University of Nottingham

# How can the Ports sector, with the encouragement of policy makers, share information to improve upon resilience planning?

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MRes in Business and Management

# How can the Ports sector, with the encouragement of policy makers, share information to improve upon resilience planning?

**by**

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## Abstract

This dissertation has been submitted in partial consideration for the degree of Master of Research (MRes) at the University of Nottingham's Business School (NUBS) for the academic period of 2015-2016. It culminates the first year of a 1+3 years funded PhD scheme of the Economic and Social Research Council's (ESRC) Doctoral Training Centre (DTC). The remaining PhD research project would build on this dissertation.

This research is funded for four years (2015-2019) in a joint collaboration between the ESRC, the Business School and UK Department of Transport (DfT).

This dissertation has been supported by stakeholders to initiate an exploration of how the maritime ports sector could share information towards achieving resilience. Academic literature has been initially reviewed supplemented by Observations, Interviews and Document Analysis, from participating in meetings between stakeholders. Innovative research techniques using Corpus Linguistics have been applied while alternative perspectives via Actor-Network theory have been considered providing unique holistic approaches to tackle with information sharing and Port Resilience.

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## Note

The structure of this dissertation is in accordance with the MRes student handbook 2015-2016 with additional input from Silverman (2013, p. 188) and Hussey & Hussey (1997, p. 132-133). The referencing style is Harvard and font is Verdana size 11 with 1.5 line spacing.

# Chapter 1 Introduction

## 1.1 Background and Rationale

Maritime ports are complex operational systems with many different types of social systems and stakeholders (shipping lines, terminal operators, harbour masters, resident industries, port users, local residents; transport and logistics service providers, etc.) The interests of stakeholders are seldom aligned and there is an urgent need for the ports sector to improve its Resilience Planning (Grainger & Achuthan, 2014). This requires understanding the complex social system of dependencies and data requirements that form a modern port ecosystem.

This MRes research project is designed to be a significant step, followed by a three year PhD programme, towards addressing this pressing national security need (Secretary of State for Transport, 2014) by critically examining how the UK's maritime port sector, with the encouragement of policy makers, can share information to improve upon Resilience Planning.

This research builds upon the on-going effort of UK government, as reported in the parliamentary review of transport resilience (ibid.), and the on-going research within the port sector by the PhD supervisors Dr. Andrew Grainger and Dr. Duncan Shaw at the Nottingham University Business School. Grainger and Achuthan (2014) have already highlighted the need for greater resilience planning and information sharing. Their report draws a conclusion that 'society at large', which is largely dependent upon ports, would stand to benefit from any improvements brought about to make ports more resilient. Thus, this research is hoped to provide a better understanding and lead a path towards identifying the problems and developing solutions to information sharing as a significant step to achieve better planning for resilience and sustain maritime ports within the UK.

Resilience Planning requires necessary data to plan ahead and mitigate the impact of any disruption and to aid recovery. Such data includes: shipping operations, environmental & geographical, metrological, human resources, manufacturing, capacity and utilisation, assets and equipment. Much of this data is currently <u>not</u> available for Resilience Planning purposes (Grainger & Achuthan, 2014).

Thus, a core activity of this research work (in its entirety building up in the PhD stage) would be to identify the stakeholder's respective requirements for data and information relevant to Port Resilience planning; develop a framework that defines obstacles to information sharing, especially with regard to confidentiality and privacy issues; and to explore the ports sector with policy makers on how such obstacles can be overcome.

The research project provides an ideal opportunity for developing a theory of data sharing amongst stakeholders with conflicting interests, as well as between the private and public sector. Network orchestration (Shaw, 2007) provides a potential base for this with its themes of network coordination via mutual value creation through information sharing.

The project uses a Social Science approach because Resilience Planning intersects different social systems that are focused on UK Ports including business, public policy and administration, transport studies and law.

This MRes dissertation has a research focus on the UK based on many reasons including the importance laid by the Government of UK for the economic survival of the nation. This is because the country's economy is dependent on large scale imports due to the geography of the country. As a natural island disconnected by sea the UK is dependent on large scale imports from the mainland of Europe. To highlight the significance (Grainger & Achuthan, 2014) of the maritime imports in terms of percentage, within the UK, 50% of the country's overall food requirement is met via imports. Out of these food imports, 91% comprise of imports via the sea-route. The largest UK ports (the top 10 handle 69% of all tonnage) are highly specialised. E.g., Felixstowe handles 40% of all container traffic. Several of the UK's major UK power stations and oil refineries are dependent on dedicated linked maritime facilities (ibid.).

Also, there is little spare capacity within the ports respective areas of specialisation. So, any prolonged failure at one of the key ports will significantly affect UK supply chains and consumers. Potential risks to ports include tidal surges, marine accidents, sustained adverse weather, acts of terrorism, industrial action and other crises. On 5th December 2013 a tidal surge almost

destroyed most east coast ports. Food rationing would have been very likely if one or several of the critical ports had failed (Grainger & Achuthan, 2014).

## 1.2 Research Questions

This MRes project will support the UK's Department of Transport (DfT) and its stakeholders by answering the following key research questions:

1. How can the UK's Maritime Transport sector and associated relevant stakeholders use information sharing to improve port resilience planning in the UK?
2. What are the barriers to information sharing in port resilience planning?
3. Is data privacy a barrier to information sharing and thus a barrier to port resilience planning?
4. How to remove barriers to information sharing between stakeholders to improve port resilience planning?

The answers to the above questions are of national importance to the UK, its maritime transport sector and its economic sustainability (DfT, 2015). The UK's case will also be of interest to most other countries that depend on maritime supply chains. Therefore, this result has a potential to affect international maritime resilience due to the possibility of applying the answers universally.

## 1.3 Research Objectives

To explore the UK maritime port sector with the support of DfT's policy makers on how stakeholders can share information for better resilience planning.

## 1.4 Ethical Consideration

Due to part of the funding coming from the ESRC, there is a requirement to follow the ESRCs ethics policy. Therefore, both the UoN and ESRC guidelines are followed for this dissertation. The candidate observed meetings and participants were pre-informed and asked for consent prior to taking field notes in the meetings. The UK Data Protection Act 1998 was followed according to the guidelines and on request by DfT no voice or video recordings were made.

A formal contract was signed between the University of Nottingham (UoN), DfT and the researcher in October 2015 to share data and outcomes equally.

However, at this early (MRes) stage of research, no Intellectual Property Issues were anticipated or encountered.

## 1.5 Personal Motivation

The motivation is to address a unique, real world problem of national significance. The outcomes would practically change the working of the transport sector and "make a positive difference". It also draws on previous experience of the candidate, including a Knowledge Transfer Partnership (KTP) project with many different stakeholders. The candidate also has a strong personal affinity with the maritime sector; this includes close family ties within the Indian government and at sea, going back several generations. The candidate already works in academia and the PhD project will provide a firm foundation for a meaningful academic career.

The supervisors, having made significant contribution to Port Resilience and Information Sharing, also have a strong relationship with the DfT and the UK ports sector.

## 1.6 Research Preparation

The candidate completed compulsory ESRC DTC modules of Research Design and Ethics, Philosophy of Social Science, Fundamentals of Quantitative Analysis and Fundamentals of Qualitative Analysis, Corpus Linguistics and Focus Groups & Interviews. The above ensured the training required to use tools and techniques for carrying out this research. In addition, the candidate attended short-term courses in academic reading, writing, PhD completion, Library information and giving presentations.

## 1.7 Timeline of activities

Year 1(MRes): Taught programme in research plus:

- Visits to key ports and the DfT
- Familiarisation with relevant institutions and stakeholder communities
- Literature review
- Initial stakeholder interviews, including an explorative study of obstacles to information sharing

- Research strategy development, including research questions and citing in the literature
- MRes dissertation.

Years 2 & 3(PhD):

- Multiple standard Action Research cycles, including: diagnosing, action planning, action (interventions), evaluation (of interventions), learning (documenting and summing up the learning outcomes)

Year 4(PhD): Final Action Research cycle:

- Final report and presentation to the DfT and stakeholders
- Overall evaluation report from the DfT
- Writing-up and submission
- Contributions to follow on funding applications

# Chapter 2 Literature Review

## 2.1 Introduction

This chapter reviews the literature around port resilience and information or data sharing as this research project explores the information could be shared among stakeholders of the UK's maritime ports and find out any barriers to information sharing.

This research project has taken inspiration from '*Port Resilience – A Primer'* by Grainger & Achuthan (2014), a Knowledge Transfer Partnership (KTP) work that highlighted that maritime ports are complex operational systems, important and that there is an urgent need to improve planning their resilience for the United Kingdom (UK). The complexities of ports is attributed to many different types of social systems and stakeholders (Bichou, 2009, p. 240) including: shipping lines, terminal operators, harbour masters, resident industries, port users, local residents; transport and logistics service providers, etc. (ibid). The literature and Grainger & Achuthan's (2014) work claims that interests of stakeholders are seldom aligned. This claim is also confirmed in the Lloyd's practical shipping guide by Khaled Bichou (2009, p. 276) who states that *"a further difficulty stems from the dissimilarity between stakeholders perceptions…".*

The definition of port is open to subjectivity with acknowledgement from Alderton (2008, p. v). This is because a port is not coherent but rather a loose entity that has trading across arbitrary boundaries leading to complexities in developing universal concepts or procedures (Alderton, 2008, p. 72). So, to achieve better planning for resilience, it is may be required to understand the complex social system of dependencies and data requirements that form the ecosystem of a modern port. In other words, resilience planning requires understanding the necessary data and it's sharing to plan ahead and mitigate the impact of any disruption and to aid recovery. Such data includes: shipping operations, environmental & geographical, metrological, human resources, manufacturing, capacity and utilisation, assets and equipment. But, much of this data is currently <u>not</u> available for Resilience Planning purposes (Grainger & Achuthan, 2014).

This chapter critically examines the published and unpublished works of how researchers and stakeholders like policy makers of the maritime transportation sector define key terms like Port Resilience and data/information sharing. The paper discusses the barriers of data / information sharing and ways to improve planning for resilience.

## 2.2 Port Resilience and it's development

There is no water-tight definition of *Port Resilience* as a term but it is based on definitions of ports and disruptions. For example, according to the National Cooperative Freight Research Program (NCFRP, 2014) of the USA, "***Ports** are defined as deep-draft coastal facilities and terminals capable of handling both international and domestic marine cargo whereas **Disruption** is defined as any significant loss of a port's regular cargo handling capacity".* The keyword to note here is capacity which is acknowledged by (Hosseini & Barker, 2016) as important for quantifying resilience.

The concept of Port Resilience has been acknowledged by various authors (Hosseini & Barker, 2016, p. 264; Achuthan, et al., 2015; Becker & Caldwell, 2015; Bahadur, et al., 2013; Bhamra, et al., 2011). The type of threats could range from natural disasters to human-made accidents. Some examples of large-scale natural disasters include the Hurricane Sandy in 2012, the Japanese Earthquake and Tsunami of 2011, the Haiti earthquake in 2010, Hurricane Katrina in 2005 and Indonesian tsunami in 2004. Human made disasters include terrorist attacks as seen in New York on September 11, 2001 or in London in 2005. Some of these threats may not be prevented but could be mitigated (NOAA, 2016). But, the general idea of resilience is to withstand and recover from disruptions as rapidly and efficiently as possible. Also, it may be attributed that 'resilience' as a concept is based on a philosophy with mitigation as a focus (Hosseini & Barker, 2016, p. 252).

Resilience of maritime ports against any disruptions is actively being given importance and researched by various academic, government and international organisations throughout the world as written below.

*In the United States of America (USA)*: the world leading Massachusetts Institute of Technology (MIT) has been actively researching and developing a

Port Resilience Project since the year 2008 (MIT, n.d.); a port resilience tool has been developed by the US Office for Coastal Management (NOAA, n.d.).

*In the United Kingdom (UK)*: port resilience is hoped to be a significant step towards addressing a pressing national security need (Secretary of State for Transport, 2014). Although the National Risk Register states that technology is not directly a source of transportation failures (Cabinet Office, 2015, p. 39), but it acknowledges the importance of resilience and role of stakeholders. But, it is being researched by the University College London (UCL) with a simulation methodology titled 'MARS' claiming to help port resilience (Achuthan, et al., 2015; Achuthan, n.d.).

*In Europe Union (EU)*: the European Energy Agency (EEA, 2014) is researching and produced a report for resilience of transport.

*In Asia-Pacific region*: the Asian Development Bank (ADB) has been researching and producing reports on making maritime infrastructure resilient (ADB, 2013, p. 2). The ADB is designing plans and reporting around themes of capacity building and resilience of various maritime infrastructures against climate changes.

*Globally, the World Bank* is researching on resilience and produced a significant publication (Ranghieri & Ishiwatari, 2014) on the learnings from the Great East Japan Earthquake of 2011. A significant emphasis is given on the collaboration of multiple stakeholders to design and develop plans to execute the process of resilience (Ranghieri & Ishiwatari, 2014, p. 82).

In many of the above research projects there appears to be a common definition of resilience that seems to be following the EEA's (2014, p. 13) version that "*Resilience refers to a system's capacity to remain operational under different external pressures…*". The above projects also appears to agree that society at large (population wise) and in general (cross culturally) appear to be significantly impacted by transport and therefore requires its resilience (ibid). What seems to be unanswered is whether this importance has given rise to the power and influence of the stakeholders of ports. If the values of the workplace are influenced by the culture as established by Professor Geert Hofstede

(Hofstede, et al., 2010) then a question is generated asking whether culture affects the resilience of ports?

Most of the above mentioned projects appear to have involved national level research with regional or localised inputs from areas that were or have been affected by some kind of crisis. The crises may involve impact from varying issues in isolation or simultaneous forms including climate change and terrorism.

The above mentioned projects have already been developed or are being developed with deliverables such as significant tools, methodologies and frameworks. Some of these deliverables may be carrying out large amounts of data processing with multiple iterations of controlled inputs producing outputs that are analysed and used by potential stakeholders for decision making. In simple words, any resilient system is based around the collaboration of stakeholders to firstly provide an input and then analyse the output in collaboration to produce a desired decision that would be executed to create a resilient system (Bichou, 2009, p. 245).

Another example to create a possible resilient system is to improve the planning by using Future Internet based integrated coordination (Rialland & Tjora, 2015). The authors propose a solution for better interaction including cross-company communication via the Cloud. The technology maybe futuristic may provide robust solutions and may create models in real time. The creation of technologies could also means that users are able to seek real time information to take decisions on the handling of the ship. However, a prototype is yet to be seen and the authors acknowledge that quantifying the potential performance is a cumbersome task.

In most of the above projects, the key assumption that stakeholders (who are themselves varied socially) would be able to collaborate using a given tool, methodology or system to provide resilience could be scrutinised for flaws. This scrutiny could be based on theories of social construction, critical social science and feminist theory. This means that not all stakeholders are equal and may or may not collaborate in the required manner or in a specified time period thereby generating potential systematic and random bias. In other words, ultimately the agents are again prone to human or social interaction inducing human or social

errors affecting the resilience of systems. Also there are dangers of disciplinary parochialism and imperialism (Sayer, 2000) possibly as stakeholders may operate in a silo culture (Forbes, 2013)! This could be due to stakeholders not seeing beyond their own discipline, or claim territories owned by others as their own (Sayer, 2000, p. 83). In fact a non-communication of stakeholders may be related to ignorance and foolhardiness as explained in the following quote by Andrew Sayer (2000, p. 85.), "Disciplinary boundaries that tend to get positioned in a way which allows each discipline to externalise difficult problems – indeed they often deny that there is anything they need to know about on the other side of the boundary".

