LIVERPOOL JOHN MOORES UNIVERSITY

LJMU Research Online

John, A, Paraskevadakis, D, Bury, A, Yang, Z, Riahi, R and Wang, J

An integrated fuzzy risk assessment for seaport operations

http://researchonline.ljmu.ac.uk/id/eprint/1787/

Article

Citation (please note it is advisable to refer to the publisher's version if you intend to cite from this work)

John, A, Paraskevadakis, D, Bury, A, Yang, Z, Riahi, R and Wang, J (2014) An integrated fuzzy risk assessment for seaport operations. SAFETY SCIENCE, 68. pp. 180-194. ISSN 0925-7535

LJMU has developed **LJMU Research Online** for users to access the research output of the University more effectively. Copyright © and Moral Rights for the papers on this site are retained by the individual authors and/or other copyright owners. Users may download and/or print one copy of any article(s) in LJMU Research Online to facilitate their private study or for non-commercial research. You may not engage in further distribution of the material or use it for any profit-making activities or any commercial gain.

The version presented here may differ from the published version or from the version of the record. Please see the repository URL above for details on accessing the published version and note that access may require a subscription.

For more information please contact researchonline@ljmu.ac.uk

http://researchonline.ljmu.ac.uk/

Figure Captions:

Figure 1: Sea-Land Interface of Maritime Transportation Systems

Figure 2: Framework for Risk Assessment of Seaport Operations

Figure 3: Generic Model for Disruption of Seaport Operations

Figure 4: Fuzzy Triangular Membership Function

Figure 5: Example of Converting Fuzzy Ratings to 5 Non-normalized grades

Figure 6: A Specific Model for Disruption Risks of a Seaport Operation

Figure 7: Sensitivity Analysis of the Model Output to the Variation of Each Sub-Criterion

