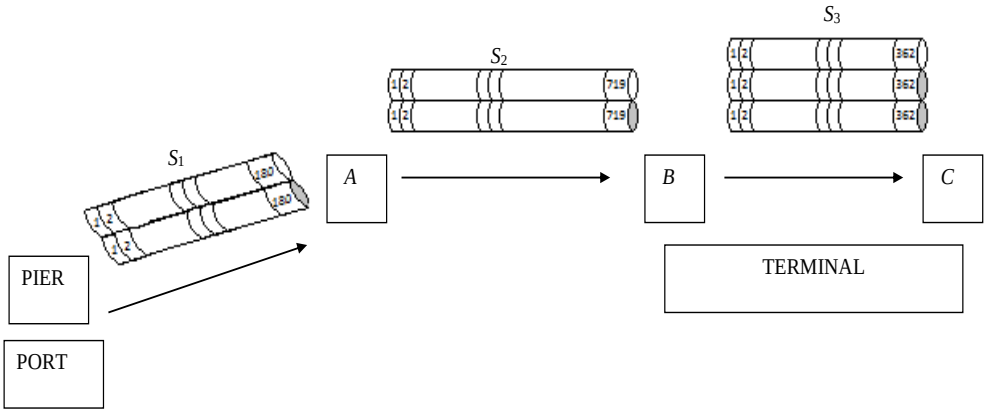

Figure 13. The scheme of the port oil piping transportation system at the operation states z_4 and z_6.

4.3. Geographical interconnections and interdependencies of the POPTCI

The terminal parts *A*, *B* and *C* have a jointly area about 78.4 ha. Part *A* is located in Gdynia Oksywie at 18 Muchowskiego street. Parts *B* and *C* are located in village of Dębogórze near Gdynia. Part *B* is located by the road nr 100 and Part *C* is between village of Kazimierz and Dębogórze and is situated next to the First Regional Logistics Base in Dębogórze. The delivery post *PB* is located between streets Pucka and Hutnicza in City of Gdynia.

4.4. Logical interconnections and interdependencies of the POPTCI

The oil products are both unloaded from and loaded on the tankers at the pier in Gdynia Port. They are transported between the pier and the terminal part *A* through the subsystem S_1 and between Part *A* and *B* through the subsystem S_2 with the support of the pumping units located in the terminal part *A*. In Part *B* oil products are stored in tanks. Moreover there take place the reception from cars oil products and filling road tankers. Oil is also transported from Part *B* to *C* through the subsystem S_3 and in the terminal part *C* occur loading and unloading carriages and train tankers. In the post *PB* is a delivery-receiving station.

5. Conclusions

We classify and describe CI assets of the POPTCI and interconnections and interdependencies between them. It aims to give us wide knowledge about a true value of the POPTCI.

Acknowledgments

The paper presents the results developed in the scope of the EU-CIRCLE project titled "A pan – European framework for strengthening Critical Infrastructure resilience to climate change" that has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 653824. http://www.eu-circle.eu/.

References

[1] EU-CIRCLE Report D1.1-GMU1. (2015). *EU-CIRCLE Taxonomy*.
[2] EU-CIRCLE Report D1.2-GMU1. (2016). *Identification of existing critical infrastructures at the Baltic Sea area and its seaside, their scopes, parameters and accidents in terms of climate change impacts*.
[3] *Informacje na temat środków bezpieczeństwa i sposobu postępowania w przypadku wystąpienia poważnej awarii przemysłowej*, [available at: http://www.olpp.pl/files/repository/BP%2021%20Informacje%20na%20temat%20%C5%9Brodk%C3%B3w%20bezpiecze%C5%84stwa.pdf].
[4] OLPP Info. (2012). 12, 26.
[5] Terminale masowe, [available at: http://www.port.gdynia.pl/pl/galeria/terminale-masowe].