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Effect of frequent policy change on disaster preparedness and systemic resilience

Presenter

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Abstract

- System Dynamics (SD) modelling used to analyse the structural behaviour of the interactions between Disaster Preparedness, Systemic Physics, and Resilience in response to policy change.
- Appears stakeholders not able to anticipate the effects of strategic risk management decisions, hence there is continuous decline in resource allocation geared towards disaster & risk reduction in their logistics networks
- This research suggests that such policies interventions can lead to increase in unintended consequences due to unacknowledged conditions
- Our SD models can provide strategic policy makers with real-time decision evaluation tool to justify the choice of a set of alternative risk reduction interventions prior to decision implementation.

Introduction

Transport services/infrastructure are key elements of efficiency in logistics systems (Mangan et al., 2008). Maritime transport for instance, accounts for close to 90% of world trade carried out by some 50,000 merchant ships transporting all kinds of cargo (ICS, 2016)

Ports have significantly influenced regional growth, constituting a determining factor for economic performance (Polyzos et al., 2008) through the provision of value-added services

The role played by ports and port authorities requires a redefinition to guarantee sustainability in the fast evolving markets (Heaver et al., 2000).

Systemic role redefinition may calls for policy change with a consequential unintended costs.

- The “theory of structuration” (Giddens, 1979) acknowledges that social life is more than random acts that are merely determined by social forces.
- The struggle for survival perturbs the environment and reshape social structure, norms, moral codes etc., creating systemic disequilibrium.
- We wish to evaluate the real-time behaviour and potential consequence in policy change on levels of disaster preparedness, and resilience, using the SD models
- Credit to the Humber Ports Complex of East Yorkshire in the UK (our case study).

Trends in maritime transport and the impact on the systemic physics (physical environment)

- Evolutions in logistics industry: Globalised production, increased reliance on sea transport for trade, technological changes and increase in vessel size ('Gigantism'), port specialisation, port decongestions (see Rodrigue, 2006), Near Porting (or Port Centrism) (Mangan, 2008).
- More emphasis being placed on maritime transport efficiency
- Upsurge in regulations due to their environmental impact and port security (Psaraftis, 2005)
- Shift in port ownership and management (Brooks and Cullinane, 2006) with government's focus concentrated on monitoring and oversight responsibilities (see Baird 1995)

Read accounts of the effects of the changing trends on port physics from:

- Goulielmo and Pardali (1998);
- Gupta et al. (2005);
- Giercke (2003);
- Isakson et al. (2001);
- Trozzi et al (1995);
- and the consequential international conventions (Goulielmos, 2000) including the MARPOL 73/78 and its Annexes (see Wright, 1999) as a means to curbing the rampant pollutions and to increase the sustainability drive which calls for systemic preparedness to reducing risks and rather increase resilience.

Defining Key Terms

- Resilience is "*The adaptive capability of a supply chain to prepare for unexpected events, respond to disruptions, recover from disruptions, and maintain continuity of operations at the desired level of connectedness and control over structure and function*" (Ponomarov and Holcomb, 2009).
- *Disaster is a result of vast ecological breakdown in the relationship between man and his environment, a serious and sudden/slow onset disruption, on such a scale that the stricken entity* [individual, community, organisation, society] *needs extraordinary efforts to cope with it, often resulting in dependence on outside help or international aid*" (WHO)
- Processes put in place to ensures that entity: complies with preventive measures; is capable to forecast state of readiness to contain the effects of a disastrous event in order to minimise loss of life, injury and damage to property; can provide rescue, relief, rehabilitation and other services in the aftermath of the disaster; and has the capacity and resources to continue to sustain its essential functions without being overwhelmed by demand placed on it, that entity is deemed disaster prepared (BusinessDictionary.com).

Methodology

- Adopted the positivist(quantitative) epistemology (i.e. reality is objective) using Euler's numerical integration methods to computer simulate [analyse] the structural behaviour of the state variables
- Employed the interpretivist (qualitative) epistemology (i.e. reality is perceptual) using personal in-depth semi-structured face-to-face interviews with seven (7) individual Chief Risk Officers (CROs) in the HPC (including the Port Authority, Port Operators, Liner Agencies, Transporters, and Academic experts)
- Interviews covered four thematic areas: risk identification and assessment; current risk/disaster management strategies and procedures; expected changes in the port industry and the potential effects; and the possible consequences of today's planning towards the future events (*scenarios of policy change*).