FIGURE 1

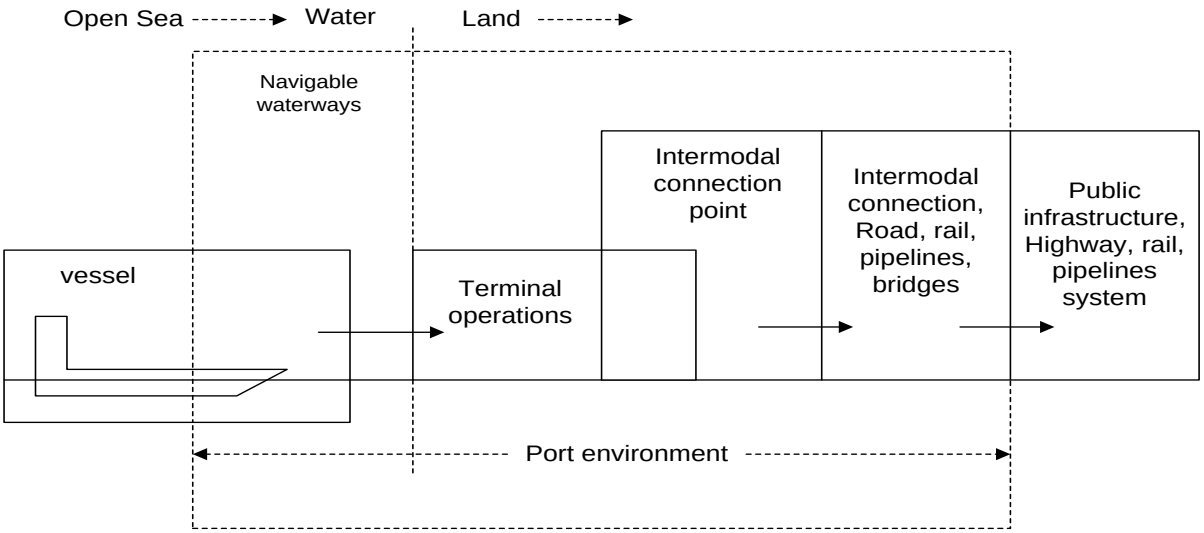


FIGURE 2

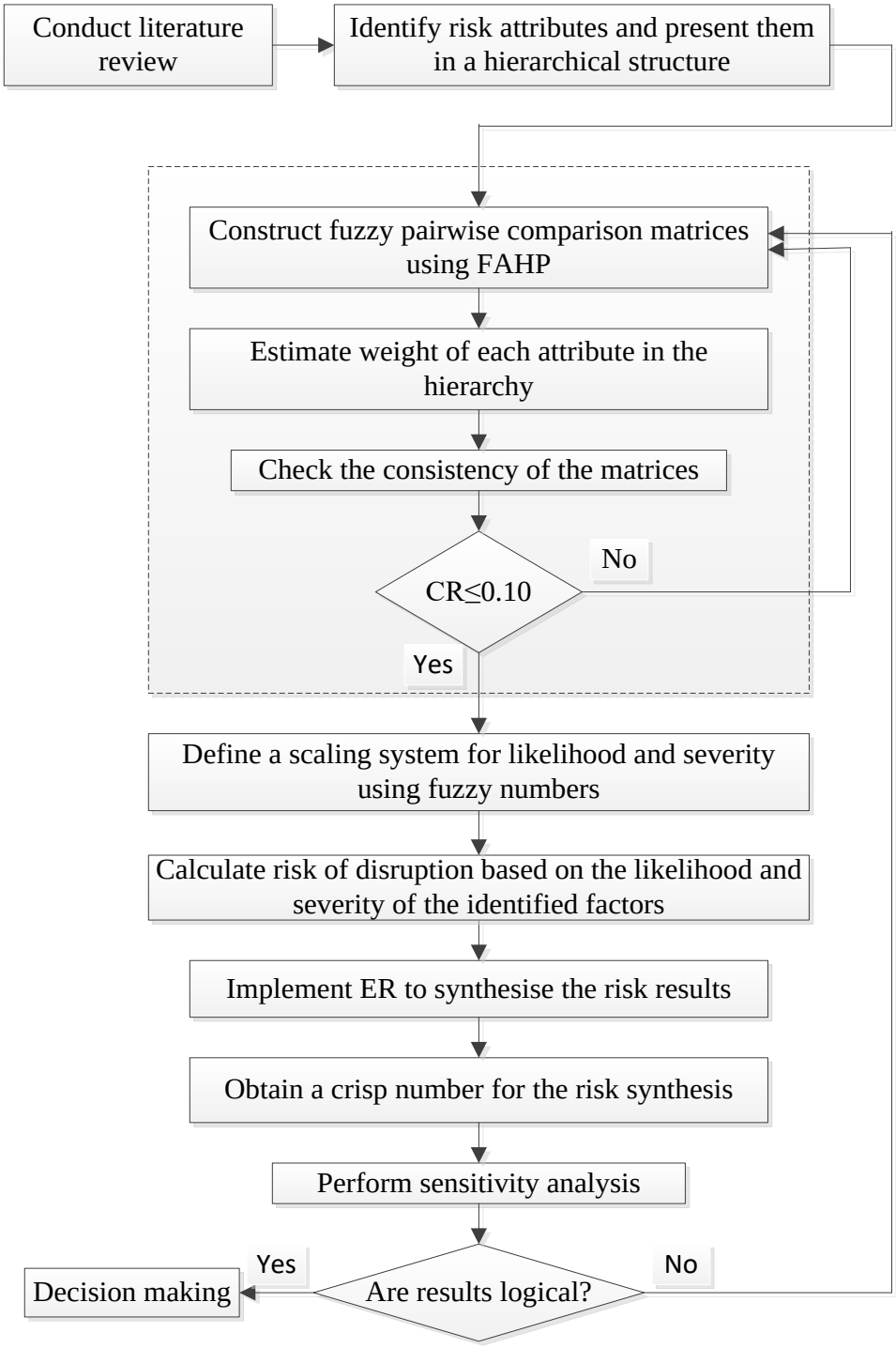

Conduct literature review
Identify risk attributes and present them in a hierarchical structure
Construct fuzzy pairwise comparison matrices using FAHP
Estimate weight of each attribute in the hierarchy
Check the consistency of the matrices
CR≤0.10
No
Yes
Define a scaling system for likelihood and severity using fuzzy numbers
Calculate risk of disruption based on the likelihood and severity of the identified factors
Implement ER to synthesise the risk results
Obtain a crisp number for the risk synthesis
Perform sensitivity analysis
Are results logical?
Yes
No
Decision making

