The Use of Simulation as a Tool for Developing Resilience of Ports

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Why ports need to be resilient?

- Ports are critical nodes in the global supply chain
  - UK being an island, ports are considered as a critical national infrastructure
- More than 90% of world trade involves shipping and port facilitates the transfer of goods from sea to land
- Disruptions can cause large fluctuations in global supply chain (economic loss and impacts to society)
- Supply chain system relies on resilience of ports
  - UK DEFRA food security report (90% food is through ports)
- Individual ports are getting specialized in their services
  - Location, Handling of vessels and goods, capacity
Resilience

• Many definitions
  – Ability of the system to bounce back after a shock and return back to its normal service levels
  – Capability of the system to provide and maintain an acceptable level of service during disruption

• Prevention, Response & Recovery

• Resilience requires strategies to be in place for managing risks that have not been identified
Resilience

Capacity / Performance measure

Time

Threat

Period of disruption

Response

Recovery

Loss in capacity
Problem

• Ports are vulnerable to threats
  – Natural disasters, human factors, organizational factors and infrastructure failures
• Complex system with wide range of stakeholders
• Interdependencies
  – Unbounded Risks
  – Requires a system wide risk management
• Impacts
  – Failures that cascade from delays to a complete closure
Project

• Aims to gain an understanding of risk and resilience within UK’s ports

• In a port environment
  – Study & understand interdependencies and associated unbounded risks and how it affects resilience
  – A simulation model that represent risk dependencies across the system and helps assess/improve system wide resilience
Case study - Port of London (PoL)

- UK’s second largest port
  - 2010 ~ 48 million tonnes
  - Serves critical supplies to South East England
- 80 terminals stretch along tidal Thames
  - Tilbury, Tate & Lyle, CORYTON & London Gateway
- Port of London Authority
  - Public & Private stakeholders
- Fragmented and complex interdependencies
Methodology

- System mapping
  - Stakeholders
  - Processes
  - Resources

- Interdependency analysis
  - Dependencies
  - Threats
  - Vulnerabilities

- Resilience assessment
  - Simulation model
  - System impacts
  - Scenario exercise
System Mapping

Environment

Port Facilities

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Interdependencies

Port Facilities

Environment

VTS
- Port duty controller
- Ship pilot coordinator
- Control centre

Pilotage
- Pilots
- Coordinator

Ship I
- Ship master/crew
- Vessel
- Agent

Towage
- Tug master/crew
- Coordinator
- Tugs

Terminal Operators
- Coordinator
- Mooring gang
- Terminal equipment
- Storage
- Transport vehicle

Freight Operators
- Agent
- Crew
- Transport vehicle

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Interdependency analysis
Simulation model

• Purpose is to measure the impact of a threat scenario on port performance (throughput, delays etc.)
  – Visual verification and interaction
  – Response/recovery measures could be tested

• Port operations simulation model
  – Specific for PoL to capture the physical, operational and management complexities
  – Focus on sea-side operations

• Discrete Event Simulation using AnyLogic
Simulation model

Flow of ships/goods (- Loss of Throughput)

Flow of ships/goods (Throughput)

Environment

Port Facilities

Time

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Outputs

• Resilience metrics
(Before, during & after a disruption scenario)
  – Ship turn around time
  – Number of ships served (by resource)
    • Tonnage, goods type ->£££
  – Queues/delays
    • Loss, utilization

• Perform analysis to identify critical variables
Scenario based exercise (Involving stakeholders)

- Brings stakeholders together and understand individual/system risks due to dependencies
- Identify/understand critical links with stakeholders
- Response/resilience strategies could be worked out in cooperation
- Set up resilience forums, support each other during crisis & joint investments on resilience
Conclusions

• Ports need to be resilient
  – Requires system wide understanding of the complex interdependencies and the associated unbounded risks

• A methodology to assess and improve resilience of port system proposed
  – The simulation model representing interdependencies will help assess resilience
  – The resilience assessment using stakeholder participation will help improve resilience

• Help port stakeholders
  – More accurately evaluate risk management procedures and practices
  – Develop port-wide business continuity plans
  – Optimize the allocation of resources
Thank you

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