Ship-Disaster and its impact on the Transportation Chain through Simulation

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ABSTRACT

This paper presents a scenario analysis to determine the impact of a ship disaster on river Elbe on the transportation chain of the port of Hamburg. It is of special interest to decide how to dodge ships for the time of the disaster, and to detour trains and trucks for loading and unloading. This paper also show the development of the scenario analysis, experiments evaluating the impact on port transportation, analysis of simulation results and conclusions

KEYWORDS

Ship disaster, scenario analysis, dodge harbor, transportation impact

INTRODUCTION

The port of Hamburg is the terminus of the great trade route leading from the Atlantic to the North Sea. The port lies on the broad estuary of the river Elbe, open to the largest container ships of today because of constant dredging of the river Elbe. Moreover rivers, canals, roads and railroad feed the port of Hamburg from the so called hinterland with goods. The port of Hamburg itself is largely artificial and has been made by scooping out ship basins with suction dredges in a topology which nevertheless is well adapted to the needs of today's container shipping, and by building up tongues of land by depositing the same sand within stone and cement retaining walls. Many of the piers of the port of Hamburg are such large that a number of great container ships can tie up along one of them at once. A specialized system of quay sheds has been build up along with the piers and slips with elaborate big container terminal crane mechanisms for loading and unloading the vessels. Moreover this big sheds are connected with each other and are connected by intermodal transportation chains allowing intermodal connection with the respective production facilities in the rear, achievable by the port railway system as well as by trucks of the more than 1,7000 trucking companies which control a fleet of more than 45,000 trucks.

For arranging this different intermodal transportations an overall workflow based logistic process scheme is necessary to develop which really is a miracle. But in general the possible resulting difficulties of handling such big numbers of containers daily at the container terminals of the port of Hamburg have been reduced to a minimum for the port e.g. by making use of advanced modeling and simulation methods. Therefore, goods my be shipped into the port of Hamburg from any place in the world, and/or transferred from one ship to another (feeder), and left the port by rail and/or by truck.

In Figure 1 the location of the port of Hamburg – the pink colored area – as well as the topology of the metropolitan area of the city of Hamburg – framed by the yellow sphere and the area that belongs to the federal states of Schleswig Holstein – north of Hamburg – and Lower Saxony – south of Hamburg –. From Figure 1 it clearly can be understood how important a disaster free shipping traffic on the river Elbe is. Because there is no alternate shipping route for container ships available. The efficient, and effective, as well as disaster free transport of freight and goods is marking the most critical vertex for the expansion of growth for Hamburg's economy as well as the German and European one.

Fig. 1: Metropolitan Hamburg with port and river Elbe [1]

The port of Hamburg with an annual cargo handling of more than 97 Billion tons is Germanys biggest seaport and one of the distinguished trans-shipment centers for freight and goods. Hamburg holds rank nine of the world's biggest container ports and is number two in Europe. Due to advanced technology the biggest container ships in the world can be handled within 24 hours which make the port of Hamburg a booming one [2],

Same important facts of the port of Hamburg: Handling of cargo of the last two years [2, 3]:

- 2005: circa 8 Billion 20-Feet-Container
- 2007: circa 10 Billion 20-Feet-Container
- Annual growth from 2005 to 2007 more than 20%
- Daily intermodal container handlings (2007)
  - approx. 30% railway ➔ ca. 8,400 C.
  - approx. 25% Feeder ➔ ca. 7,000 C.
  - approx. 45% trucks ➔ ca. 12,600 C.
  - Total handlings approx. 28,000 C.

NATURAL DISASTERS AND TECHNICAL ACCIDANTS

Natural disasters in general are

- Floods
- Storms
- Forest fires
- Droughts
- Landslides
- Avalanches
- Earthquakes

Anthropogenic disasters in general are

- Oil spills
- Industrial accidents
- Toxic spills from mining activity
- Terrorist attacks
- Etc.

In general most anthropogenic accidents do not tend to cause as many deaths or as much economic damage as natural disasters. However, their catastrophic potential, especially in environmental terms can be much greater than that of natural disasters, as it is the case of increasing carbon dioxide (CO_2) emissions and henceforth to the resulting climate changes, consolidated as phenomena of global warming, for which Al Gore and the U.N.´s Intergovernmental Panel on Climate Change (IPCC) won the 2007 Nobel Peace Prize. As a result of global warming flooding, hurricanes and other disasters happen more often and in parts of the world where it never happened in the past and more people lost their homes than ever before.

SHIP DISATER

Ship disasters can happen for several reasons. One reason can be up to a wrong technical assumption of the right vessels length. Because scientists have discovered that a rogue wave pattern helped cause one of the UK's biggest maritime disasters. More than 40 people died when the MV Derbyshire was lost during a typhoon in the South China Sea in 1980. An inquiry ruled last year that a hatch cover had failed to withstand the pressure caused by huge waves which buffeted the 160,000-tonne bulk carrier. Now further research has shown the ship got into trouble because the waves were exactly the same length as the vessel. The study, carried out by experts at the University of Lancaster, has called for ships such as the Derbyshire to be made much stronger so they can take the strain of extreme weather conditions [4].