FIGURE 3

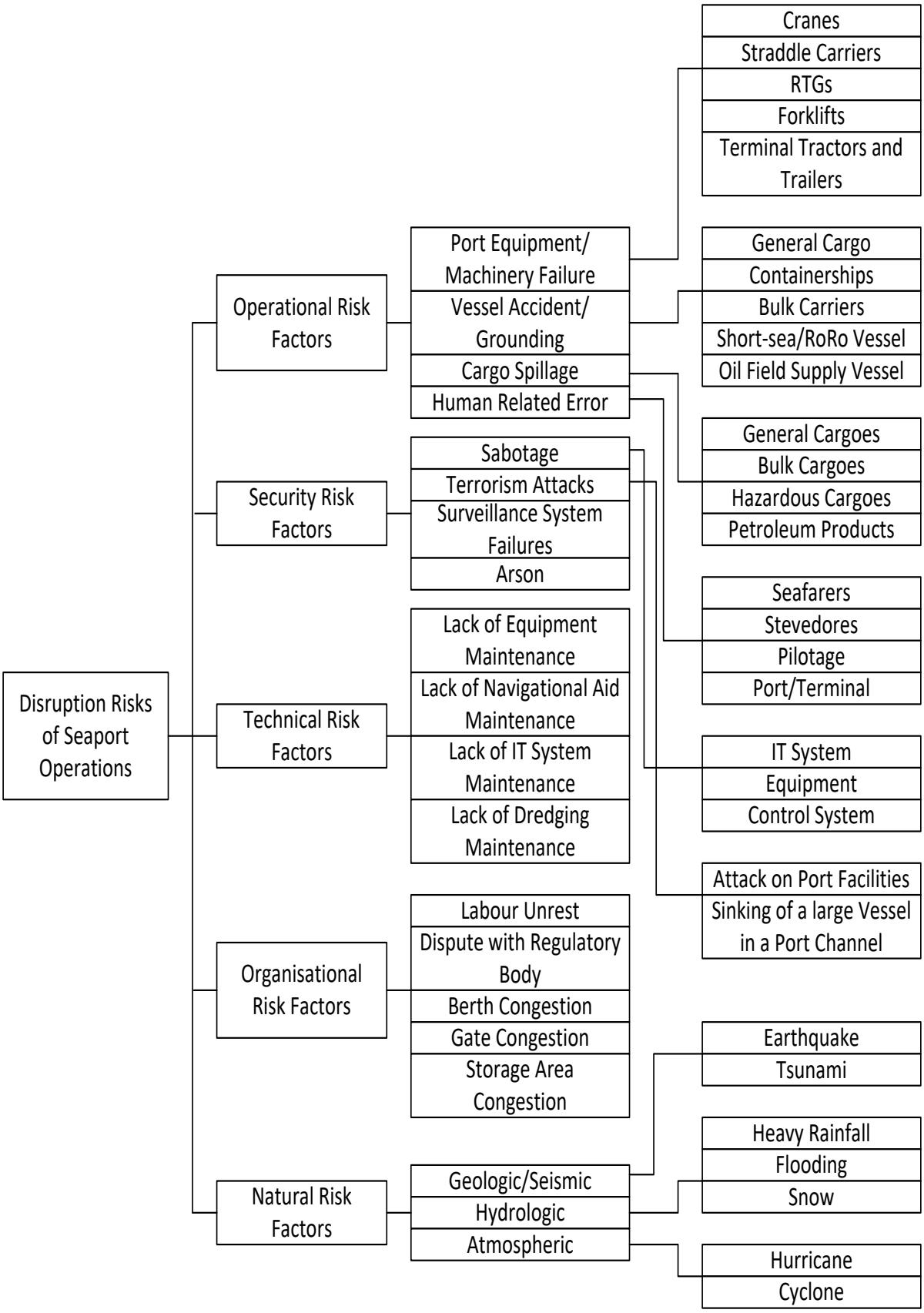

Disruption Risks of Seaport Operations
Operational Risk Factors
Security Risk Factors
Technical Risk Factors
Organisational Risk Factors
Natural Risk Factors
Port Equipment/ Machinery Failure
Vessel Accident/ Grounding
Cargo Spillage
Human Related Error
Sabotage
Terrorism Attacks
Surveillance System Failures
Arson
Lack of Equipment Maintenance
Lack of Navigational Aid Maintenance
Lack of IT System Maintenance
Lack of Dredging Maintenance
Labour Unrest
Dispute with Regulatory Body
Berth Congestion
Gate Congestion
Storage Area Congestion
Geologic/Seismic
Hydrologic
Atmospheric
Cranes
Straddle Carriers
RTGs
Forklifts
Terminal Tractors and Trailers
General Cargo
Containerships
Bulk Carriers
Short-sea/RoRo Vessel
Oil Field Supply Vessel
General Cargoes
Bulk Cargoes
Hazardous Cargoes
Petroleum Products
Seafarers
Stevedores
Pilotage
Port/Terminal
IT System
Equipment
Control System
Attack on Port Facilities
Sinking of a large Vessel in a Port Channel
Earthquake
Tsunami
Heavy Rainfall
Flooding
Snow
Hurricane
Cyclone