These social errors produce questions regarding the reliability and validity of the deliverables including tools, frameworks and methodologies acting as agents of resilience. This suggests that the agents to promote resilience are producing interesting outputs by simulating downtown time consequences and claim to promote stakeholder collaboration, however, without consideration for the deep social issue of information sharing between those stakeholders. Such tools maybe technological valid and seem to produce a lot of data satisfying the criteria of being accepted in a Big Data Ecosystem. The tools may qualify to be used for their sophisticated software and hardware systems to convert huge data sets into some statistic. However, the final analysis depends deeply on information sharing again which may be prone to issues with data privacy between stakeholders and lack of understanding of the foundational constructs for that joint decision. This is supported by the EEA report that highlights a negative comment that "stakeholders tend to have a partial perspective of their own systems and varying levels of interests among them" (EEA, 2014, p. 14). This lays the foundation to closely analyse the collaboration of stakeholders as a social problem of information sharing which is possibly driven by culture and/or data privacy and or other unknown issues. To overcome problems we could relate to a quote in Sayer (2000, p. 86.), "'As Bourdieu argues, unless we rigorously question our own dispositions and positions within the social field, we are unlikely to break their influence' ". This quote could be implied as saying that we possibly need to deeply understand the social nature of the communication barriers that may include data privacy.

If the idea of port resilience is linked to the barriers of information sharing, and that in turn is linked to the silo culture (Forbes, 2013) of the stakeholders which is linked to the boundaries of disciplines. Then this is a gap in knowledge and this phenomena of lack of information sharing among stakeholders within one sector that needs to be studied under Postdisciplinary studies (Sayer, 2000). This project could then be used to verify whether "Postdisciplinary studies emerge when scholars forget about disciplines and whether ideas can be identified with any particular one, when they follow ideas and connections wherever they lead instead of following them only as far as the border of their discipline, and when they identify with learning rather than with disciplines" (Sayer, 2000, p. 89). In addition, Sayer's final proposition of "…achieving a more coherent understanding of the social world" maybe tested (Sayer, 2000, p.90).

It is interesting to note the reoccurrence of the keyword capacity for resilience of ports appears to be related to systems thinking. If we consider systems thinking for the application of resilience then the works of Senge (1992) need to be considered. For example: Senge (1992) has explained systems thinking to be used for observing *inter-relationships,* observing *structures* highlighting *complex situations,* so rather than observing *linear causes and effect chains* it would be observing *processes of change* holistically. So, it appears that systems thinking involves participating at all levels to provide a holistic view. Senge (1992) states that: *"you and the cause of the problem are part of a single system. The cure lies in your relationship with your enemy"* (p.121). This idea could be very important and related to the concept of achieving resilience as in the case of a disaster, natural or human-made, it would be the organisation (port) and its stakeholders that would be held for the adaptation or lack it. These ideas following Deming (1986) of *plan, do, study, act (PDCA) as shown below*:

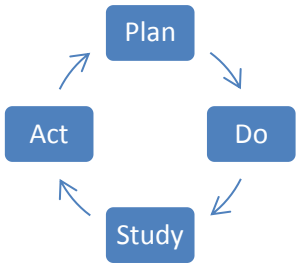



**Figure 1 Showing Deming's (1986) cycle**

The PDCA cycle allows an individual or an organisation to learn, develop and improve: a cycle towards achieving mitigation of disruptions.

*Capacity* is an interesting keyword that is highlighted frequently throughout the literature. This is because if capacity is a key element that determines resilience then it is a curse and a gift at the same time depending on the financial capacity and the power relations prevalent in the economy. For example, in the USA, following the Sept'11, 2001 terrorist attacks and natural disasters such as the Indonesian Tsunami and Hurricane Katrina, several new agencies have been developed.

Globally, there are ongoing developments for the spare capacity and multi operability of ports. But this is achievable in the USA because of federal control and financial capacity as mentioned in a work by Trepte & Rice Jr. (2014) on port capacity bottlnecks. However, a major threat is the expansion of the Panama Canal which could affect the operations of ports in the US altogether (Justice, et al., 2016). In detail, the panama canal which is the only available shortcut linking the Atlantic and Pacific oceans, is limited at the moment from 70,000 – 80,000 TEU types of ships frequently referred to as Panamax vehicles (as they are safe to cross the canal). If the ships are larger than this tonnage, then shipments are offloaded on the coast of US and transport over land or transferred to smaller vessels. However, now with the expansion of the Panama Canal, large ships would be able to frequent between Pacific Ocean and the Atlantic thus endangering the operations of the ports in the US. This is because of no need to stop in case of a direct transfer let's say between Europe and Japan.

In the UK, this is a different story, with most of the ports being privatised and / or operated by large scale multi-national operations. For example, the port of Southampton in the UK is operated by Associated British Ports (ABP) but they have outsourced the container terminal to be operated by Dubai World Ports (DWP).

In case of Adaptive Capacity, it may be important to consider the view of Maslow's (1954) hierarchy of needs. These have been tabulated below and shown in a pyramid as well:

**Table 1Tabular explanation of Maslow's (1954) hierarchy of needs**

Source: Maslow (1954)

| Name | Explanation |
|---|---|
| **Self-Actualisation** | The need to accomplish something |
| **Esteem** | The need for power, prestige, status and self-confidence |
| **Affiliation or Acceptance** | The need to belong and to be accepted by others |
| **Security and Safety** | Fear of loss of job, property, food, clothing or shelter |
| **Physiological needs** | The need for food, water shelter, sleep and sex |

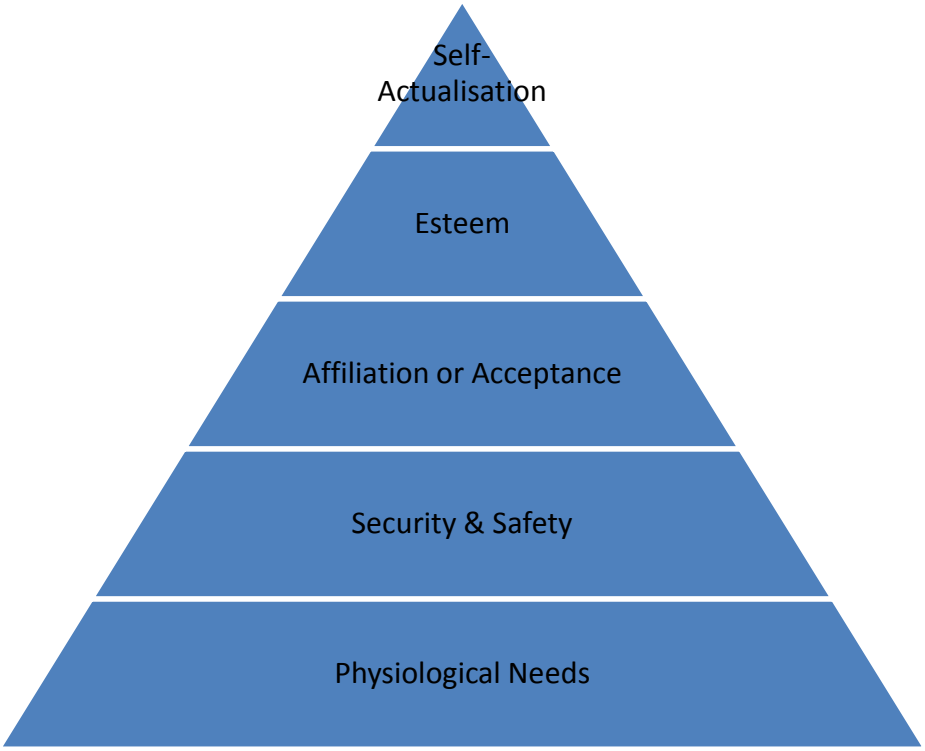



**Figure 2 Maslow's (1954) hierarchy of needs**

The importance of capacity in transport infrastructure and the relationship with port planning is also mentioned by Bichou (2009, p. 51) who states that *"the core objective of port planning is to seek a balance between shortages in capacity and over-capacity at adequate cost, price and service levels. This involves decisions related to operational productivity and optimisations, network*

*and demand modelling, design and layout configuration, market research and development, project appraisal and economic valuation, investment financing and analysis, competition and pricing, and public policy and development".* This shows that planning resilience of ports is a multi-disciplinary activity that spans across *engineering, economics, business management, geography and environmental studies* (ibid). So, planning is also referred as a *techno-economic process*.

An interesting observation is that the definitions of capacity may then change according to the subject or discipline. For instance, the capacity of ports according to Bichou (2009, p. 51) "*indiciates the capability of the infrastructure system to accommodate transport modes and vehicles and to provide associated services at specific cost and service time level".* But, there are various definitions of '*port capacity'* as referred by Bichou (2009, pp. 51-52) who mentions classifications such as *commercial capacity, practical capacity, economic capacity, achievable capacity, theoretical and capacity, each being related to a different discipline.*

For example, with an engineering dimension if the design capacity is considered then it refers to "*the maximum technically possible utilisation rate that can be achieved in the short-run with the existing port facilities and resources: infrastructure, equipment, labour, technology, etc.".* But, if the practical capacity is considered then it refers to as "*the maximum capacity which can be achieved at a quality of service acceptable to most customers, for instance by incorporating a general tolerable level of congestion"* (ibid).

Commercial Capacity: "*The maximum capacity that can be provide a higher or particular level of service quality for example in terms of a ship's faster turnaround time"* (ibid).

Economic Capacity: "*The capacity beyond which the average operating costs for port activities and services being to rise"* (ibid).

For resilience, both capacity planning and management are further related to *structural* and *non-structural measures* need to be considered in a balanced form. There is further specification into the planning stages which might change

on the time line of activities. So, for short term is operational planning, for medium term of three to five years is strategic planning and for anything beyond five years is long term planning (ibid).

Incremental Capacity: "*Describes situations where incremental port capacity is added at regular time intervals"* (ibid).

For planning the balance between constraints and drivers is further explained by Bichou (ibid) as being important. The drivers include business and economics whereas the constraints include spatial planning, land use, environmental sustainability, policy and society factors (ibid).

Various technics have been developed for the purpose of solving decision problems out of which the most common seems to be the multimodal networks which has been commonly used in the 1980s for solving problems around logistics services, transportation services and network routing (Bichou, 2009, p. 55).

While considering port security risk assessments for port resilience, however, even with several sophisticated models such as Regulatory Impact Assessment (RIA) in the UK and the National Risk Assessment Tool (N-RAT) in the USA, there are several issues with the underlying assumptions or the data and its analysis (Bichou, 2009, pp. 276-277). For example, there could be a lack of historical data for terrorist activities; or the data may have a lot of noise; or the data analysis may not follow adequate statistical reasoning. According to Bichou (2009, p. 277), "*the two main drawbacks of port security regulations in relation to risk assessment and management are… the inconsistencies in the current maritime and port reporting system and the failure to consider the supply chain dimension of security"*.

## 2.3 Data Sharing

### 2.3.1 Why is data important?

This can be understood from the work of (Juran, 1990) who states that *"the absence of relevant information is a major reason why problems go unsolved for so long"*.

The methodological considerations are important even from the perspective of developing technology (Urciuoli, et al., 2013, p. 482). They state that the challenges of adaptability by end users of a technology are based on existing beliefs, attitudes and behaviours are '*naively forgotten'* (ibid). This consideration by Urciuoli, et al. (2013), triggers a question on whether difficulties in Data Sharing as a concept could be attributed to the 'human behaviours'? This is because data is being shared between different human beings. And, as human beings we all contribute to social associations and interpret any outcomes in various ways. These interpretations vary due to the 'human lens' which is subject to the individuality of each human being (Maykut & Morehouse, 1994). The individuality itself could be affected by the disposition by the interpreter and the interpreted. This resembles the basic arguments in defence of qualitative research and questions of rigour being raised.

Stepping away from the above explanation, another way to look at the relation with data sharing is to follow the process of induction. Since data sharing is related to social dialogue and social dialogue is subject to various interpretations, it could be stated by process of induction that data sharing is subject to various interpretations.

This problem in interpretation could be extended to data sharing where data may be misinterpreted. For example, in the field of Environmental Management, as seen in Volk, Lucero and Barnas (2014), the major issues highlighted for data sharing were *lack of clarity in the data request, and insufficiencies in documentation describing the data*. These are segregated into the categories of data sent and data received respectively. The authors class the major problems with meta-data and quote Brogman et al. (2007); Quinn and Alexander (2008) for a major phenomenon known as *data proliferation*. The authors conclude by stating that there is confusion between people causing difficulties in sharing data and leading to inefficiencies in systems. According to the authors Volk, et al. (2014), these difficulties could be attributed to *'elephants in the room such as lack of resources, agency politics and team interpersonal dynamics* (Volk, et al., 2014, p. 892).

The importance of data sharing could also be experienced by the amount of data that is being shared. For example, according to the Asian Development Bank (ADB), there are 40 different types of documents and about 200 data elements that need to be exchanged (Urciuoli, et al., 2013, p. 474). IBM makes a similar claim as they are processing about 200 million declarations every year (ibid). The last updated report by ADB (2015) considers data exchange as an important trade facilitation indicator.

## 2.4 Barriers to Data Sharing

The most common barrier appears to be *Confidentiality!* This is found in the work of Urciuoli, et al. (2013). The lack of trust between businesses and stakeholders appears to be a major challenge.

The distributed nature of the maritime industry and distributed specialisms may also attribute to the lack of data sharing. This theory is generated from the tranferable findings from Volk, et al. (2014, p. 887) that suggested that data sharing may be an overlooked obstacle among scientists in distributed teams. Another shortcomming is that most of the respondents were willing to share data which is different to actually sharing the data. They quote Kiesler and Cummings (2002) who report that face-to-face communication may be limited when working in teams that are distributed. Also, reference is given to Hinds and Kielser (2002) who are reported to conclude that differences of opinion, perspectives and expectations are difficult to manage in teams that are distributed. For working with the government, the work of Ellison et al. (2006) is quoted who say that data sharing is not achieved up to a desired satisfaction.

Data Management training is a big obstacle (Volk, et al., 2014, p. 892) due to traditional training being outdated with the advent of new sophisticated tools for data management that use software largely. This outdatedness of traditional training forces many students to have minimal skills to manage data thus leading to inefficiencies in the system of data sharing. The blame is put on the educational resources. However, the authors later acknowledge a pragmatic approach. This is because not all educational programmes can be comprehensive to the extent that provides a comprehensive training for all that is yet to be

managed. So, the pragmatic approach is to provide educational resources in the most reasonable manner.

*Loss of productivity, confusion, and miscommunication* are annotations that frequently occur simultaneously with data sharing (Volk, et al., 2014, p. 884). These when combined with multi-institutional collaborations result in multiple problematic scenarios (Robertson 2008; Schmidt 2009; Turnhout and Boonman-Berson, 2011). These problematic scenarios could be divided into *intra-organisational* and *inter-organisational* issues.

While considering *intra-organisational issues* (i.e. within the same organisation), categorisations of roles for data management such as that of analysts, content manager, data collector, and data steward could provide an insight into the barriers for sharing data. One implied theory is that how are these categories linked to the role of the policy holder? That means to say that as the number of roles increases, the number of human beings increase. Thus increasing the complexity of interpretations could correlate and result in an increased population. But, if data sharing is divided into two independent categories of giving and receiving data that the following table gives a ranked report (Volk, et al., 2014):

**Table 2 Problems in requesting data**

Source: (Volk, et al., 2014)

| Rank | Problem |
|---|---|
| 1. | Lack of clarity in data request |
| 2. | Format of data request not specified |
| 3. | Unreasonable timeline |
| 4. | Unreasonable expectations |
| 5. | Lack of credit share after data was provided |
| 6. | Data not used after request fulfilled |
| 7. | No timeline associated with request |
| 8. | Data request changes frequently |
| 9. | Data receiver doesn't respond to emails |
| 10. | Lack of Job performance credit |
| 11. | Data request is misdirected (went to wrong person) |

| | |
|---|---|
| 12. | Data receiver dissatisfaction not communicated |
| 13. | Too many data requests due to misdirected requests |

As an alternative to the above consideration, the table below mentions the problems while receiving data:

**Table 3 Problems while receiving data**

Source: (Volk, et al., 2014)

| Rank | Problem |
|---|---|
| 1. | No data collection description / no protocol |
| 2. | Data aggregated or summarized without explanation |
| 3. | Failure to define zeros, empty cells, NA or placeholders |
| 4. | Column headers are absent or undefined |
| 5. | Missing data without explanation (incomplete dataset) |
| 6. | Data manager is overextended and unavailable when needed |
| 7. | Protocols exist but are difficult to locate |
| 8. | Unreliable timelines for when data will be available |
| 9. | Data file in inaccessible format |
| 10. | Data inaccessible (e.g. in wrong format for your use) |
| 11. | Data received does not correspond with data request |
| 12. | Data is delivered in pieces because of data scope issues |
| 13. | Data manager doesn't respond to emails |
| 14. | Data incorrectly labelled/not what is claimed to be |

As a specific category of human profession, as quoted by Volk, et al. (2014, p. 887), scientists may not voluntarily share data due to *loss of right and privileges with data.* This specific consideration of the 'scientific' category indicates problems with intellectual property which may be associated with problems around confidentiality.