- Data processing and analysis applied steps in Grounded Theory’s (Glaser and Strauss, 1967) coding processes (see Corbin and Strauss, 2008; Straus and Corbin; 1990; 1998; Kim and Anderson, 2012; Kopainsky and Luna-Reyes; 2008).
- Verbal descriptions from interviewees were simplified and transformed into a conceptual model (figure 1, 2, 3) to help us identify and organise principal components and feedback loops of the system being studied (Goodman, 1974)
- We employed the causal loop mapping (CLM) which is a diagramming methodology (tool, or technique) to conceptualise feedback system of our model (Morecroft, 1982) as a means to provide a holistic thinking during problem identification and problem solving (Eden, 2004; Wolstenholme, 1982)
- Thus we assumed this illustrate what the problem owners think, and how they communicate their intensions to others qualitatively

Model Formulation, Testing And Results

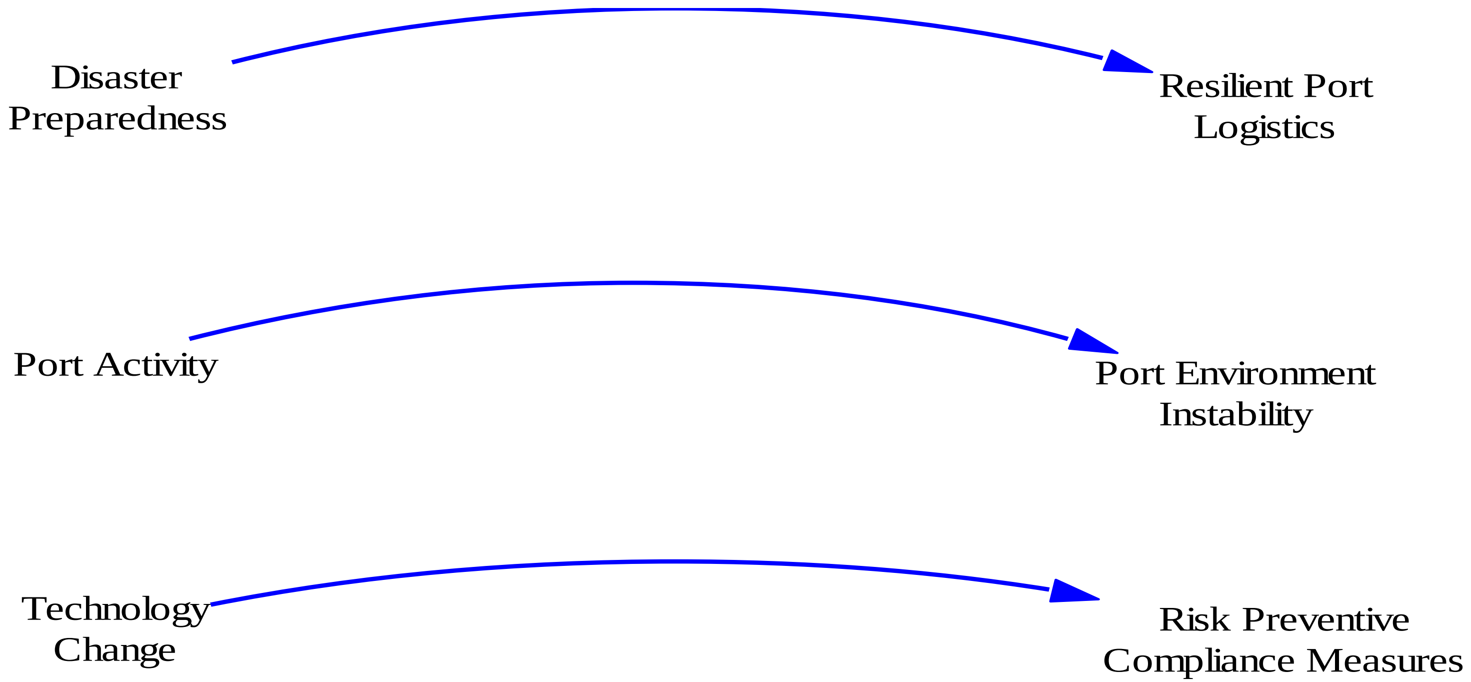

Figure 1: Basic causal links between variables

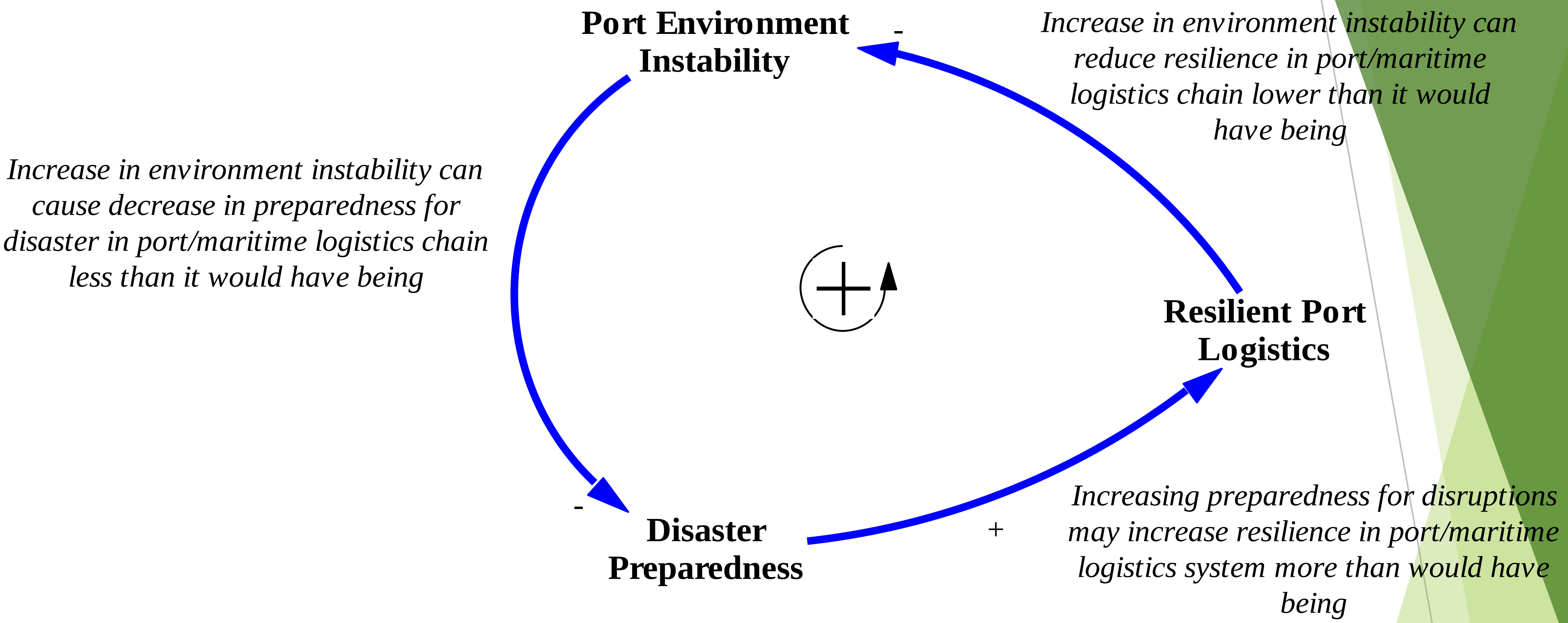

Figure 2: The causal loop diagram connecting Resilience, Instability, and Preparedness