Other reasons can be bad weather conditions, wrong assumptions from radio communication, etc. The disaster scenario simulation analysis is based on the geographical situation of the port of Hamburg and the estuary of the river Elbe, as shown in Figure 2.

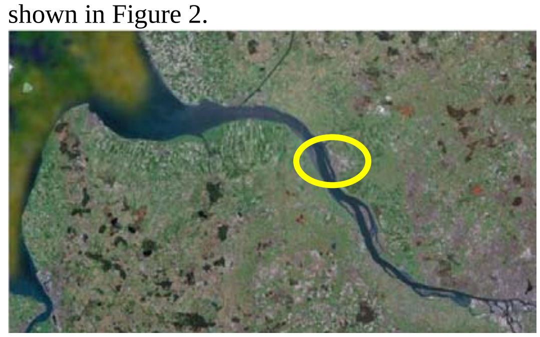

Figure 2: Disaster localization along river Elbe, modified according to Jens Froese, January 2008

Disaster-Scenario Part I:
Foggy, visibility below 300 m. Ship A decrease it's speed to disembark the pilot that was picked up at the sea while entering the river Elbe. Container ship B is driving behind ship A planning to overhaul ship A. A radio communication between ship A and B was done to ensure the overhaul.

Disaster-Scenario Part II:
Foggy, visibility below 300 m. Ship A head a little bit for starboard to let container B overhaul. Container ship B start with the overhaul maneuver

Disaster-Scenario Part III:
Foggy, visibility below 300 m. Ship A unfortunately reduce it's speed very slowly und mowed only very little to the starboard, which means ship A support the confirmed overhaul in an ineffectual manner. As a result the overhaul process takes to much time. Beside this situation, the oncoming super container ship C has to drive in the center of the fairway due to its heavy gauge.

Disaster-Scenario Part IV:
Foggy, visibility below 300 m. Container ship B be aware about the super container ship C on the radar and turns to starboard for the sake to pass the super container ship C, portside by portside.

Disaster-Scenario Part V:
Foggy, visibility below 300 m. Super container ship C is not aware about the coming up container ship B due to human error. Because of this it suddenly views optically, at the distance of 300 m, container ship B and beliefs to avoid the collision only through fast turning portside

Disaster-Scenario Part VI:
Foggy, visibility 300m Container ship B and super container ship C collides due to the shortness of clearance distance.

As a result of the collision of the two container ships on river Elbe one staff member of container ship B drown because he fall overboard through the loosening of a container coaking and another staff member of container ship B was smushed by telescoping containers.

Moreover on container ship B a fire begins to burn. Additionally on container ship B an oil tank became leak and oil effuse into the Elbe.

Disaster results:
- collided ships capture the whole waterway
- also in case of a low blockade the heavy shipping traffic is impossible
    - rescue operations
    - danger of another ship collision
    - at least only one waterway for navigation

Consequences:
- Ships can't leave the port of Hamburg
  → increasing costs for ship owner
- Ships can't arrive at the port of Hamburg
  → economic disadvantage for Hamburg Port Authority, HHLA; conveyance companies, consignees, …

Possible temporary solution: dodge ports, as shown in Figure 3:
- Cuxhaven [5]
    - Sea port at the estuary of the river Elbe
    - since 1997 deep water harbor
    - Handling 2006 approx. 32,900 TEUs
- Container Terminal Bremerhaven [6]
    - Handling 2006: approx. 4400,000 TEUs
    - Sprawl tidal quay, see Figure 5
- Rotterdam, Netherland [7]
    - Biggest European port
    - Handling 2005 approx. 9286,757 TEUs

(TEU = Twenty feet Equivalent Unit)

Figure 3: Possible dodge ports in case of a ship disaster at the river Elbe

Scenario for temporary transportation load
- Settings for different scenarios:
  1. Number of ships with destination Hamburg can vary
  2. Intake capacity of dodge ports can vary
- Scenario 1:
    - Destination Hamburg:

        - 2 Ships with 8,000 TEUs each
        - 3 Ships with 4,000 TEUs each
    - Detour
        - 1 Ship with 4,000 TEUs → Cuxhaven
        - 2 Ships with 8,000 TEUs each → Bremerhaven
        - 1 Ship with 4,000 TEUs → Bremerhaven
        - 1 Ship with 4,000 TEUs → Rotterdam

Figure 4: Sprawl tidal quay at Bremerhaven [5]

- Scenario 2:
    - All ports have the same status
        - 40% of additional load can be transported by rail
        - 5% additional load can be transported by Feeder ships
        - 45% additional load must be transported by trucks → ca. 10,000 trucks have to drive to the dodge ports
        - 10% of goods can´t be trans-ported as additional load, be in stock, → additional costs

CONCLUSIONS

In summary the following conclusions are made:

- Ship disaster causes significantly increasing additional costs, which has been analyzed in-vestigating the intermodal transportation chain from ships and terminals to pre- and post-sea transport, storage and distribution by rail and trucks through simulation
- Ship waiting time before the potentiality lea-ving the port as a consequence of this ship di-saster increase ship owners transportation cost
- A relative large number of containers can't be transported/delivered on time due to shortened additional waterborne and landborne transport capacity as part of the whole intermodal chain, which was analyzed through simulation based on the several scenarios

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