While considering *inter-organisational issues, i.e. o*n an institution level, this problem be take a larger form with organisations not willing to share data voluntarliy. As a large number of organisations are present in the UK, mostly private companies are controlling different ports with different specialisations.

There is a large scale possibility that data confidentiality may be correlated as a major barrier to the process of data sharing which could be related to the larger problem of port resilience (Volk, et al., 2014).

*Data / Information sharing as part of communication?*

Data Sharing could be considered important when related to communication. This is because communication has been considered important by Oakland (1995) as being thought to influence attitudes and behaviours. These attitudes and behaviours would in turn affect the acceptance or non-acceptance of strategies and plans – *decision making*. If this could be considered while planning for resilience then it implies that culture becomes an important influence on planning resilience. This could be both individual or organisational culture.

If Oakland's (1995) work is considered, then the role of first-line supervisor controls the success by communicating key messages overcoming resistance to change. This could be related to resilience as adapatability could be considered important for a system to overcome change. In other words, people and processes would need to undergo change with communication as an important contributor for achieving resilience.

An interesting global observation, seen in Urciuoli, et al.'s (2013, p. 481) work on drivers and barriers of using electornic platforms (e-platforms), concludes that the challenges faced by stakeholders include *lack of standards*, *limited budget* and *legal requirements*. However, they also state that both the government and private sector are encouraging the adoption of e-customs platforms. For instance, their findings indicate that "*successful IT solutions should put more emphasis on technologies or approaches to reduce investment costs, improve standardization, data quality and confidentiality".* Urciuoli, et al. (2013, p. 482) recommend the following:

1. "*re-enginnering business processes"*
2. *"Gain panoramic overview of all stakeholders and required technical capabilities"*

And, Urciuoli, et al. (2013, p. 482) further say that the above recommendations may facilitate the development of the following:

1. *"A global unified data standard"*
2. Cost saving effective solutions for example recycling or reusing existing IT systems and *piggy-backing*.

But, the major barriers to information sharing are classified as being under the umbrella of confidentiality.

The barriers to sharing information or data could also be considered from literature on *knowledge sharing* from other industries. For example, in the pharmaceutical industry, when sharing knowledge it has been suggested by Lilleoere & Hansen 's (2011) work to consider 'knowledge' as multi-faceted and the one standard for R&D professionals that does not exist. Their work is further based on Birkenshaw (2001, p.16) who stated that IT tools are not going to replace social interaction, rather IT tools should be complimentary to social interaction which is important for successful management of knowledge. This idea that social interaction is important for sharing knowledge then leads one to think about the *role of proximity*.

*But then the question is whether proximity is important for social interaction and thus for sharing information or knowledge or data?*
This relates to the question of physical distance (proximity) and is answered by by McLaughlin, et al. (2008) who have utilised the concept of Nonaka & Takeuchi (1995) that face-to-face communication is more efficient for sharing information or knowledge (i.e. closer the distance the better is the sharing of information or knowledge).

In another way to answer, Lilleoere & Hansen (2011) divide knowledge into explicit and tacit knowledge and find that physical proximity to colleagues was an important factor for the identified knowledge sharing enablers. They found that no physical proximity lead to silo culture and quote a statement in the finding "*silo thinking due to physical barriers, e.g. dislocation – isolation"* (Lilleoere & Hansen, 2011, p. 60).

Going beyond proximity, issues about data, meta-data and big-data need to be understood. This can be done with examples from the Steel industry which like the Pharmaceutical industry acknowledges that the lack of knowledge about where knowledge was available is a barrier according to Gupta & Govindarajan

(2000 as cited in Lilleore & Hansen, 2011, p. 66). This lack of knowledege about knowledge leads one to think about *Meta-Data* which is data about data and it is importance for resilience because it is correlated to usability of data. For example, consider Hosseini & Barker's (2016) work where they use various forms of capacity to determine resilience. Meta-Data is also related to big data by the Information Commisioners Office, UK's independent authority that protects public interest and data privacy of individuals while promoting public bodies to be more open (ico., 2014) This means that if the importance of resilience is to be determined then analysis of Big Data needs to be carefully considered with challenges of data privacy and confidentiality for individual and insitutional protection.

## 2.5 Culture as a barrier to information sharing

Culture could be an unexplained external pressure that could also act as a barrier to achieving resilience. For example, the importance of culture is seen in Geert Hofstede's (1980) quotation:

> *"If differences in environmental culture can be shown to exist between countries and if these constrain the validity of management theories, what about the subcultures and countercultures within the country? To what extent do the familiar theories apply when the organisation employs people for whom the theories were not originally conceived, such as members of minority groups with different educational backgrounds, or belonging to a different generation? If culture matters, an organisation's policies can loose their effectiveness when it's cultural environment changes."* (Hofstede, 1980, p. 153)

The above 'Hofstedian' idea could be extended while considering the resilience for ports. For example, Oakland (1995, p. 28) states that "*beliefs that pervade the organisation about how business should be conducted, and how employees should behave and should be treated…".* The keyword to note is 'belief' and that is a subjective term which is related to culture and interpretation of culture. In case of data sharing, if confidentiality is considered as a barrier, then the concept of confidentiality could be considered as a 'belief' that may be prevalent

in any organisation with a specific culture affecting the decision to share or not share data.

The importance of culture in a process can be seen with Oakland's (1995) TQM model presented in the figure below. In the figure, it is clearly visible that while considering systems, people and technology or tools; culture, communication and commitment play an important role. But, this role of culture seems to be not so well researched in the existing literature. And, there are some new studies that study the relationship between trust and information sharing (Allen, et al., 2014).

Also, there are some studies on the utlisization of the human being as a sensor to understand emergencies by studying the technological utilisation of social media tools such as twitter and weibo (Avvenuti, et al., 2016). However, the findings from these studies may not directly relate and address the barriers to communciation for stakeholders of the ports.

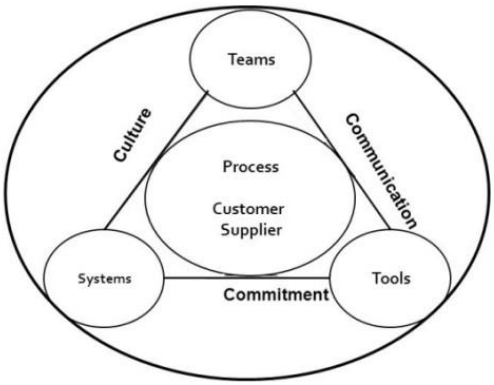



**Figure 3 Showing Qakland's (1995) TQM model**

Source: adapted from http://images.slideplayer.com/21/6328362/slides/slide_2.jpg

Moving on from the TQM model, *environmental issues* could be brought up when considering the integration of systems. For example, Welford & Gouldson (1993, p.87) quote that:

> "*In order to realise competitive advantage based on environmental management, companies must seek to develop strategies which translate*

*actions into benefits. This may be done by incorporating the increasingly important environmental dimension in the decision making process and strategies of a firm, managers can seek to reduce costs and exploit the opportunities offered by increased public environment concern within a dynamic market-place*".

But, in an older work by Peter Drucker (1977, p.229), it is recognised that

> *"the weapon of fear… which for so long was substituted for managing manual work and the manual worker, simply doesn't work for all knowledge work and knowledge workers. Knowledge workers, except for the very lowest levels, are not productive under a spur of fear; only self-motivation and self-direction makes them productive".*

And yet again to quote someone different, McLaughlin, et al. (2008, p. 112), quotes that

> "*emperical evidence on barriers to knowledge sharing stresses the importance of behavioural and cultral factors rather than to outline the reasons associated with technology".*

The above quotations show that while environmental factors are important to be considered for the purpose of determining barriers to information sharing and develop resilience further, it is also important to consider the motivation which could be goverened by cultural factors more than technology.

## 2.6 Economic Resilience

Economic Resilience raises questions about the effects of trade facilitation and sanctions and their implications. For example, as of 8th June 2016, Korean shipyards have got $2.4billion worth of orders from Iran after the lifting of trade sanctions (The Wall Street Journal, 2016). This leads to new variations of questions for sharing of data. This is because on one hand there are issues of confidentationality and protection from potentially volatile region of the world. However, it is also the region that produces huge quantities of oil that affects the trade and development of the rest of the world. Grainger's (2011) work on trade facilitation specifies economic factors of *institutional limitations, conflicting*

*interests of stakeholders and their lack of knowledge* as important. Taking further examples from the National Cooperative Freight Research Program (NCFRP, 2014) also indicates that the closure of Ports could seriously affect the economy with both the supply and demand of commodities being affected (Hosseini & Barker, 2016, pp. 252-253).

**Community Resilience** has also been considered by Boucquey, et al. (2016) and Pauwelussen (2016) with Action Researchbut by considering Actor-Networks to be more holistic.

## 2.7 Systems Theory perspective

According to a forward by William C. Rogers, the staff officer at the Transportation Research Board (USA), resilience in ports can be seen as a physical process of inputting freight into the port, processing suitably and outputting with great speed and efficiency (NCFRP, 2014).

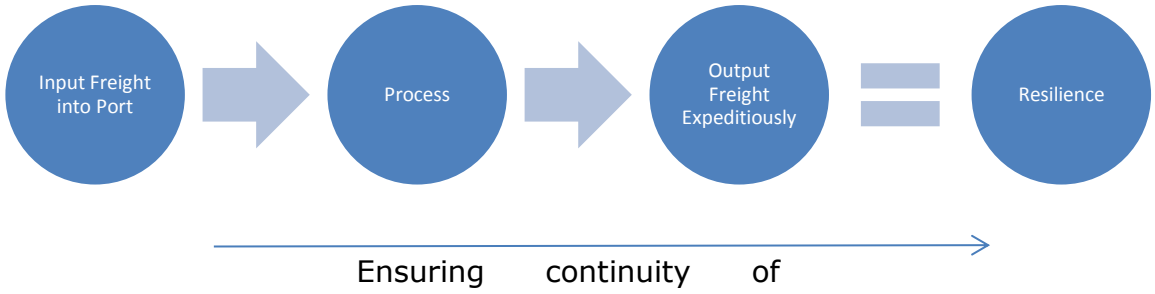



**Figure 4 Showing continuous operational process demonstrates Resiliency**

While addressing capacity as a key element of resiliency, Rogers acknowledges financial expense as a considerable barrier to providing redundant or spare capacity to handle cargo in the event of a disruption.

According to the British Standard BS7850:1992, a process is defined as *"any activity that accepts inputs, adds value to these inputs for customers, and produces outputs for these customers. The customers may be internal or external to the organisation".* But, then one needs to also consider the ISO 9001:2000 standard while making decision making processes (Branch, 2007, p. 308). The advantages of the ISO 9001 standard are that it provides a clear understanding of any problems while giving confidence about the overcoming

any issues present and providing a focus on improving systems among many other advantages. The ISO 9001 standard claims to provide a clear, honest, impartial and honest report (ibid). It is also related to the International Ship Management (ISM) Code of the International Maritime Organization which is required for operations of shipping companies and ships (Branch, 2007, p. 470). Similarly, the ISO 28000 standard provides for security management in the supply chain (Bichou, 2009, p. 273). This codes aide in the formulation of policies and procedures to address emergency response, safety, environment, accidents, internal and management reviews (ibid). In other words the codes enhance the authority and power of a Master.

These standards and codes provide appropriate processes and procedures as part of risk management. The advantages of these codes for any organisation may be demonstrated by a comparison with other organisations in term of a stable income or enhanced finances. However, the disadvantages include wrong assumptions leading financial losses. The point to be understood is that even with the codes and the application of standards, the assumptions for decisions about risks need to be carefully considered as these may be affected by interpretation of information (Branch, 2007, pp. 471-472). For example Bichou (2009, pp. 248-249) states the dangers of using statistics: "*the approach that causes are random and statistically independent but certain common causes can lead to correlations in event probabilities which violate the independence assumptions and could* ***exaggerate the likelihood of an event fault****".*

Similarly, the application of tools and reliable techniques such as the *Delphi technique, quantitative risk assessment (QRA), probabilistic risk analysis (PRA), Fault Tree Analyais (FTA), Event Tree Analysis (ETA), Failure Modes* and *Effects analysis,* are examples under the Formal Safety Assessment (FSA) in the UK (Bichou, 2009). However, their application requires a clear classification and demarcation between operations and functions which is complicated in the case of port operations (Bichou, 2009, p. 252).

On one hand Risk Management is very clear process like or formula like techniques (Bichou, 2009, p. 247).

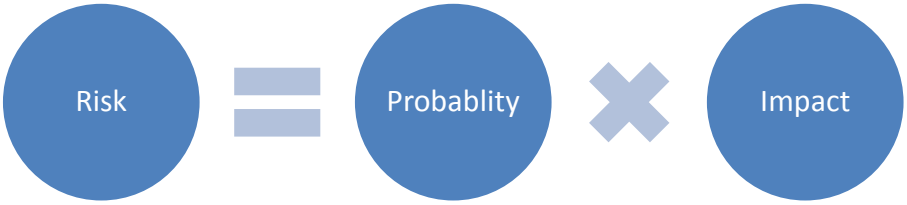



**Figure 5 Showing the formula of Risk (Bichou, 2009, p.247)**

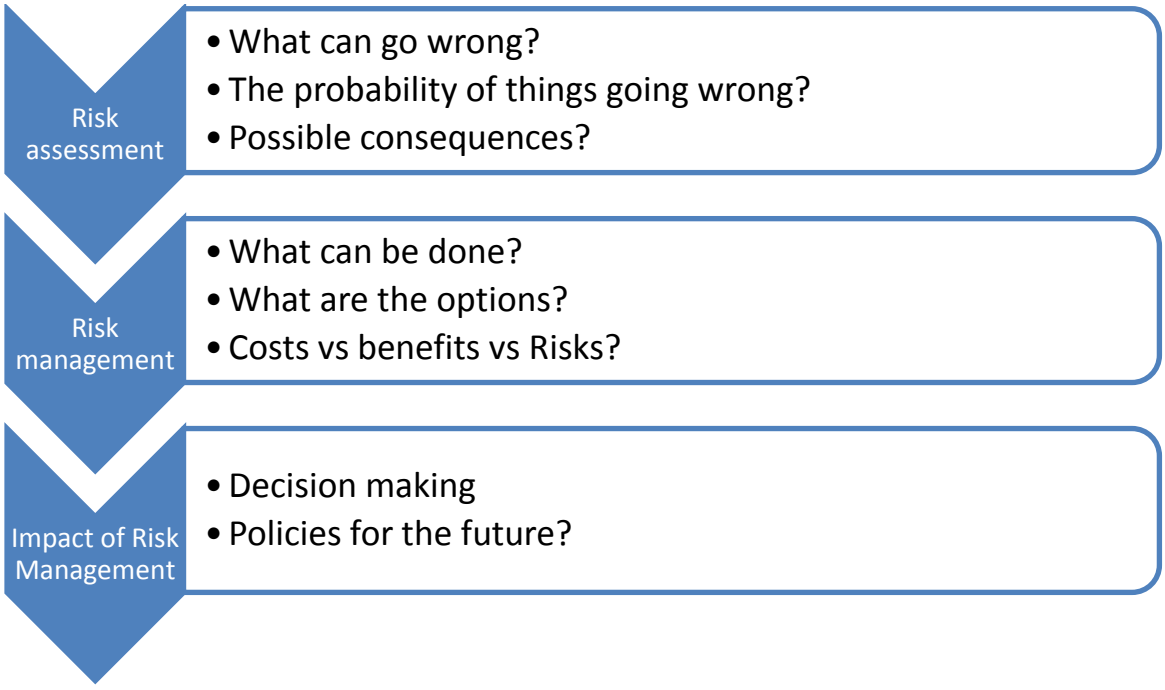



**Figure 6 Showing details of Risk management (Bichou, 2009, p.247)**

On the other hand Risk management have a large proportion of subjectivity (Bichou, 2009, p. 250) for understanding the causes and consequences which forces one to think about the application of methodology for research.