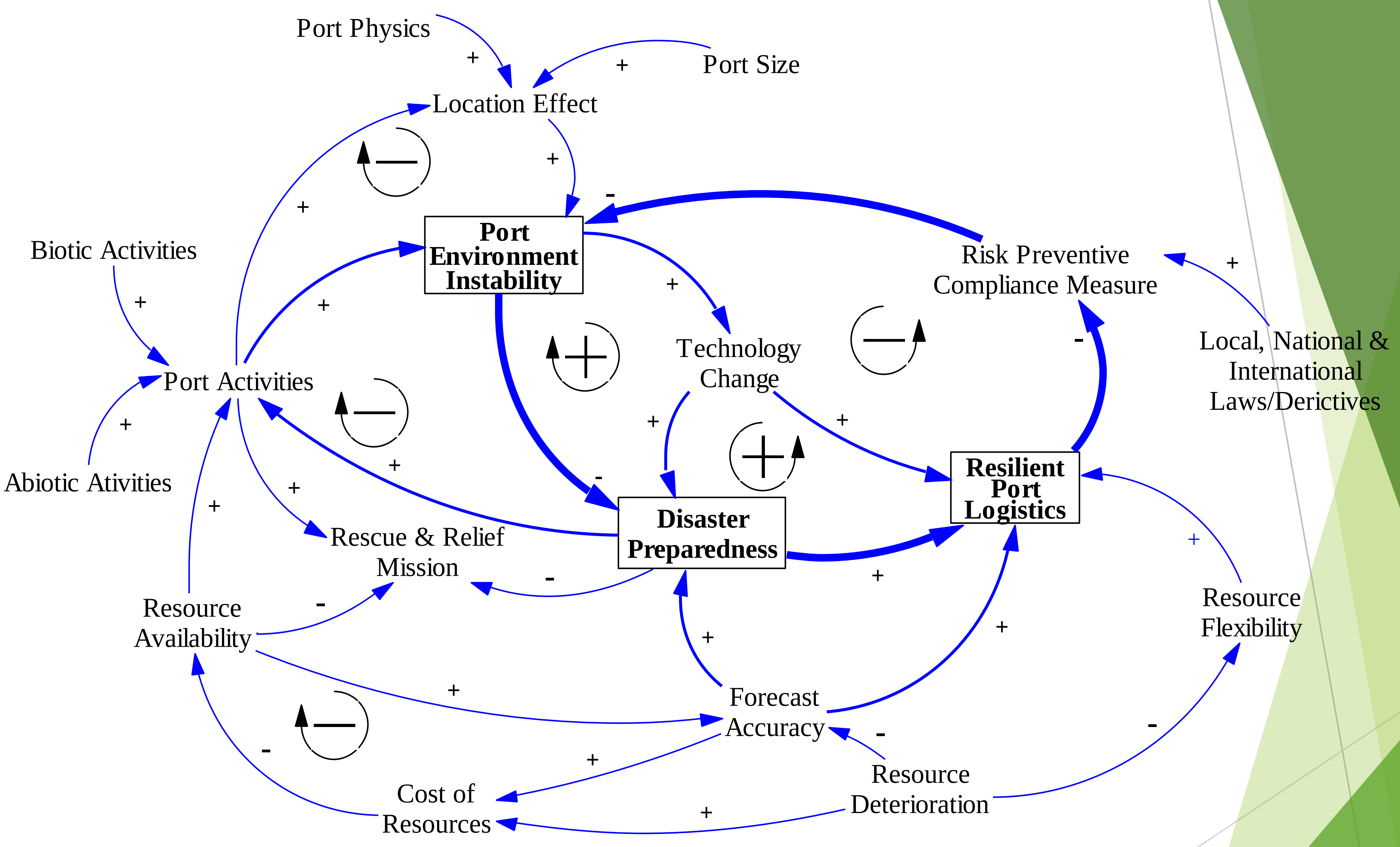

Figure 3: The integrated CLM indicating interdependencies in research variables extracted field data

- "Extreme conditions test" SD simulation runs were performed for a100 day period
- SD is "*the study of information-feedback characteristics of industrial activity showing how organisational structure, amplification* [in policies], *and time delays* [in decision and actions] *interact to influence the success of enterprise*" (Forrester, 1961),
- SD's primary assumption is that the dynamic tendency of a system is determined by the internal causal structure of that system (Meadows and Robinson, 1985). Therefore we propose that the level of disaster preparedness could determine the response and recovery interventions to employ

We analysed a few scenarios about the impact of change in technology capacity on structural behaviour of the maritime logistics industry for a 100 day time horizon, holding all other variables constant.