FIGURE 4

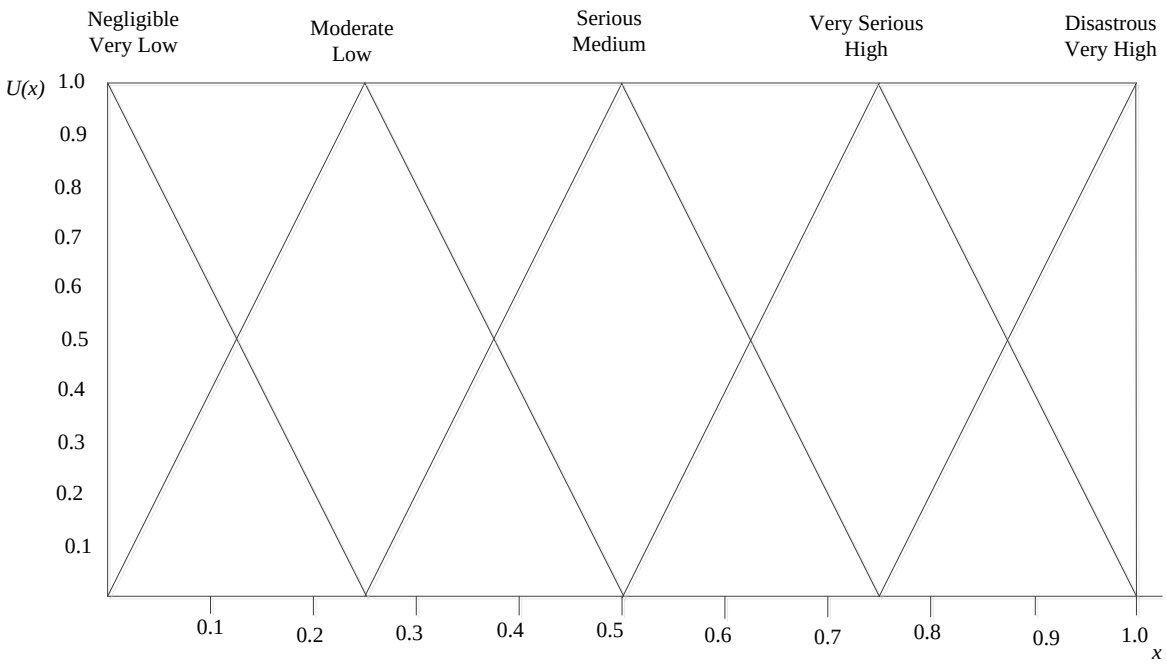

Negligible
Very Low
Moderate
Low
Serious
Medium
Very Serious
High
Disastrous
Very High
U(x)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
x