## 2.8 Methodological Considerations and Opinions

Most of the research that has been conducted in the area of Port Resilience utilises both quantitative and qualitative methods. Although the methods vary depending on the location of research and the type of research questions, but,

there is a trend to use Quantitative research methods. For example, a recent work on Resilience by Hosseini & Barker's (2016) utilises Bayesian networks to quantify resilience but at the same time appears to consider qualitative variables. As another example of quantitative approach for resilience is the work of Loh & Van Thai (2015) on utilisng structured equation modelling. A related example in data analytics, in the UK, by the Information Commissioner's Office, utilised 'desk research' - a literature review of articles and reports followed by 'structured interviews' of practitioners in various organisations supplemented by data collected from conferences and seminars (ico., 2014, p. 2). This indicates that most of the existing research is derived from a positivistic philosophical assumption. For example, Bichou (2009, p. 247) states that *"The empiricist approach regards accident as random events whose frequency is influenced by certain factors".* This means that may be previous studies have not tried to understand the deeper meaning.

Previous studies could be subject to questioning on the interpretation of the variables and the outcomes of the application of their positivistic framework. This is acknolweged by ico. (2015) as comments on feedback. They acknowledge having issues with legitimate interests, public sector dealings, EU General Data Protection Regulation (EU GDPR) and anonymisation with some having alternate implications. In their comments, the emphasis has been placed on the usability patterns of data rather that the methods of collection. For example, ico. (2015, p. 3) feedback on ico.'s (2014) paper stated that there should be a new way to handle data confidentiality. It implies that rather than considering the regulation at the data collection stage, the emphasis should be on the usage of data as that has more potential for harm. Similiarly, anonymisation may not be an directly associated as personal data may be disolved in the large amount of Big Data no longer remaining personal. However, the use of knowledege gained as a result of analysis this Big Data may affect the person or individual leading to suggestion of careful consideration of anonymising the individual and transparency. Therefore, it has been commented that greater transparency should be strived for to help the individuals understand what data about them is stored and how it is likely to be used with potential implications. The above fresh attempts indicate a trend towards a more interpretivistic philosophical approach of research in

which there is greater emphais on ethics, reflectivity and transparency in an iterative manner – *a paradigm shift*.

The ico. (2015) indicate a trend shift with suggestions on ways to conduct ethical research via privacy engineering, privacy impact assessments, technical security, limiting data collection, actions to raise awareness, and, terms & conditions. This is being suggested as inter-institutional collaborations for example via universities and expert organisations to bring together technical guidance. This would fall in-line with Oakland's (1995) suggestion of training as being crucial to provide success by overcoming language problem. This is because a standardised way of working would be achived. Similarly, it also indicates a structured way working in line with the systems approach which might require a continuous motivation and understanding while adapting to changing requirements for continous improvement (ibid). It could also well be in-line with Ishikawa's (1985, p. 155) statement "*…an effective system for integrating the quality development, quality maintenance and quality improvement efforts of the various groups in an organisation so as to enable product and service at the most economic levels which allow for customer satisfaction…".*

Consideration of assumptions is given importance by Ajzen & Fishbein (1975, p. 520) who conclude their work stating that many of the contradictory and inconclusive findings are attributed to inappropriate assumptions. This means that possibly a balanced and holistic methodological approach is needed.

## 2.9 Summary and next steps

'Resilience' is loosely defined as indicated by the literature on resilience which means that resilience has various definitions in many contexts and many interpretations. There is a rapid growth in the literature around Port Resilience, but, most of it is concentrated to specific geographical locations or a specific port possibly as a result of government actions indicating ad-hoc processes to provide solutions to disruptions at ports. The literature on Port Resilience thus continues to highlight the need for greater resilience planning and information sharing. This is to benefit society at large, which is largely dependent upon ports, as it

would stand to benefit from any improvements brought about to make ports more resilient.

A review of literature on resilience and information sharing from other sectors such as health, manufacturing, energy, communications and transportation shows that many authors have talked about the practical benefits of planning for resilience in various sectors, which may be related to the national critical infrastructure of United Kingdom (UK) or any other country, i.e. information, networks, people, systems, processes, facilities and property which are critical for essential service provision and the loss or compromise of which would lead to economic or social consequences or loss of life (CPNI, 2016). These research efforts on resilience planning and information sharing from different sectors help this research by directing it towards a multi-disciplinary approach of research for maritime ports and transport systems while providing an opportunity to reutilise findings across sectors or consider lessons for better resilience planning of the critical national infrastructure.

The literature on resilience indicates that a holistic view is needed, which means a view considering both human (for example harbour masters, port users, local residents, transport and logistics service providers, etc.) and non-human entities (for example technology, devices, computer systems, cranes, resident industries, shipping lines, terminal operators, etc.) to be important actors in the functioning of ports and therefore important for planning resilience. Also with a holistic view, the cultural aspects affecting Port Resilience planning and information sharing are under-researched, which means considering the cultural aspects of actors participating in the functioning of ports, including language of communication and working patterns affecting humans (for example different policy makers, managers, harbour masters with different styles of working) and non-humans (for example machinery, technology and industries or suppliers having different working culture) and how that affects resilience planning still needs more research.

Several barriers of data sharing are identified in the literature on information sharing and confidentiality and lack of trust are highlighted. But, these barriers are yet to be linked particularly to a largely privatised ports industry for example

in the UK. Also, very few studies in Port Resilience have been conducted with a holistic nature considering the view of all stakeholders of UK's ports sector. And, most of the studies on resilience planning have been focused on localised problems of an institution or a specific port. Therefore, further research is needed to deeply understand the phenomena of confidentiality acting as a barrier to information sharing and overcoming it to achieve resilience of maritime ports.

### 2.9.1 Linking back to the research questions:

*Q1. How can the UK's Maritime Transport sector and associated relevant stakeholders use information sharing to improve port resilience planning?*

Information sharing, in the context of resilience, is generally used for planning ahead and mitigating disruptions (caused by humans or natural reasons). But, information sharing could also be used to understand the detailed operations of ports, their arbitrary boundaries and their resilience in general of people, systems, facilities and networks with the sharing of data. The information sharing literature indicates the type of data being shared but very few studies have talked about the social dependencies and the effect of culture on the sharing of information. As the Port Resilience literature indicates, there are different definitions of ports. Also, there are different assumptions about what is resilience, how is it achieved and to what level is it achieved. No one has talked about considering the impact of Port Resilience by observing its use in everyday common language. Thus, there is a gap in understanding about the contexts in which Port Resilience is assumed to exist, its impact as a concept and how information sharing is being used to plan for Port Resilience by considering its usage in everyday practical language.

The literature on Port Resilience and information sharing indicates that information is being shared based on certain assumptions that Port Resilience is important. This makes it reasonable to test the assumption of the existence and importance of Port Resilience in common everyday language as a measure of the impact and awareness of Port Resilience while considering the usage of information sharing to achieve it.

While several new technological innovations and researches such as e-platforms are being developed for information sharing and resilience, but, there seems to be a general assumption that these new platforms would be intuitively used by all stakeholders in a standardised manner. This assumption about a standardised usage of e-platforms needs to be better understood and tested.

Another gap in understanding is that although the e-platforms are being considered to allow working remotely, but, there no considerations about the increased physical distances between actors (human and non-human) leading to increased proximity which may cause the loss of any tacit knowledge. Thus, while technological advances have been made for information sharing, physical proximity and its impact on tacit knowledge have not been considered and this is a gap in understanding for the purpose of information sharing for Port Resilience.

Also, there is a gap in understanding the effect of non-human entities or technological entities on using information sharing for resilience purposes. This is because information is shared between both human and non-human entities and very few studies have considered a 'holistic' definition of actors or stakeholders that need to share information to achieve resilience of ports. The definition of actors has not considered the effect of non-human entities such as machines, gadgets, computers, organisations such as DfT, firms and countries, all of which need information to progress along their processes. Thus, existing research seem biased with humans only and not holistic. It is surprising that the literature in general indicates the philosophical nature of resilience, information and sharing in terms of the nature of reality and source of knowledge, but, it then appears to consider humans to be the only actors. In this age of humans being integrated with technology it could be useful to consider both humans and non-humans (such as machines and technology devices like computers) as actors. Thus, a more holistic approach to research is needed which could trace the associations between actors (both human and non-human equally) to consider the effect of proximity on information sharing while working remotely when developing e-platforms to avoid loss of tacit knowledge. This means reconsidering the definition of who is an actor (by including non-human or technological entities) and how they would share information while minimising

the loss of knowledge, otherwise what is the point of information sharing if it leads to loss of knowledge? So, there is a gap to be bridged in which information sharing although being used for resilience planning in different sectors needs to be addressed more specifically and tailored for Port Resilience in a more holistic manner.

Although the literature on resilience also indicates practical benefits and lessons learnt from various industries that affect the national critical infrastructure, but, the varying definitions of resilience in varying contexts highlight the need to understand what needs to be made resilient and why. For instance, the UK's Centre for Protection of National Infrastructure (CPNI) identifies 13 national infrastructure sectors including transport. However, not all are considered as critical infrastructure and they (CPNI, 2016) define it as *'those critical elements of national infrastructure (facilities, systems, sites, property, information, people, networks and processes), the loss or compromise of which would result in major detrimental impact on the availability, delivery or integrity of essential services, leading to severe economic or social consequences or to loss of life.'* This information needs to be identified and shared between appropriate stakeholders. Thus, there appears a further need, going beyond academic literature, for researching how the transport department and other third parties involved in Port Resilience in the UK and abroad have successfully carried out Port Resilience projects. This would possibly shed light on how information sharing has taken place in the field for Port Resilience.

*Q2. What are the barriers to information sharing in port resilience planning?*

The literature indicates that there could be several barriers to information sharing including technological barriers such as lack of a common electronic platform to collaborate, challenges of adaptability by end users of technology, distributed nature of the maritime industry, distributed specialisms leading to lack of face-to-face communication, lack of communication in general, miscommunication, confusion, loss of productivity, confidentiality, lack of trust, lack of physical proximity, silos, varying assumptions of stakeholders, varying attitudes and behaviours of stakeholders, non-standardized ways of working, differences of opinions, lack of motivation, lack of understanding, lack of awareness, team interpersonal dynamics, varying definitions of resilience,

varying contexts of resilience, subjective understanding of causes and consequences, poor training, limited budget to undergo training or develop technologies i.e. financial barriers, lack of resources, agency politics, legal barriers, loss of right and privileges with data i.e. intellectual property rights, multi-institutional collaborations leading to inter- and intra-institutional problems. Lack of clarity in the data request and insufficiencies in documentation describing data i.e. data about data or meta-data were also considered as barriers. While requesting data there could be lack of clarity in request, non-specification of required format of data, unreasonable times, unreasonable expectations, lack of sharing credits after sharing data, non-usage of data after being requested, frequent changes in requests for data, non-response to e-mails while requesting data, lack of credit for job performance or data being sent to wrong person. While receiving data there could be barriers such as no protocols or description about the data, empty or missing data, wrong format, or simply non response to request. So, there are various barriers to information sharing, but, the gap in understanding is that if some of the barriers are also potential enablers then how to classify and differentiate between barriers and enablers and no research has specifically targeted barriers for the UK ports sectors. So, the barriers specific to information sharing for the UK ports sector need to identified and understood better. To understand barriers it will be helpful to consider the perspective of the stakeholders of ports such as the Department of Transport (DfT) who are the central coordinators between stakeholders in the UK and they could help in identifying, classifying and prioritising barriers.

*Q3. Is data privacy a barrier to information sharing and thus a barrier to port resilience planning?*

The literature on information sharing and resilience indicates that confidentiality and lack of trust are the major barriers to sharing information. This is possibly due to poor transparency, lack of awareness or a subjective understanding of the causes and consequences during decision making that lead to varying decisions about classifying data as private or not. Legal requirements around data confidentiality could also lead to data being classed as private or not being shared suggesting data privacy as a barrier to information sharing. Further, some authors like Volk, et al. (2014) regard lack of resources, agency politics and team interpersonal dynamics as elephants in the room with major issues

such as lack of clarity in data request and insufficient documentation describing data (meta-data) possibly causing problems in classifying data as confidential. The literature on information sharing and Port Resilience planning suggests a link between data privacy and information sharing and further the interpretation of information affects the development of standards and codes for processes and procedures and systems such as International Ship Management code (ISM) of the International Maritime Organization (IMO) which affect planning for resilience. But, as the context in which Port Resilience is still non-specific and there is no empirical evidence to demonstrate that data privacy is a barrier to information sharing, specifically for UK ports sector, further research is needed.

*Q4. How to remove barriers to information sharing between stakeholders to improve port resilience planning?*

The literature on information sharing and resilience indicates inter-institutional collaborations and training to overcome language problems and cultural problems to bring a standardized way of working for better information sharing and planning. For example, the UK's Information Commissioner's Office (ico, 2015) report recommends usage of data. Existing studies have highlighted the development of technology for example e-platforms to enable cooperation between stakeholders and proposals have been made for the usage of cloud based technologies to enable remote cooperation between stakeholders. But, existing studies seemed to be using a positivist's lens with the assumption that all stakeholders will use the technology and statistics as intended in a formula like technique and that only by developing technology all problems will be solved. These assumptions about formula like techniques and statistics are classed as dangerous for port operations by some critics such as Bichou (2009) saying statistics could lead to exaggerating the likelihood of an event fault in case of violation of assumptions. This means there is a danger to port operations with varying assumptions in a distributed maritime industry if dependent only on statistical tools for planning resilience. So, existing studies on Port Resilience and information sharing have not considered the interpretive lens to understand the cultural requirements or the practical impact by considering the usage of Port Resilience planning in common everyday language. Existing studies have also not considered the importance of tacit knowledge and the impact of varying physical proximity between stakeholders on tacit knowledge. The identification of

what data needs to be shared and the social dependencies between stakeholders need to be identified. As mentioned above in the summary and link to research question1, these stakeholders need to include non-human entities and existing studies have seldom gone beyond modelling and simulation of scenarios to consider the extent to which actors join or leave networks and how that impacts the planning for Port Resilience. Thus, in order to understand how to remove barriers for information sharing it is important to go beyond the existing studies and try to find the deeper meaning of resilience, the actors (both human and non-human entities), their social dependencies, how they are interacting, what is being exchanged and what is needed to be exchanged to achieve Port Resilience. Some authors like Urciuoli, et al. (2013), have coined the terms re-engineering business processes and gaining panoramic overview of all stakeholders and required technical capabilities. They say developing global standards and piggybacking by reusing existing technologies are recommendations on removing barriers. But, the gap in understanding is that how these recommendations can be applied for the UK specific ports sector with the help of the DfT.

## 2.10 Overview of chapters

In Chapter 3, I will introduce the research methodology for carrying out the research as part of this MRes research degree while being a sub-set of the overall 4 year PhD programme. This will be under the overarching umbrella of Action Research, a methodology demanded by the project sponsors, to carry out research that takes input from the sponsors and the research candidate while mutually benefiting them.

In Chapter 4, I will talk about the application of Corpus Linguistics as a tool to understand the extent to which Port Resilience is being used in everyday language. This tool would hopefully help in understanding the context in which Port Resilience is being used, while supplementing the findings from the literature and shedding light on how information sharing could be improved for the maritime sector.

In Chapter 5, I will consider a newly defined 'holistic' view by considering the ideas from Actor Network Theory in order to understand how actors, including humans and non-humans, could be affecting the sharing of information in the context of Port Resilience planning.

In Chapter 6, I will mention what I found from Participant Observations in various meetings with the Department for Transport (DfT), meetings with third party vendors working in Port Resilience, meetings with other researchers working as consultants, meeting with the UK Cabinet Officer and talk about an international project on port resiliency at Massport, USA. The above should hopefully reveal how information is being shared in the field at the moment between stakeholders of Ports in the UK and give a small insight into similar successful activities abroad. This may hopefully also shed light on what could be the next steps to improve upon information sharing for the UK ports.

In Chapter 7, I discuss the overall findings in the context of the research questions and discuss the application of research methods.

In Chapter 8, I will present a conclusion, limitations of carrying out this research for this MRes degree and recommendations for the future.