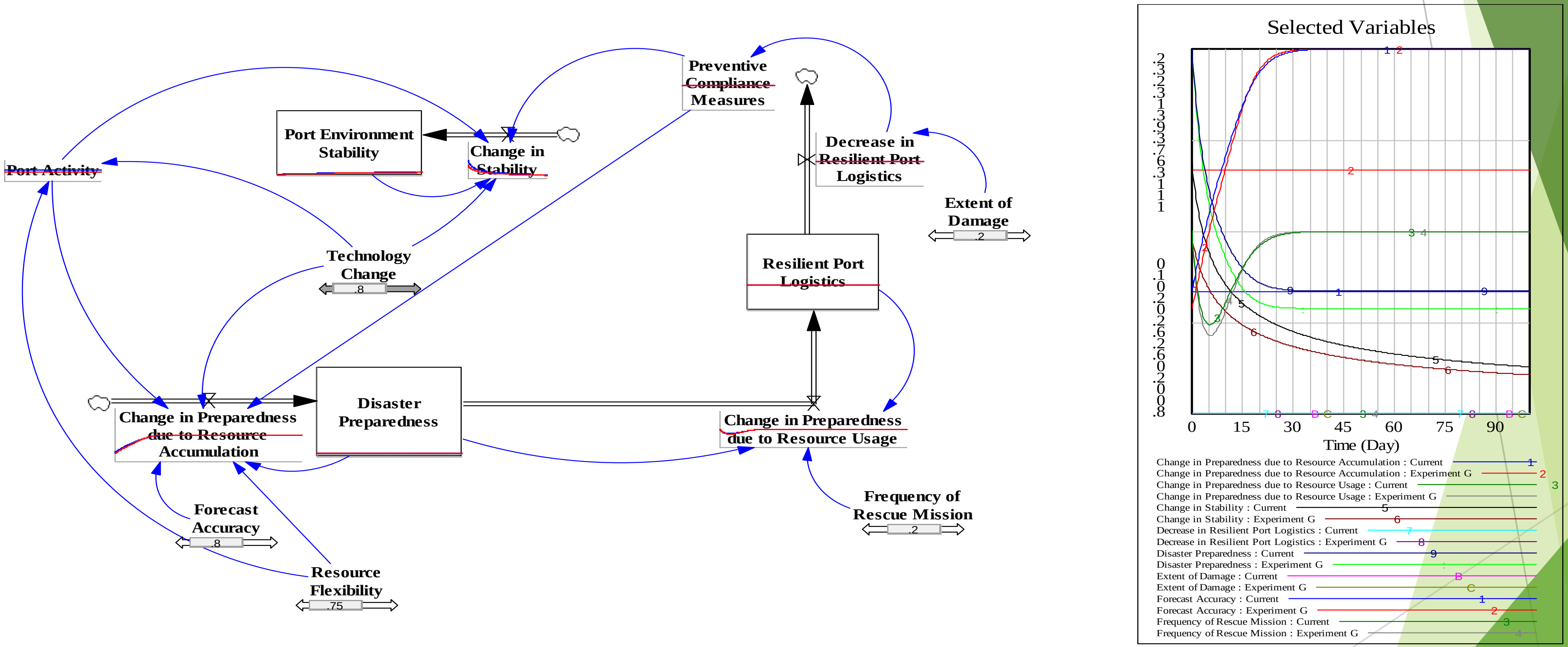

Figure G 4: A summary of the conceptual models and the corresponding dynamics of key variable when policy requires all variables changed

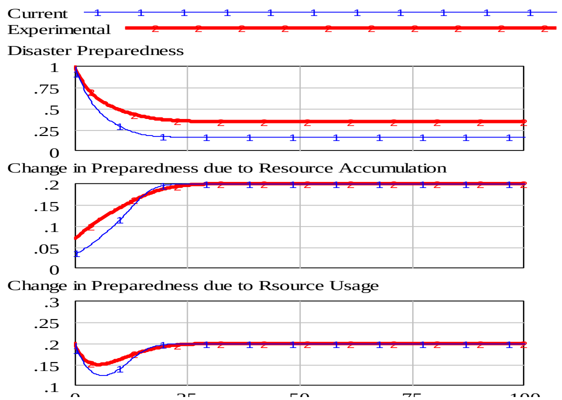

Figure 5: The real time change in DP over 100 day in response to increase change in technology capacity of the logistics chain