FIGURE 5

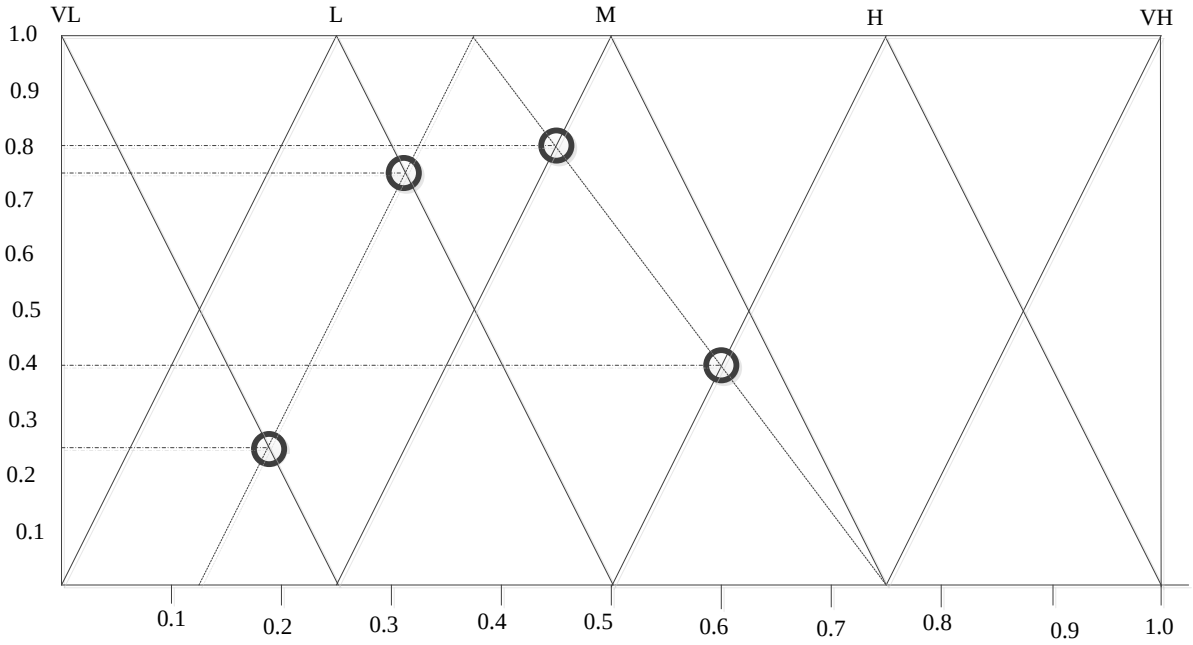

VL
L
M
H
VH
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0

FIGURE 6

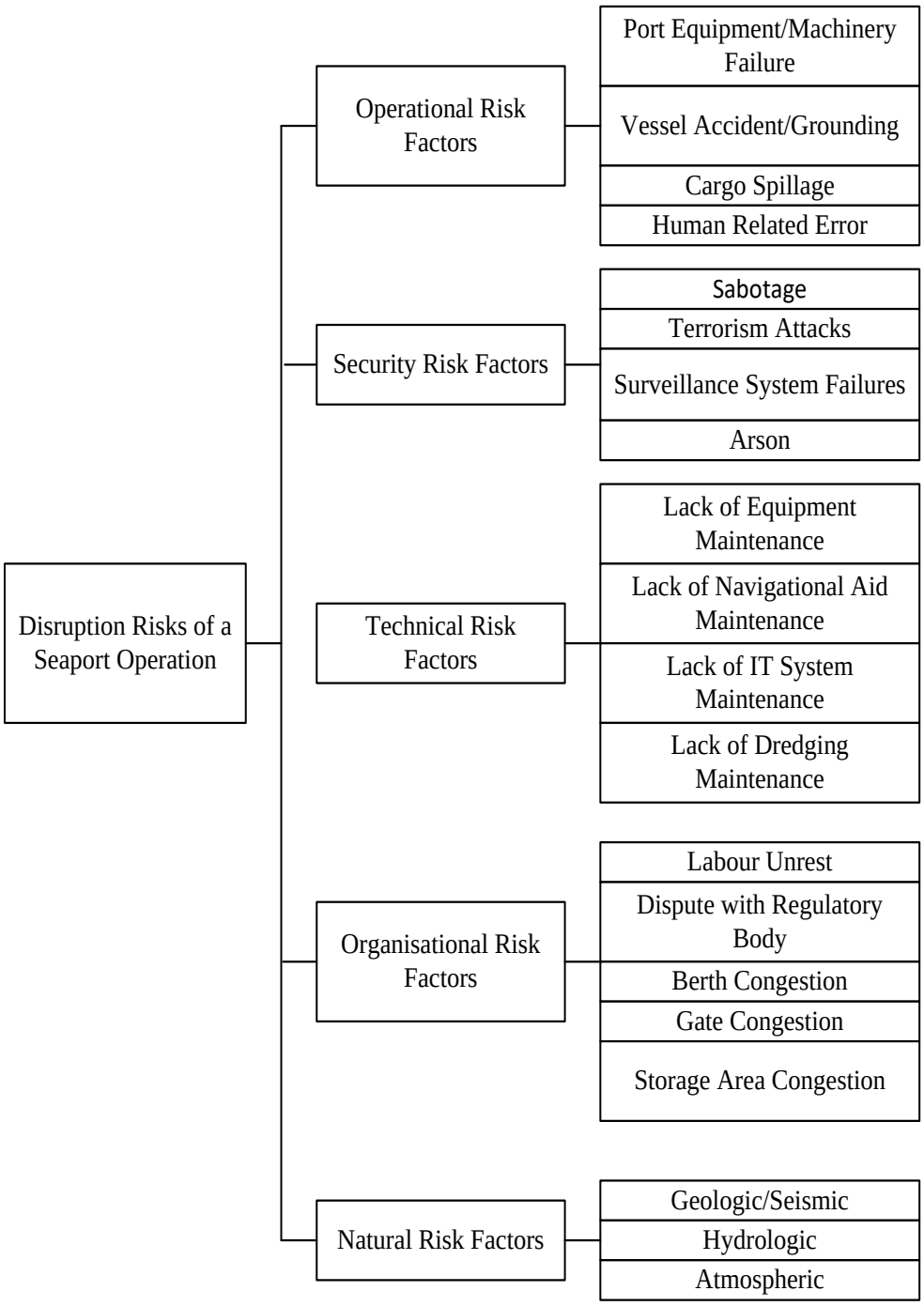
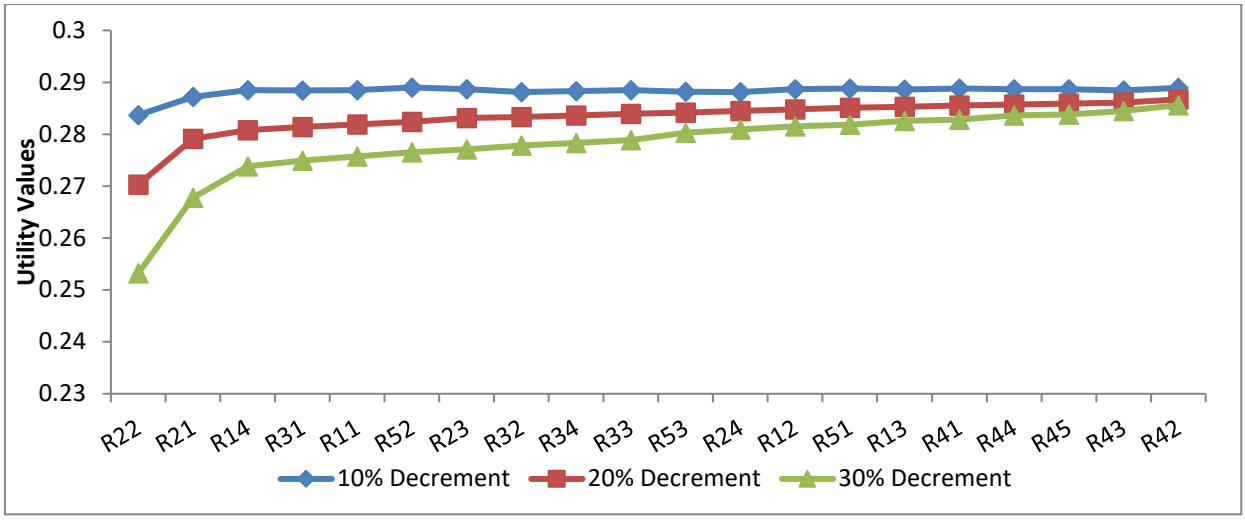

Disruption Risks of a Seaport Operation
Operational Risk Factors
Port Equipment/Machinery Failure
Vessel Accident/Grounding
Cargo Spillage
Human Related Error
Security Risk Factors
Sabotage
Terrorism Attacks
Surveillance System Failures
Arson
Technical Risk Factors
Lack of Equipment Maintenance
Lack of Navigational Aid Maintenance
Lack of IT System Maintenance
Lack of Dredging Maintenance
Organisational Risk Factors
Labour Unrest
Dispute with Regulatory Body
Berth Congestion
Gate Congestion
Storage Area Congestion
Natural Risk Factors
Geologic/Seismic
Hydrologic
Atmospheric

FIGURE 7


0.3
0.29
0.28
0.27
0.26
0.25
0.24
0.23
Utility Values
R22
R21
R14
R31
R11
R52
R23
R32
R34
R33
R53
R24
R12
R51
R13
R41
R44
R45
R43
R42
10% Decrement
20% Decrement
30% Decrement