# Chapter 3 Research Methodology

## 3.1 Introduction

Action Research has been exclusively demanded for the entire four year PhD project. However, it was agreed, with the supervisors, that for this MRes dissertation (which is a preliminary stage to the PhD) due to time constraints, commitments for taught modules and limited access to the DfT and ports, a literature review would be carried out supplemented with some participant observations to explore along with the DfT on how information sharing is being carried out and explore port resilience. At this preliminary stage that this project uses a *qualitative approach* because the '*needs*' to share more data (greater resilience) and the possible *barriers* to doing so (e.g. privacy) are based on the diverse social contexts of the different stakeholders at different levels of UK's multicultural society. The individual and social contexts of data users, their roles, will explain their data requirements as well as their capabilities to supply data and their constraints on doing so.

But, studying Philosophy and Research methods during the MRes gave further insight in to the assumptions and rationale for choosing research methods. And, further training with Corpus Linguistics and Actor-Network Theory gave a fresh perspective to this research.

## 3.2 Philosophical Assumptions and Justifications

Although Action Research has been demanded (for the entire PhD project) by the project sponsors, but, for this MRes dissertation it was thought to understand the methods more deeply. Surprisingly, the choice of methods is problematic as defining, differentiating, combining or evaluating methods appear deeply embedded in several open-ended debates around paradigms, politics, ethics, researchers' background and training.

Philosophically, as qualitative and quantitative methods may be underpinned by *incommensurable paradigms* (Kuhn, 1970 cited by Bryman, 2016, p. 636) so determining any actions or inactions appear lost in the *paradigm wars*. For example, some scholars' like John Smith (1984 cited by Murphy and Dingwall, 2003, p. 171) and Seale (1999 cited by Murphy and Dingwall, 2003, p. 173) talk against relativism and its application to qualitative research. However, some

scholars like Bryman (1984) debate that the choice of methods cannot be made alone on the basis of philosophy as the relation between philosophy and technology (method) is vague. So, a choice of methods may not be directly derived from philosophical stances but investigated in relation to the research question along with philosophy (Bryman, 1984, pp. 89-90).

Politically, it's not easy to choose methods as the existence of them may questioned due to disagreements in their founders. For example, the founders of grounded theory 'Glaser and Strauss', are now in disagreement according to Melia (1997).

Technically, if some argument is made to exclusively divide quantitative and qualitative approaches on the basis of numbers and words, then, a counter argument may be made that both approaches are inseparable with implicit overlapping. That means qualitative researchers may implicitly be using quantitative terminology, so why a division? Thus, some researchers like Silverman (1997) argue that qualitative and quantitative approaches maybe best understood by seeing them as complimentary to each other. So, it is observed that many researchers make *a pragmatic* choice about methods based on utility (Bryman, 1984; Bloor, 1997; Melia, 1997; Silverman, 1997; Davies, 2008, p. 84).

To sum up, these debates resemble a wave with ups and downs. While philosophy and politics matter, the suggested way forward is to draw a pragmatic line of action by the researcher based on their interpretation of what is most suited.

Therefore, this research project appears to be dominated primarily by the Pragmatist's choice. This is because the research questions focus on asking the right kind of questions, the premises of pragmatism are satisfied and it is proposed that an empirical determination of the barriers to information sharing via a framework would result in research progressing one step closer to solving the problem of resilience of ports (Baskerville & Myers , 2004, p. 331).

However, if a choice of philosophical assumptions has to be made then it is assumed that knowledge is socially co-created and the *ontology appears to*

*participatory reality* in which *reality is co-created by mind and cosmos* (Lincoln, et al., 2011, p. 100).

## 3.3 Data Collection and Analysis Methods

For this dissertation a review of academic literature and documents has been carried out supplemented by qualitative research methods such as Participant Observations supported by the DfT as part of the Action Research. Casual interviews and narratives of policy maker (DfT) were attempted but no recordings were taken on DfT's request and only field notes were made. Specific visits were made to the Port of Southampton and to the DfT (in London) who organised participation in meetings at the Cabinet Office and with third parties. New methods of Corpus Linguistics and Actor-Network Theory have also been experimented to supplement the literature.

## 3.4 Justification of using Action Research

Action Research could be justified because it is particularly robust at solving practical problems while developing scientific knowledge (Baskerville & Myers , 2004, p. 329). It is an accepted (and established) research method in information systems research, organization development and education. For example, according to Hussey & Hussey (1997, p. 65) Action Research may be used to improve the management – staff communication in an organisation.

Action Research was developed from two sources:

1. Tavistock Institute's method of 'a sort of psychosocial equivalent of operational research' (Baskerville & Myers , 2004, p. 330), which aimed to understand the complex causes of widely variant "social illnesses"; and
2. Lewin's work at the University of Michigan where he was studying social psychology using field theory and its social systems view (Lewin, 1946).

Enid Mumford developed an Action Research style of participatory design called ETHICS (Mumford & Weir, 1979) after working at the Tavistock Institute, then Trevor Wood-Harper developed the method for Information Systems research (Wood-Harper, 1985).

In this research, the project sponsors and stakeholders aim to foster greater information sharing within the sector (Baskerville & Myers , 2004). Also, to help

mitigate the impact of a major disruptive event to the UK relates to applying research to bring about a conscious change (Hussey & Hussey, 1997, p. 65). However, critically for this project, Action Research accommodates complex systems (such as ports and its stakeholders) with the idea of 'social action', where by researchers intervene as participants in their own research to make changes and learn from the process. In this project the candidate's findings, with the help of the DfT, would feed (intervene) into policy making and the resilience planning practices within the sector.

## 3.5 Justification for using Corpus Linguistics

One of the reasons to use corpus linguistics was based on the indication from the literature that there is a variation in the language that is being used in the planning of resilience for maritime ports. In other words, this research approach was taken to understand the varying use of the buzz word - 'Port Resilience' as typical or atypical of general English usage (Baker, 2006, p. 152). Biber & Reppen (2015) used this approach of corpus linguistics for answering questions that relate to language variation, discourse analysis, linguistic characteristcs such as phraseological sequences or comprehensive linguistic descriptions indicating patterns of variation. This research approach of using corpus lingusitics also has wider applications for dictionary creation, interpretation of literary texts, forensic liguistics, language description, language teaching materials and language variation studies (Clear et at 1996, Louw, 1997, Wools & Coulthard, 1998, Johns 1997, Biber 1988 as cited in Baker, 2006, pp. 2-3). The many advangates of using corpus linguistics include, reduction of researcher bias, an incremental effect of discource, resistantance to changing discourse and triangulation to use the power of both the qualitative and quantitative approaches to research (Baker, 2006, pp. 10-17).

## 3.6 Justification for Using Actor-Network Theory

Actor-Network Theory brought another fresh dimension to the project with a unique definition or redefinition of the 'social' as a network to include human and nonhuman entities. It goes beyond the traditional and conventional approaches of research and this is explained in further detail in Chapter 5 of the dissertation.

## 3.7 Summary

In summary, a literature review, document analysis and participant observations have been mainly utilised i.e. qualitative research methods, for exploring the ports sector with additional analytical lenses using Corpus Linguistics and Actor-Network Theory.

# Chapter 4 Applying Corpus Linguistics to explore Resilience

## 4.1 Introduction

This chapter explores the patterns and usage of 'Port Resilience' in relevant reference corpora such as GloWbE, NOW and COCA, by applying the research approach of 'Corpus Linguistics'. This research method may be useful to standardise a definition of 'Port Resilience' which is otherwise considered as a relatively new, important but under defined, misinterpreted and miscommunicated term (Grainger & Achuthan, 2014). The term is misinterpreted due to complex relations between stakeholders with varying disciplines leading to different meanings in language and thus poorly operationalised. Port resilience is important as it is being advocated globally to counter threats to maritime ports – complex systems, important for the functioning and survival of any economy or nation. For example, 90% of food imports in the UK are via the sea route utilising maritime ports and their failure poses a threat to food security (Achuthan, et al., 2015, p. 1). Port failures could be due to varying threats such as natural disasters, climate change, terrorism, economic, engineering or operational failures. Thus, it would be beneficial for the survival of the global economy and maritime industry to understand the usage of port resilience as a step towards achieving a standard definition and possibly clarifying the language of operations to securing ports.

## 4.2 Revisiting the Research Context for Corpus Linguistics

### 4.2.1 What is port resilience? Are there any definitions?

As seen in the literature, there is no standard definition available for *Port Resilience* as a term but it is based on definitions of ports and disruptions and it has been recently appearing in government communications, papers and research articles throughout the world (Grainger & Achuthan, 2014). The type of disruptions could be a result of natural or human-made disasters. Examples of large-scale natural disasters include the Japanese Earthquake and Tsunami of 2011 and Hurricane Katrina in 2005. Human-made disasters include terrorist attacks in New York on September 11, 2001 or in London in July, 2005. As many of these threats may only be mitigated rather than being prevented (NOAA, 2016), the general idea of resilience is to withstand and recover from disruptions as rapidly and efficiently as possible still. Also, it may be attributed that

'resilience' as a concept is based on a philosophy with mitigation as a focus (Hosseini & Barker, 2016, p. 252). Thus, its use in everyday language needs to be carefully understood to help human society.

### 4.2.2 The problems with port resilience

The literature claims that interests of maritime port stakeholders are seldom aligned. This claim is also confirmed in the Lloyd's practical shipping guide by Khaled Bichou (2009, p. 276) who states that "*a further difficulty stems from the dissimilarity between stakeholders perceptions…*". This could lead to varying interpretations and applications of port resilience in the world.

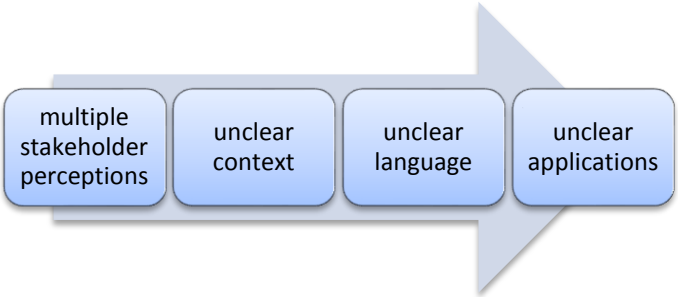



**Figure 7 Showing problems of Port Resilience**

For example, *in the United Kingdom (UK)*: port resilience is hoped to be a significant step towards addressing a pressing national security need (Secretary of State for Transport, 2014). Other examples from the world are tabulated below.

**Table 4 Showing examples of resilience projects from around the world**

Source: Summary derived from Literature review in Chapter 3

| Region | Institution | Research Details | Context limitation |
|---|---|---|---|
| **UK** | University College London (UCL) | Simulation tool for port resilience – 'MARS' (Achuthan, et al., 2015; Achuthan, n.d.). | Application is limited to *operations management and business continuity* |
| **USA** | Massachusetts Institute of Technology (MIT) | Port resilience tool has been developed with US Office for Coastal Management (MIT, n.d.; NOAA, n.d.) | Limited to analysing *climate change* effects on port operations |

| | | | |
|---|---|---|---|
| **Europe** | European Energy Agency (EEA) | Report on Resilience of Transport (EEA, 2014) | *No specific focus* |
| **Asia-Pacific** | Asian Development Bank (ADB) | Reports on making *maritime infrastructure resilient* (ADB, 2013, p. 2) | • *Capacity building* and resilience of various maritime infrastructures against climate changes<br>• Combining civil engineering and climate change |
| **Global** | The World Bank | Planning resilience via collaboration of stakeholders (Ranghieri & Ishiwatari, 2014, p. 82) | Limited to *large scale disasters e.g.* learnings from the Great East Japan Earthquake of 2011 |

The above table shows that globally significant institutions such as World Bank acknowledge a *lack of standards* and ***no standard way of defining resilience*** thus leading to misunderstandings between stakeholders (Ranghieri & Ishiwatari, 2014, p. 82).

Further, the discipline or context of *application of Port Resilience is unclear*. Is it for the application of civil engineering for building better infrastructure; or the application of management for operational, financial or human resource resilience; or a combined application of engineering and management; or geography for addressing climate change? Or what is the influence of culture (Hofstede, et al., 2010) and language on the meaning of port resilience and its understanding and usage by the stakeholders of the maritime industry? Thus, indicating that port resilience and its usage in natural language needs to be understood possibly with a different approach, perhaps with corpus linguistics.

### 4.3 Choice of reference corpora

Pre-existing reference corpora with global impact and latest data such as GloWbE, NOW and COCA were chosen. This was done to carry out an exploratory study to find out the patterns of usage of Port Resilience in a global setting. The

*Global Web-based English* (GloWbE, 2016) corpus was used as it contains 1.9 billion words from 20 different countries allowing an insight into the meaning of any variation in English. It claims to be 100 times larger than the International Corpus of English. Similarly, the *News on the Web* (NOW, 2016) corpus was used as it claims to supplement GoWbE with the latest information with approximately 3 billion words until present day and 4 million words added each day. It therefore has one of the most updated and largest collections of words. Corpus of Contemporary American English (COCA, n.d.) was chosen as most of the few research articles originated in USA or were found to be using American English or technical language. COCA claims to be the larger and more widely used than other available corpora like the British National Corpus (BNC). It has approximately 520 million words spanning 25 years from 1990 to 2015.

The reasons for using reference corpora are many including time limitations to carry out a large-scale analysis without the need to build a preliminary corpus. As the term 'Port Resilience' is relatively new and subject to a lot of debate with varying uses in the maritime industry throughout the world, it is important to analyse its usage in different contexts and understand the several meanings associated with it. This is because the literature, as specified in the research context, has already indicated that the stakeholders of the maritime industry are confused by the usage of the term 'Port Resilience'.

Another reason for using a digital reference corpus like COCA or BNC etc. and corpus linguistics in general was that it provided the ability to search huge sample of natural language. Using software and computers allows one to examine a huge amount of data for words and phrases in real context. This could be then extended to performing statistical analysis such providing detailed frequency information of the occurrence of a word or phrase. The analysis was done by using these reference corpora to possibly act as a benchmark against subsequent analysis in the future (Baker, 2006).

### 4.3.1 Findings from applying Corpus Linguistic methods

*Keyword search and Frequency of occurrence of 'Port Resilience' and 'Resilience' in GloWbE, NOW and COCA*

A keyword search using 'Port Resilience' was made using the web interfaces of reference corpora with default settings. The research investigated the frequency of occurrence of 'Port Resilience' in GloWbE, NOW and COCA. However, this resulted in zero results. Thus, 'Resilience' was chosen for subsequent keyword searches.

*Keyword in Context (KWIC) or Concordance analysis using 'Resilience' in GloWbE*

This was done to investigate the global context of appearance as Port Resilience is interpreted by stakeholders of the maritime industry in different ways in different contexts leading to confusing results. So, at the time of research an interesting idea was to note the varying contexts and highlight any key themes associated with usage of Port Resilience. The research question was to specifically find out how many times and how have the Maritime stakeholders (transport industry, government etc.) used these terms and if they are correlated to demographic annotations. This would help in narrowing down the contexts where the terms are used and find out how they are understood in different contexts.

Additionally, WebCorp (2016) corpus was used as a concordance tool to supplement analysis from GloWbE and carry find out the historical usage of Port Resilience. This was done for access to naturally occurring language from the internet. The default settings were used for this exploratory study using the Bing(Azure) API interface/search engine.

*Collocation using POS: noun+resilience*

A collocation analysis was carried out using the web interface of GloWbE with the intention to finding a relevant noun that would immediately occur to the left of the resilience. The idea was to target the part of speech (POS). This was done with the hope to find out the key contexts or themes that would emerge in naturally occurring language in a globally relevant reference corpus GloWbE. It would reveal how resilience is being used throughout the world and its relation to the existing themes identified in the literature i.e. a method to understand the

meaning and associations in a large-scale analysis (Baker, 2006, p. 96). Due to time limitation, the use GloWbE corpus was dominant for analysis in this first exploratory study.

Default settings were used for the search and analysis with the word span being set to the default setting of 3 words to the left and 3 words to the right. The words were then sorted according to their position and analysed for relevance.

The data was then transferred to a Microsoft excel spreadsheet. The excel sheet was helpful in analysis with the use of filters on various columns. By applying a filter and sorting the total frequency of occurrence and Mutual Information (MI) from highest to lowest, and removing anything with an MI value <3 highlighted some significant words.