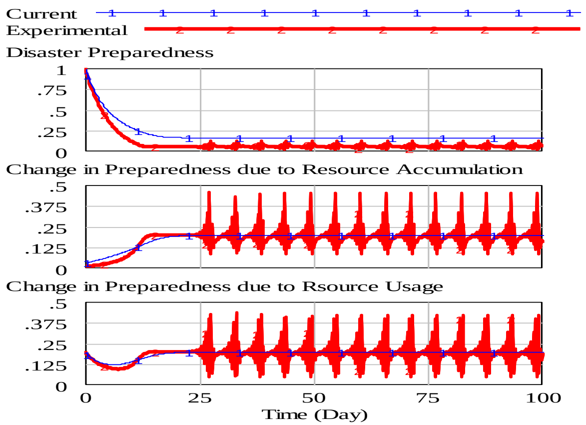

Figure 6: The real time change in DP, CPRA, and CPRU over 100 day in response to decrease in technology capacity of the logistics chain

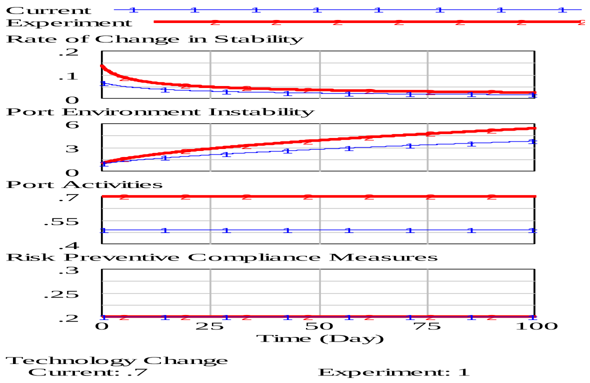

Figure 9: The real time change in PEI over 100 day in response to increase in technology capacity of the logistics chain

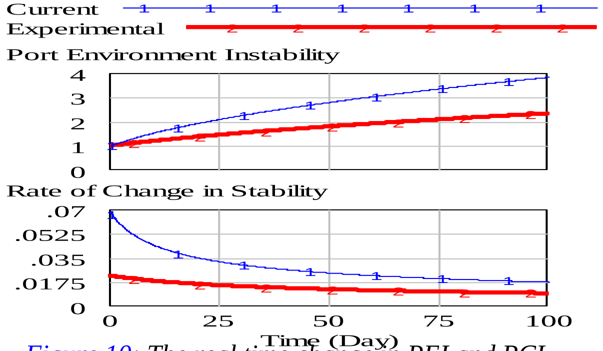

Figure 10: The real time change in PEI and RCI over 100 day in response to decrease in technology capacity of the logistics chain

Conclusions (outcomes/ contribution)

- The graphs (figure 4) represent the real-time change in preparedness, physical environment stability (systemic physics), and resilience, when policy requires that all variables change contemporaneously
- Figure (5 - 10) describe the scenarios when only technology capacity changes and all other variables held constant.
- The graphs suggest that there is strong influence relationship (or interdependency) between environment stability, disaster preparedness, and the adaptive capacity to bounce back from disruptions (resilience)

- As the trajectory of the curves of environment instability increase (figure 9 – 10), graphs for disaster preparedness (figure 5 -6) and resilience (figure 7 – 8) decline exponentially, suggesting that increasing perturbation of systemic physics influences levels of preparedness and resilience adversely.

- We further observe some erratic (random) behaviour in the trajectory of graphs of disaster preparedness (figure 6) and resilience (figure 8) when technology capacity declines very low in the maritime logistics industry

- Therefore when levels of preparedness is unstably low due to lack of (or irregular) inflow of resource, it can potentially influence systemic resilience (since the outflow of preparedness flows directly into the stock of resilience as inflow). This phenomenon may be due the system's inability to match resource demand against supply when system becomes more unstable.

- We argue that systemic resilience can be influenced by perturbations in systemic physics (i.e. the physical environment including the biotic and abiotic elements) and the preparedness of the system towards a particular disruption incident.

- *Derived theory:*

  The level of disaster preparedness and resilience of a system is contingent on the size and physics of the network'

- Thus, the more stakeholders of a system (governments, agencies, organizations, businesses and civil society) understand risk and vulnerability of their environment, the better equipped they will be to mitigate disaster

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