*Ngram Analysis*

Ngram analysis using 'Google Ngram viewer'(2013) was also conducted to investigate the usage of Port Resilience, Resilience and Disaster resilience from 1800 to 2008 (default setting). This would shed light on the pattern of usage.

## 4.4 Analysis of findings

### 4.4.1 Frequency of Occurrence of 'Port Resilience' in COCA, GloWbE and NOW

**Table 5 Summary of Frequency for 'Port Resilience' in three reference corpora**

| Corpus | Frequency of word 'Port Resilience' | Total words | Date reference |
|---|---|---|---|
| COCA | 0 | 5.2 million | 2010-2015 |
| GloWbE | 0 | 1.9 billion | 2012 (released:2013) |
| NOW | 0 | 3 billion (approx.) | 2010-present |

The above table summarises a search with the term 'Port Resilience' produced zero results in all three reference corpora of *COCA, GloWbE and NOW. All three corpora generated* an error message stating "*Sorry, there are no matching records*" that indicated that the term Port Resilience was not present.

This was an interesting observation as the minimum frequency was set to the default value without any filters. The phrase 'Port Resilience' was inputted with different cases in most of the reference corpora mentioned above, however, that also produced zero results. This led to indicate in connection with the literature that the term 'Port Resilience' is relatively new and under used. This could be because of articles that are not published or not included in the relevant corpora as of present date. However, as the analysis indicates, a least usage in written form adds to the plausible theory that Port Resilience may be generally misunderstood.

Zero frequency results do not mean that the term does not exist or may not be used. It may be used by relevant stakeholders industry and this was indicated by the literature review and from unstructured interviews conducted by the author with the officers of the Department of Transport on a prior assignment. However, due to confidentiality issues and the lack of access and availability of any interview data, the usage of port resilience remains to be determined possibly via a discourse analysis in the future. This limitation is also due to the lack of time for this research that prevented obtaining the relevant permissions to obtain discourse data from the maritime industry. Also, with the recent events on terrorism, the high level of security prevented access to discourse data as being pertained as a security threat to the maritime ports.

The collocates option within the query of 'Port Resilience' also resulted in zero results, implying that the phrase Port Resilience may need to be broken down into two separate words of 'Port' and 'Resilience'. The subsequent queries were related to 'Resilience' as it is associated with many themes as indicated in the literature.

### 4.4.2 Frequency of Occurrence of 'Resilience' in COCA, GloWbE and NOW

A comparison of frequency of occurrence for 'Resilience' was made between GloWbE, NOW and COCA. It was interesting to note that the word 'resilience' on its own generated a frequency of 19533 results in NOW among 3 billion words as compared to 2704 results in COCA among 5.2 million words. The results are summarised below indicating a higher presence of 'Resilience' in the English language as compared to 'Port Resilience'.

**Table 6 Summary of Frequency of Occurrence for Resilience in three reference corpora**

| Corpus | Frequency of word 'Resilience' | Total Words | Date reference |
|---|---|---|---|
| COCA | 2704 | 5.2 million | 2010-2015 |
| GloWbE | 11405 | 1.9 billion words | 2012 (released:2013) |
| NOW | 19533 | 3 billion (approx.) | 2010-present time |

A variety of usage of the word 'Resilience' was seen in the GloWbE reference corpus. For example, in Great Britain, the frequency of occurrence for Resilience was 2727. A sample from context lines is shown in Figure5 (Appendix1) showing evidence of the different variety of usage including the health sector, business and management, engineering and general public policy for the society.

*4.4.3 Key word in Context* (KWIC) or Concordance analysis of the context in GloWbE

A *Key word in Context* (KWIC) analysis of the context in GloWbE showed the occurrence of following words. The words were sorted using GloWbE's web interface with default settings. The results of KWIC are shown in the figure below with resilience in the middle and the commonly occurring words listed on the left and right.

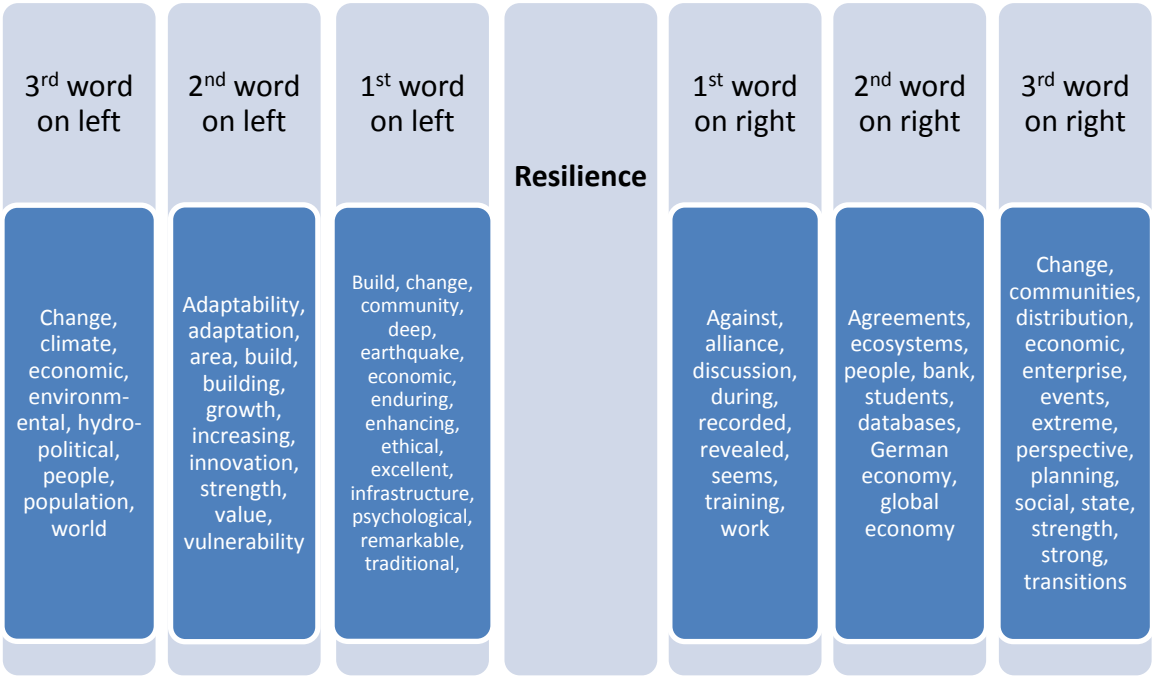



**Figure 8 Showing KWIC analysis for resilience in GloWbE**

The listed words are separate themes in their own rights indicating that the word Resilience is associated with several themes. This is confirmed from the literature presented in the research context that the word resilience is being used in multiple ways throughout the world. This indication could act as a plausible reason that multiple themes are the reasons why there is a miscommunication or misinterpretation of the word resilience in the maritime world.

A collocation analysis of the word 'Resilience' indicated that the one of the highest occurring nouns associated was Climate with a frequency of 32 and MI score of 5.95. The collocation analysis was used to better understand the usage and meaning of the word resilience. Also, it was thought that GloBwE is covering the English usage for about 20 countries and it would indicate how the word 'Resilience' is being used throughout the world. A further excel analysis revealed that out of the resulting 101 collocates for resilience, 43 were relevant with frequency more than 3 and MI score ranging in values from 3.06 (lowest) to 15.6 (highest). The application of a filter (as seen in Appendix 3) produced themes such as Earthquake, Disaster, Climate, Infrastructure, Preparedness, Vulnerability, Community, Environmental, Risk, Systems, Building etc. Many of these appeared similar to Figure 8. This indicates that *Resilience* in itself is a developing concept and has several interpretations. Its applications to maritime and ports is still in an extremely nascent stage.

#### 4.4.4 Ngram Analysis

Ngram analysis (see Appendix 3 for results) revealed that 'port resilience' does not exist and produced a zero result.

But, it was interesting to note that there is an exponential increase in the word 'resilience' since the year 1992. Its use is reflected in climate change and this could be possibly due to the signing of the Kyoto Protocol in the year 1992 which has promoted resilience against climate change (UNFCC, 2014).

Ngram analysis also shed light on the exponential increase in the use of disaster resilience since the year 2000. This could be possibly due to various natural disasters like Earthquakes in several countries, volcano eruptions, Tsunamis (Indonesia in 2004), hurricane Katrina in 2005 or human disasters such as the

9/11 New York in 2001. These disasters have led to new responses on a national level (Achuthan, n.d.), and this may have increased the use of the term disaster resilience.

### 4.4.5 Additional Concordance for Port Resilience using WebCorp indicating recent usage

An additional analysis using WebCorp was conducted for Port Resilience as a supplementary method. This was done with settings: case insensitive, using the Bing (azure) API search for the keyword 'Port Resilience'. *28 results* were produced starting from the year 2011 until the present time. Out of the total 28 hits, 16 were from the year 2016; 2 from the year 2015; 5 from the year 2014; 3 from the year 2013; 1 from the year 2011; and one with unknown date. This result is very interesting and could indicate that the usage of the Port Resilience is fairly recent with most usage in the year 2016. Further qualitative analysis of the web pages indicated that active research was either taking place or commissioned in the year 2016. For example,

> "http://scale.mit.edu/research/port-resilience
> Text, Wordlist, text/html, UTF8 (Content-type), 2016-06-24 (Server header)
> *In response, CTL has initiated the MIT Port Resilience Project, which will focus on developing*
> *11: of Technology as the lead institution. The MIT Port Resilience Project builds upon CTL's deep and continuing*
> *12: risk management, and supply chain security (see Port Resilience – Reports and Publications for relevant CTL*"

The above example of a concordance indicates that Port Resilience involves large research institutions that are actively working on the concepts under different themes. Thus implying that port resilience is undergoing active development but with limited occurrence in natural language or the print media. It may be used in closed research groups at the moment but this determination is subject to future research.

## 4.6 Summary

This chapter has shown how Corpus Linguistics was utilised to find that 'Port Resilience' is in a very early stage of usage in everyday language. This is indicated by its lack of presence in any of the relevant reference corpora. However, this does not mean that the term 'Port Resilience' does not exist as it may exist in unexplored discourses. The pattern of occurrence and usage of the sub-term 'resilience' was then found out as associated with several themes

including climate and disaster. The corpus data analysis therefore shows that resilience and its association with the maritime industry takes place across several disciplines with multiple interpretations leading to multiple uses in varying contexts. Thus, relating to the literature and reinforcing the understanding that there is a lack of standards for the term.

# Chapter 5 An alternative approach to Port Resilience – a view from the Actor

This chapter offers an alternative view to analyse the epistemological assumptions, i.e. origin and derivation of knowledge that could be utilised for the purpose of studying port resilience and information sharing. For this purpose, 'Actor-Network Theory' (ANT) is explained and its use analysed because ANT is useful for analysing a complex network of humans and technological systems (Latour, 2005). For this research, resilience of maritime ports is explored including the search for barriers to information sharing via an Action Research utilising Participant Observation or Ethnomethodology, Document Analysis and Interviews. The chapter starts by characterising traditional philosophical approaches such as positivism and other approaches like interpretivism as inadequate for studying complex 'socio'-technical (human and technical) networked systems, due to defects in existing definitions of 'epistemology of social sciences' (Latour, 2005, p.102), defining 'social' as human only. The discussion then progresses on to alternative approaches such as ANT, analysing its suitability to answer the questions about the nature of knowledge, its criticisms, and its relation to other approaches including its applicability to the network of maritime ports in the United Kingdom (UK). Reference is made to latest researches considering ANT to be plausible for studying complex networks and resilience in the maritime industry. This chapter finally argues in favour of applying ANT for 'port resilience' by *reassembling the 'social',* i.e. redefining existing concepts of the 'social' as a network of humans and non-humans (e.g. technology & material objects).

## 5.1 Characterizing traditional approaches to deriving knowledge

One of the traditional 'scientific' approaches, *positivism,* developed by Auguste Comte (Kremer-marietti, 1998), assumed that *'observations'* solely made it possible to observe the 'social' and produce 'facts' and 'valid knowledge'. *Falsifaction,* a further development by Karl Popper (Chalmers, 1999, p.60), argued for deducing theories from observations and then testing them to be falsified - *hypothetico-deductivism* (Godfrey-Smith, 2003). However, positivism was problematic as it was argued by Chalmers (1978) that observations are not the starting point of 'science'; that somethings could be known *'a priori';* that

theory preceeds observation (theory-dependence); and that observations could be fallible like theories because of being interpreted in different ways by different observers. Another problem was the utilisation of *induction* as it was problematic to justify its use by itself, resembling the riddle of '*who validates the validating'* (Chalmers, 1978). Positivism is more suited to 'natural' or 'hard sciences' with emphasis on quantitative techniques of data collection and analysis; *assuming that reality is singular, measurable and quantifiable*, and the creation of a 'gold standard' leads to rigour (Lincoln, et al., 2011).

Another approach, *Interpretivism*, an alternative to positivism, *assumes reality to be multiple and constructed*; *knowledge as co-constituted by elements of the 'social' (humans)* (Maykut and Morehouse, 1994, p.3); and developed by Maurice Merleau-Ponty, Michael Polanyi, Max Weber and Wittengstien among others. Following the advocation of 'social' action to be understood by Weber's interpretive understanding ('*deutend verstehen'*) and Wittengstein's rules (Winch, 1990, p.111), interpretivism assumes humans as different to the objects of study as humans create and comprehend different meanings. So, interpretivism is associated with qualitative research with emphasis on human-as-an-instrument (*Naturalistic Inquiry* by Lincoln and Guba (1985) cited in Maykut and Morehouse (1994, p.48)). But, can the interpretive inquiry of a human only 'social' by human only inquirers, be considered a holistic approach to study heterogeneous networks of humans and non-humans?

Traditional approaches are inadequate to understand complex human-technical networks (Latour, 2005). The approaches being reductionist would divide a network into separate categories of human (subjective) and technical (objective). The separation of categories would make technical unequal to human aspects making the study not holistic, with the assumption of 'social' being humans only and unable to explain 'social' phenomena. So, while considering socio-techno networks, *conventional approaches would only consider finding things outside of the network by outsiders*. The inadequacy of the traditional approaches is further complicated for determining actions or inactions as they are submerged in paradigm wars with *incommensurable assumptions* (Kuhn, 1970 cited by Bryman, 2016, p.636). Thus, making the case for an alternative approach to socio-techno networks that would consider knowledge

being derived holistically by tracing associations from within an inclusive network of 'actors' – humans and non-humans.

## 5.2 Introducing Actor-Network Theory and its rationale

Actor-Network Theory or ANT as it is commonly known is an alternative to conventional approaches for studying relationships in complex networks of non-humans (material objects) and humans – *assemblage* (Latour, 2005). It was created by Bruno Latour with support from Michael Callon and John Law (p.10). They argued that existing approaches are just *'sociology of social'* (p.248) and inadequate due to confusing science with politics, or imposing methods of natural sciences, or never failing to explain, or not considering the non-social (material) and restricting the number of participants in a network. Latour (2005, p.256) criticised positivism for forgetting human consciousness by being objective, for prematurely transforming concerns into facts and arguing that fabricated facts cannot be solid (p.112). He argues against *'critical sociology'* and blames existing approaches for confusing two tasks of '*realism*' - multiplicity and unification (p.114). This means to abandon the search for socio-psychological causality and avoid pseudo-explanations about motives, interests and intentions. Munro (2009) supports Latour by saying that "*concept of humans acting as the sole agency is outplayed"*. So, the way forward is to *understand the ties* (associations) which hold the assemblage (networks) *without restricting participants* (actors). Latour (2005) terms ANT as a shift towards '*sociology of associations'* with the aim being:

> *"There is no society, no social realm, and no social ties, but there exist translations between mediators that may generate traceable associations"* (Latour, 2005, p.108).
>
> *"To learn ANT is nothing more than to become sensitive to the differences in the literary, scientific, moral, political, and emperical dimensions of the two types of accounts"* (Latour, 2005, p.109).

Ports and their network appear as potential candidates for applying ANT because ports are complex heterogeneous networks of humans (e.g. harbour masters, ship captions, machine operators, terminal operators, ship workers, engineers, managers) and non-humans (e.g. ships, cranes, computers, money, machines,

management, mechanism, economics, culture). These actors are intra and inter-connected to other ports, institutions, government. In the UK, the privatisation of ports adds to the complexity of networks due to self-interests of actors. Thus, while existing researches on port resilience have utilised conventional approaches which as argued before have ignored the non-social, ANT offers a holistic alternative.

*Ontologically*, ANT assumes there are multiple realities of all 'actors' similar to interpretivism. However, the difference is in ANT's definition of 'actor' which includes human and non-human. In order to understand the definition of a common world, as seen by the collective of actors with multiple realities, a reassembling of the 'social' is necessary to include all actors (Latour, 2005, p.247). To understand the nature of the universe, ANT specifically examines five major uncertainties about the nature of: i) groups, ii) actions, iii) objects, iv) facts and v) type of studies done under 'science of social' (p.22). Precisely stating 'social' is difficult but important to understand "*how many are we?"* and "*can we live together?"* for "*progressive composition of common-world"* (p.254).

*Methodologically*, ANT has three duties of *deployment, stabilization and compositions* as suggested by Latour (2005, p.249) in faithfulness to *Relativist principles* (p.21). The *first duty deploys controversies* to include everyone and assess the number of new actors in any future network; the *second duty* follows the actors build standards and formats to *stabilize uncertainties*; the *third duty* assesses how the newly identified network *can replenish our understanding of being in the same network* (p.249).

***ANT suggests tracing associations*** between controversies (p.23) by first identifying the 'social' by tackling sources of uncertainties and then including the non-human equally with the humans **in a 'reassembled social'** called assemblage or collective or network. To reassemble the social with a flat hierarchy, three moves follow to localise the global, redistribute the global and connect different sites (p.172).

**Figure 9 Three Basic duties of ANT. (Source:self-drawn)**

***For deriving knowledge***, the associations between symmetricaly treated actors, i.e. humans and non-humans treated equally, may then be analysed (Latour, 2005, p.247). The heterogenous actors continously exchange properties including information among them and following this exchange may lead to better understanding the 'social phenomenon' (Arnaboldi and Spiller, 2011, p.646).

Port resilience can be related to ANT to learn by tracing the formation of groups or networks within and between ports, in order to understand the strategies or operations that led to group formation. This could be important to strengthen the operations and strategies in the times of disruption (e.g. economic; terrorism; weather). For example, the creation of new alliances of major shipping lines in the container shipping industry could be traced to understand the strategies behind the mergers or acquisitions of companies.

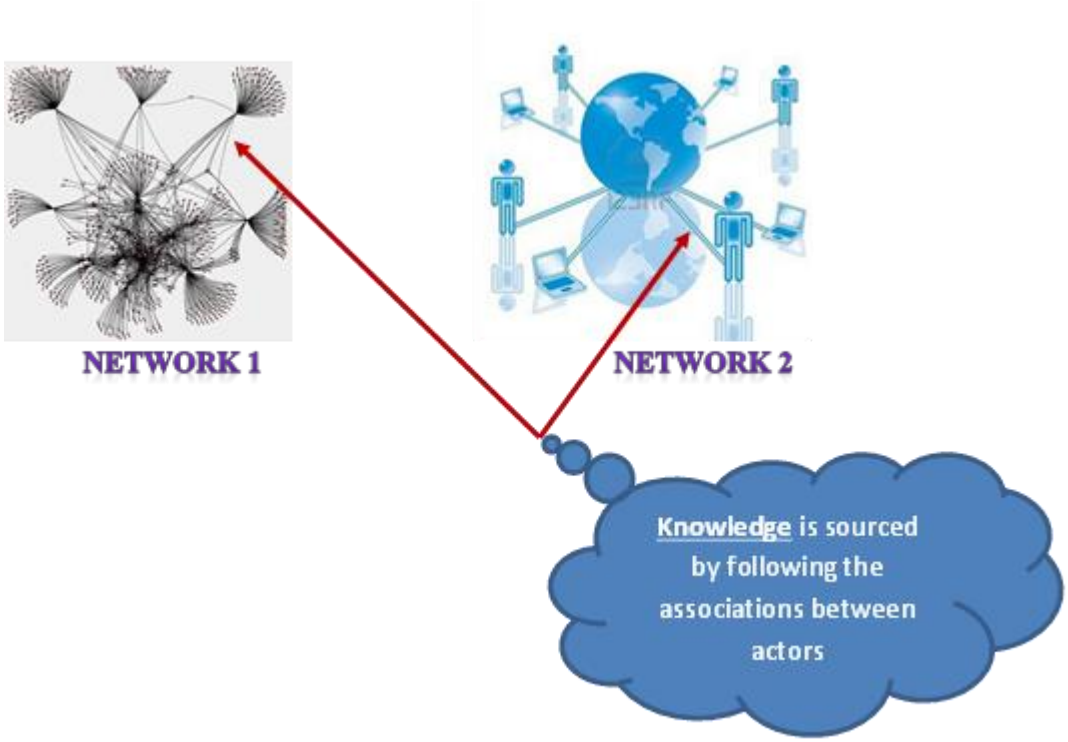



**Figure 10 Deriving Knowledge (Source:Self-Drawn)**

## 5.3 Debates about ANT

ANT is criticised to be Machiavellian, demiurgic, managerial and engineered as acknowledged by Latour (1999, p.16). Latour (2005) acknowledges starting ANT in a confused manner, being self-contradictory during its development for initially criticising the acronym 'Actor-Network Theory' for separating actors-networks but later supporting it. So although ANT is acknowledged as 'radical' by critics (Collins and Yearley, 1992; Lee and Brown, 1994; Wajcman, 2004) this is debatable as mentioned below:

1. **Accusation of Machiavellianism**

ANT is compared to Machiavellianism for being cunning and creating schemes that are derived out of being dishonest about the real agenda and trying to win wars (Amsterdamska, 1990, p.502). Olga criticises Latour for being self-contradictory and creating confusion using the 'chicken and egg' or 'egg and chicken' riddle by using tautological phrases, i.e. different words to say the same thing (pp.497-498). Olga also argues that Latour's so called network theory has flaws because the role of humans is non-comparable to the role of non-humans and there is no point in a human being dictated by a non-human. Olga says that

Latour "*must be joking"* and gives examples of a microbe dictating the research funding for a scientist (p.501). Latour's epistemology is criticised as the idea of "*might makes right"* (p.501), and he is indifferent to the means and methods of enrolment and control of the network.

Countering criticism, Latour (2005, p.252) says '*Machiavellianism* is good' as it supports ANT by providing new ways, breaking out of trends to learn innovatively.

**2. Weakness in Vocabulary and the Insider vs Outsider problem.**

ANT's weakness in vocabulary was highlighted by Lee and Brown (1994). They accused ANT of not giving the freedom for actors to build their own space by restricting them with poor vocabulary. So toplogy – which is the shape of a network, was an issue (p.785). ANT appears weak in determining who is in and out of the heterogeneous flat network. *Relativist principles* of ANT are criticised by Collins and Yearley (1992) who call it an 'epistemological chicken' and 'destructive' (p.323); that for symmetry human should be at the centre of universe (p.311) and that vocabulary of ANT does not explain the acceptance or denial of knowledge claims (p.322).

**3. Politics, Power and Gender**

ANT is accused by Lee and Brown (1994, p.780) to be a combination of liberal-democratic and Nietzschean thought. But, Latour acknowledges that ANT is a way of learning from the actors about their world-building capacities without imposing any a priori definition (p.20). He clarifies that actors cannot be exactly 'studied' and the way to learn is to follow the actors – *circumlocution (ibid.)*. However, ANT by not considering pre-exiting structures is ignoring any prior disposition which may be guiding the formation of new structures (ibid.).

ANT utilises *Foucauldian concept of power*, where capacity and effectiveness determines power (Wajcman, 2004, p.42). Wajcman quotes Bruno Latour's 1986 work on 'Associations of Power' which states that '*power is not a possession*', '… is a consequence rather than a cause of action' (ibid.). In other words, groups (people, country, machines, etc.) are consequences of heterogeneous operations. So, the inquirer must trace the formation of groups in order to find out the operations that cause the groups to be formed (ibid.). This is the basis of

ANT and applicable to Ports as capacity is considered important for port planning by Bichou (2009, p.51) who states that *"…the core objective of port planning is to seek a balance between shortages in capacity and over-capacity at adequate cost, price and service levels…".* For example, Vaughan's (1990) research on Space Shuttle found technical assistance and power were a consequence of action by heterogeneous relations with suppliers and not solely of a 'self-regulated' NASA.

*Summarizing the debate in support of Latour* (2005, pp.37-40): ANT starts with the idea of no society so it does not favour any particular group or *aggregate.* The social is traced by association of actors, appreciating multiple view-points of objects and following the translation of an actor as an intermediary (reliable carriers of meaning) or mediator (unpredictable carrier of meaning). This is unlike conventional thinking which has created issues about politics and power by restricting participants or constraining them contextually thus engineering the social. ANT claims to build on conventional approaches by ***decentring the Human, fusing identity and action, and preventing marginalisation*** by considering the equality of human and non-humans and freedom to trace their own social. As validity is achieved by the associations and actions of the actors with abstraction, so, ANT goes beyond simple *reflexivity* of the inquirer (p.33). Also, with the actors leading, ANT promotes *disinterested science* (p.256). Thus two major criticisms acknowledged by Latour (2005, p.251) - i) "e*xtending politics everywhere…"* and ii) *"indifferent to inequalities and power struggles…" – i.e. power and politics* cancel each other. Abstinence from Power is achieved by providing *no powerful explanations* without checking (p.255). So, we get holistic insight, i.e. knowledge, by addressing the ontology, i.e. by reassembling the social and tracing the associations of actors. Thus, ***ANT goes beyond Comte, Durkheim, Weber and Parson's works as technology has changed the definition of 'social'*** **(p.260)**.

## 5.4 Supporting ANT in Relation to Other Approaches

*Technofeminism and ANT* may be related as ANT utilises feminist ideas of overcoming marginalization by making human and non-human entities as part of a network, to consider inclusivity and heterogeneity of actors, and provide a

holistic approach to overcome the issues with power relations. Wajcman (2004, p.44)

*Ethnomethodology, Three dimensional (3D) drawing and ANT* appear related for tracing the movements of actors by recording the locations which constitute the world. This learning by following the actors gives unique freedom to actors to draw any shape so there is no imposition of a priori definition of shapes (Latour, 1999, pp.20-21).

Diane Vaughan's (1990) *study of NASA's Challanger tragedy*, resembles ANT by considering constraints on social control like the *technical dependence of regulators on the regulated*. It relates autonomy, interdependence and social-control by concluding that *knowledge of organisational relations is important* because technical risks do not consider organisational relations making technical confidence shaky (p.256).

## 5.5 Resilience and application of ANT

Recently ANT has been applied to understanding resilience as part of an *Action Research* to understand, the micro-dynamics of stakeholder collaborations (Arnaboldi and Spiller, 2011)*;* for marine ontology (Boucquey, et al., 2016); or coastal community networks (Pauwelussen, 2016). By applying ANT rules of *enrolment, fact-building,* and *circulating translations,* the authors agreed this radical approach of learning as evolutionary and suitable to understand resilience.

## 5.6 Summary

Conventional approaches, to understand social networks, are problematic due to dealing only with known forces such as power or domination (Latour, 2005, p.249) in an imprecise 'Social' i.e. without non-humans. ANT, alternatively, recommends 'reassembling the social' by tracing associations of both human and non-humans actors, to understand the effect of interdependence and generate knowledge about their social world. There are criticisms of ANT being machiavillean and weak on deciding who is outside and inside the network. But, ANT innovatively follows actors, distinterestedly, without imposing a priori, to define and understand their own networks. ANT has been recently been applied

to the marine sector considering non-human entities like ships and machines to understand Port Resilience. Resilience is a philosophical concept (Hosseini and Barker, 2016) in which a network or system has to bounce back to its original state of operations and shape after disruption by known or unknown forces. So, ANT offers a better hope of knowing and *dealing with the unknown* which is important for understanding how to achieve resilience.

# Chapter 6 Findings from the Field

As part of the Action Research work with the Department of Transport (DfT), the researcher was invited to attend strategic meetings in the UK Government. The findings from these meetings are presented in the following sections as part of the Participant Observation activities that took place while shadowing the work of the DfT and its partners such as the Cabinet Office and other third parties.

## 6.1 Findings from participating in the UK Government Flood Group meeting at the Cabinet Office

As part of Participant Observation method, a meeting of UK Government's Flood Group was attended on 26th April 2016 from 10:30am to 12:30pm at the Cabinet Office, 35 Great Smith Street, London. The researcher was invited to represent the DfT along with a policy manager from Maritime transport division of the DfT and the observations and comments from the meeting are presented below.

The meeting indicated that this was a working group of the UK Government on flooding and the progress was at a conceptual stage which meant that the working group was trying to understand post-acknowledgment of the severe consequences of recent repeated flooding in the UK and that yes flooding is a threat, but, we need to take some serious actions very quickly.

However, it was very evident from the discussion among the working group that there was no consensus on a set direction to respond to floods between the various people representing different departments. As the meeting was being coordinated by the Cabinet Office, it was acting as a draft provider, i.e. providing working drafts for the subsequent actions to protect against floods and these drafts of actions are needed to be consented upon or improved by other departments.

The direction of the flood group was being set by the *Brigadier Matt Holmes review on flood response* and the *National Flood Resilience Review* which is the UK government's actions to deal with floods by considering modelling and weather, critical infrastructures, temporary fixes and strategy for future investment (Gov.UK, 2016a) along with other reviews such as *Local Resilience*

*Forums, Government Committees* such as EFRA and EAC (Woodhouse, 2016, p. 14).

The future priorities being pointed out as: "*further strengthening our partnership, consistency across all FRS/EA areas, sharing best practices, template for other public sector partnerships, doing less with more; integrating and innovating; focussing on community resilience*" (Woodhouse, 2016, p. 19)*;* relate to the sharing of information. This could mean that information is not being shared either in the ways that are not thought to be appropriate, due to data protection, lack of trust or misunderstanding. This remains to be seen and more research is required.

During the meeting, it was explained to the participants that the Holmes review was possibly derived out of the military training and background of Brigadier Matt Holmes which led to a difference in understanding by other members or those supporting Brigadier Holmes for responding to floods. For example, it was quoted by a participating member that *"...Everything is too wordy for him…* [Brigadier Holms]...*and being a military man he [*Brigadier Holms] *likes to see action, instant plans and models".* This could mean that people from non-military backgrounds work different from people from military backgrounds, they have different expectations and people from military background would like to respond instantly to events as they do in times of action (normal military duty). This could also mean that it took time to explain to civilians (from a non-military background) to explain things to people with military backgrounds. The processes from a military background are understood differently by civilians and the reason and justification to carry out activities that are possibly derived from a military operation are seen in different light by people from different education or training or background. This difference between thinking due to a military or non-military background resembles the problem of pre-disposition leading to different interpretations which has been referred to by many authors studying and writing about qualitative research such as Michael Polyani and Maurice Merleau-Ponty (Maykut and Morehouse, 1994, p.3; Chalmers, 1978). There was heated debate about the reason for involving a military thinking into civilian matters, the outcome of the debate being that since response to adverse natural events such as storms and floods are to be responded by those trained to deal

with extreme adverse conditions, which is the military. The involvement of military or those with a military background is seen throughout the world among many countries including the USA, UK, Russia, China, India and other nations.

In a way this development of the flood plan was considered 'odd' by some of the members present at the meeting, while for some other members it was logical. This differentiated opinion was interesting. On knowing the background of the people who found it logical, it became clear that they were themselves from a 'pure science' training or education or had some involvement with the military being associated with the ministry of defence. And these people with a pure science background explained that the military is an agency in most countries which has both the resources and training to respond to unknown situations in the fastest manner. The rest of the agencies are bound by limited resources or limited by lack of trained people.

The theory and practice of responding to flood situations in the UK is being scrutinised and the outcomes of various reviews is to be merged and then considered for this scrutiny and future planning. There are further recommendations to study the responses being made in similar conditions by other countries such as Australia. So, learning by international experience is important.

It was discussed that the Ministers were agreeing to follow up meetings following the props sent by the then Prime Minister David Cameron. However, now with a changed government it is to be seen what is going to the path of action.

The discussion was then on whether the response should be considered and developed in isolation or a cross between different agencies or a merger between different response types. The idea was then spoken about establishing a national flood operations centre which was considered a good idea that involved stakeholders for decision making in a collaborative environment. So, a collaborative environment with a collective response was suggested.

The complication for the UK was given the different parliamentary workings in England, Wales, Scotland and Northern Island. There was a Scottish representative over the phone attending the meeting 'virtually'. However, it was

clear that Scotland has its own terms of reference (TOR). *These TORs could be a barrier to information sharing due to differences in understanding*. These differences are problematic for emergency response because it is not a local matter but a matter of national concern (i.e. including all the four regions of the United Kingdom).

The difference in political workings and the existence of various stakeholders makes the promotion of a collective working becomes complicated. This was argued during the meeting as a topic of expand the group to include every stakeholder or don't expand the flood group and continue with limited stakeholders. The discussion was inconclusive but it was acknowledged that this is a problem in both cases (political affect and group membership) because if the group is limited then who should be left out of the group and if the group is expanded then how to reach a consensual working. For example, in the meeting it was questioned whether *the Department for Business, Innovation & Skills* (BIS, 2016) should be included in the membership of the group for responding to flood problems. Post-Brexit, in July 2016, BIS has been replaced by *Department for Business, Energy & Industrial Strategy* - BEIS (BIS, 2016). The *Department of Energy and Climate Change* (DECC) was represented at the meeting while BIS was not. However, as of July 2016, post-Brexit, DECC has merged with BEIS (DECC, 2016). The above mergers of departments, due to political changes, shows that the nature of defining who is in the collective is problematic.

Going beyond the discussion of the expansion of the group, the discussion let to the acknowledgement that workshops are important to raise awareness between various stakeholders. And, that the workshops should be organised with input from the various reviews and in association with the local authorities and local responders. This was possibly linked to the response actions seen by local responders in the case of flooding which led to minimising the damage. So, a personal experience could be shared and incorporated into the systematic development of a national response plan.

The development of workshops included the acknowledgement that infrastructure in the UK including energy, food, transportation is at big risk from

flooding and other natural threats. But, the development of workshops is problematic given that the geography of different regions creates different problems. So, different workshops would have to be created for different regions. For example, the power stations in the southern coast of England may be different to the ones on the other coastal districts. So, as each coast has different characteristics, the understanding of different coasts needs to be enhanced and incorporated in to the planning for resilience. And, one way of enhancing this understanding is to work with the local authorities for the individual coasts, who would have more localised knowledge. Thus, workshops would be a reasonable platform to enhance knowledge of different coasts. This would also allow data to be peer reviewed increasing the reliability and validity of findings. But, having different workshops for different regions increases the distances people have to travel between regions. This is limited by the budgets available. This could mean that if information is to be shared via the means of workshops then it is constricted by budgets. So information sharing could be affected by budgets.

The planning of workshops was also affected by the people involved in the workshops as they could have family or personal commitments so moving people between regions is problematic. So, sharing of information could be affected by the personal commitments.

But, a question that occurs here is: if information sharing is improved by removing the silo culture, then does moving people across regions (i.e. not letting them work in isolation and sharing information) lead to the removal of the silo culture? From the meeting it was evident that, people wanted to organise more of these workshops, which was acting as an enabler to information sharing; but, personal commitments and geographical distance delaying the organisation of workshops was acting as indirect barrier to information sharing.

The role of Local Resilience forums (LRFs) was mentioned by the Cabinet Office and more of their details were mentioned by giving reference to document produced by Cabinet Office (2013). The LRFs are part of National Resilience Capabilities Programs (Cabinet Office, 2013, pp. 34-42) where their work is

directed for maintaining essential services and functional work streams. The LRFs are also part of emergency response and recovery (Cabinet Office, 2013, pp. 43-55) where their work includes following the principles of response (pp. 44 - 45); as a strategic co-ordinating group (pp. 46 -48); giving command and control (p.49) while collaborating and co-ordinating with other forums and tiers (p.50); and, then helping in recovery with principles and strategy (pp. 52 - 54).

The importance of the document dictating the role of LRFs is the *duty to share information* (Cabinet Office, 2013, p. 28) which is supplemented by another document by the Cabinet Office on *Formal Information Sharing Under the Civil Contingencies Act 2004* (Cabinet Office, 2012). According to the Formal Information Sharing document, there are two important categories of responders (Category 1 and Category 2) that need to share information for emergency response. There is a mention of a *culture of co-operation* (Cabinet Office, 2012, p. 2) and category 1 and 2 responders have to share information with other responders of the same category type. This is also part of the agreement in the *Civil Contingencies Act 2004* which is called 'CCA' and the *Contingency Planning Act* (ibid.). While these acts providing a culture of sharing was considered good, but, there appeared a flaw in the system where not all information is to be shared and it is the responders which decide the information that should be shared or not shared (i.e. controlled). The non-sharing or controlling of information is based upon the responders' understanding of the information and this appears to be subjective. This is because on one hand, information is supposed to be shared between responders without any formal requests to *avoid over-bureaucratisation* (Cabinet Office, 2012, p. 8) and on the other hand formal requests for information sharing may depend on agreeing by a group of LRF and this agreement may be subjective like agreements in general. Further, if the information is sensitive (i.e. the information has implications for national security) then it cannot be shared, this is often recognised by a *certificate of disclosure of information* (Cabinet Office, 2012, p. 14), however, many times this certificate may be missing which may lead to misinterpretation of what information is sensitive (i.e. will compromised national security) and what information appears to be sensitive (i.e. may compromise security but this is uncertain) (Cabinet Office, 2012, pp. 14-15) – this spotting of sensitive

information appears to be subjective, dependent on context and may be a barrier to information sharing.

There was indication of misunderstanding or lack of understanding by some members on the effect of flooding on ports, particularly the interoperability of ports in case of the failure of a port or group of ports. This was due to the questions asked by some of the non-transport related stakeholders that commented that interoperability of ports may be easy given the number of ports available. For example, the Associated British Port (ABP, 2016), a company, has 21 ports in the UK. But, each port has different specialities and interoperability was difficult as explained by the representatives of Department of Transport (DfT). It was mentioned that in case of failure of ports, it may be easy to offload people but it is difficult to offload cargo as each cargo has different requirements to be handled in specialised manner which makes cargo handling complicated. Similarly, food may have options but energy related products have very limited options as seen in the case of flooding of port of Immingham where coal could not be supplied or offloaded and it caused a concern for the supplies to the Drax power station. This explanation and attempt to understand by different stakeholders showed the lack of awareness among them which meant that pre-conceived ideas about the operations of ports may prevent resilience or sharing of information as it may be not considered as a priority. But, post-explanation and acknowledgement that inter-operability of ports is difficult, by the members present at the meeting, showed that workshops could work towards sharing information, clarifying information, raising awareness and changing priorities. This is also acknowledged in the documents for the role of LRFs that training is important for responders to understand and share information (Cabinet Office, 2013, pp. 26-27). So, workshops, education and training could act as important enablers of information sharing.

*Business Continuity Planning* was briefly mentioned as important for different ports and their resilience. Planning for business continuity has meant that the ports have been made to undertake primary reviews of all assets and consider varying parameters from different threats that could break the continuity of business. This has involved considering the sea conditions being affected by weather and climate change, the changes in sea level, tidal surges, earthquakes,

tsunamis and other threats such as terrorism. Assets of the ports estate including terminals, berths, cranes etc. have been considered and their failure has been assessed by different modelling tools. However, it was mentioned that bespoke business continuity planning has been carried out by different auditors such as Price Waterhouse Coopers (PwC) and this has been constrained by budgets and time. Also the bespoke nature of business continuity planning may have led to complications in sharing of information due to different specialities of ports along with other varying parameters. Different auditors may have different perspectives and the measures and standards may cause differences in reporting and predicting. These varying parameters and their consequential different reports may lead to different priorities and interpretations leading to delayed decisions or inadequate decisions which are both dangerous. So, bespoke business continuity planning although much needed to be individualised for each port may also prevent information from be shared in the appropriate manner or time and may act as a barrier to resilience.

Information sharing among local regional groups was considered to work very well. This was possibly due to the proximity of the groups in the local region with a better understanding of the priority to share information or in accordance with the Civil Contingencies Act 2004. This remains to be explored with more research. For example, the Environment Agency (EA) was attributed to using action cards and these may be developed to specify the action that needs to be taken in order to respond to different situations. And, these action cards may be shared at a local level. So, although it was clear from the discussion that local regional groups function well, but, the details of why they work well was not clear.

In summary, training and education were highlighted as important for the transfer of information, the understanding of information and development of the correct priorities. Training and education could be provided via the means of workshops. But, developing workshops is problematic given the personal commitments (family life etc.) and geographical distances of people involved in the workshops. Similarly, it is difficult ascertain on a national level the membership of the group for taking things forward (e.g. who should be a member of the flood group). And, it is acknowledged that people with different

training and backgrounds will interpret things differently leading to different consensus, priorities and opinions affecting the planning for resilience. The classification of information being sensitive is problematic if it depends on the individual as there could be many interpretations and understandings. The individual may classify something as sensitive (i.e. will compromise national security) which may be important to share for the purpose of resilience, this represents a condition of deadlock in which the same sensitive information could breach national security but could also improve the resilience.

## 6.2 Findings from participating in meeting between DfT and Catapult, a third party supplier

A meeting was conducted between the Department of Transport (DfT) and Catapult on 26th April 2016 from 1pm to 2pm at the premises of DfT in London. The meeting was attended by a policy maker from the DfT and two representatives from Catapult, one of them a direct employee while the other was a hired external consultant. According to the Catapult's representatives, Catapult is working with Innovate UK (an organisation promoting innovation in the UK) to create cutting edge technologies in the UK and possibly help in the resilience of businesses. Catapult utilises people various education backgrounds such as scientists, engineers and management to create cutting edge technology. The funding is from Innovate UK and Catapult claim to have utilised the funding to build a state of the art facility which encourages economic growth in the UK. They achieve this by a developing a collaborative environment in which people from different backgrounds and training are brought together to share information and develop. They claim to have launched ten different streams of works which they call 'catapults' including: i) *Cell Therapy,* ii) *High Value Manufacturing,* iii) *Offshore Renewable Energy,* iv) *Satellite Applications,* v) *Digital Catapult,* vi)*Transport Systems,* vii) *Future Cities,* viii) *Energy Systems,* ix) *Precision Medicine and x*) *Medicine Technologies.* The representatives claimed that Catapult had major successes in products particularly in satellite applications, for example in helping the Oxford Space Systems. The company had successes in bridging gaps between the conceptual stages and the final product stage, for example, ideas which were thought to be very good but were not yet ready for implementation were given a catalytic turnover by Catapult and ideas were transformed into products very quickly.

This meant that the company had very rapidly produced successes in a short period of time. They claim that following their success, venture capitalists have invested rapidly which has fuelled the company to work even faster and better. The customers are claimed to have seen that the company is supported by the venture capitalists and this increased funding, increasing the reliability of the company. The customers are also claimed to acknowledge that their business continuity has been enhanced with the input from Catapult. This is because they claim to differentiate between working on things that are inconsequential and things that matter to the functioning of the business. In a sense, funding from Innovate UK is considered as a 'gold standard' to suggest that the company being funded is really worth it and can provide innovative products and solutions. So, customers claim to have been helped throughout their product development life cycle which is from the pre-planning stages through the concept design and development of product, to its final testing and roll out stages i.e. the project completion. The way catapult has seen this success is by information sharing through a rapidly developing network which is called the 'Catapult Network' which provides for the state of the art facilities and *dynamic innovation spaces.* These networks are being utilised to help companies in the UK grow faster and more dynamically assist by customising solutions using existing Catapults.

According to the representatives of Catapult, "*Catapult is not 'siloed' and has a lot of cross-over*". This means that catapult has overcome the silo culture which is prevalent in most organisations and they have learnt to work across domains. This is possibly because they work in a networked system where information is exchanged over a wider scale. And, they are disseminating information via workshops and different showcase events and conferences such as the Imagine Festival 2016 (Transport Systems Catapult, 2016). So, it was evident from the meeting that according to the representatives of Catapult, silo culture was a problem to information sharing which was overcome by Catapult.

To show how the silo culture was overcome by Catapult, its representatives gave reference to a discussion paper on the needs and activities of a catapult system as part of a Knowledge Transfer Network – KTN (Ridely, 2011). The removal of silo is linked to the story of integration in which different organisations are

brought together to create innovation (Ridely, 2011, p. 8). The story of integration involves Catapult acting as a facilitator in bringing the organisations together by providing state of the art facilities (Ridely, 2011, p. 11). The provision of these facilities encourages organisations in the transport sector to participate. Also, it is acknowledged (as of December 2011) that minority stakeholders lack a leadership (ibid.). So, Catapult covers this gap in leadership by being the facilitator and by giving a balanced leadership to help minority stakeholders (ibid.). The major goal for Catapult as a facilitator is to ensure the sustainability of these networks and prevent breakdown of the networks. This required utilising funding to the appropriate level and providing adequate support to the stakeholders participating in the network to continue their participation and contribution (ibid).

They story of specific silos, as pointed out by the representatives (by using the document) was based on traditional divisions of the transport sector being divided into different silos of *road, rail, marine and aviation* (Ridely, 2011, p. 14). But, over a period of time organisations have started to recognise the importance of working together (ibid.). They quote about 100 organisations of different sizes (large, medium and small scale organisations) from different sectors including transport (such as marine, aviation, rail and road), the government, academic institutions (universities), professional bodies (chartered associations etc.), trade bodies (such as chambers of commerce), who have all joined hands to *develop holistic thinking* (Ridely, 2011, p. 14). This holistic thinking involves exchanging information via exchanging people, for example, by placing people into different sectors on deputation. The deputation is also called as *secondment* (p.14) and it creates a diverse set of skilled people which are accessible which normally organisations would not be able to access. Thus, the placement of people adds to the existing skills set in the organisation and enhances their knowledge base and exposure. This seems to resemble the idea that diversity drives innovation and exchange of people in different sectors (*cross-sector placements*) is an enabler of information sharing which catapults innovation.

According to the representatives, the basic idea behind the success of Catapult is the *use of existing assets* and building up on existing knowledge to create

innovative knowledge. The concept of *here and now* is helping the company to success and the use of commodity of the shelf (COTS) products is helping to working with limited budgets or low finance and work more efficiently as time or money is spent on development of expensive technology. So, in simple words the way to success is *recycle and reuse* existing assets. But, the representatives still acknowledged that the uptake by the different stakeholders that is the change is still slow.

One of the benefits of collaborative participation with recycling and reuse of assets is the breakdown of silos, specifically called the *pan transport silos* (Ridely, 2011, p. 15). Catapult claims this breakdown to happen in the first few years (0-5year period) of the start of collaboration. So, it is evident from Catapult's case study the collaboration is an enabler of information sharing which is an enabler for the breakdown of silo culture.

Catapult has generated a list of consequences for non-collaboration (Ridely, 2011, p. 16) in which it is mentioned how the lack of collaboration via a facilitator like Catapult or its facilities would lead to standards that would act as barriers to businesses. So, it is evident that barriers to business may be standards that have been developed in isolation (i.e. without any collaboration).

During the meeting there was mention and promotion of using satellites for the purpose of developing resilience of ports. This meant to use the existing system of satellites and then create inexpensive user interfaces that would help in communication or enhancing the sharing of information. Specifically, the Iridium group of satellites (which is a collection of existing satellites in space that underused) would be used so no new satellites need to be launched (Iridium, 2016). This would be useful for the purposes of transport infrastructure, operations and security. The Transport Security policy team (TST, 2016) is actively collaborating with Catapult. This means that new technology is being developed for new uses or purposes by using existing infrastructure. However, while using the existing system, there are unanswered questions about the confidentiality of data while sharing information. So, on one hand existing infrastructure and data can be used using tools like data mining, but, on the other hand, sharing of data with regards to confidentiality remains a problem.

However, the advantages of using satellites with relatively lower costs for resilience were pointed out as outweighing the problems. These advantages included a breakthrough from the constraints of geography as satellites provide a remotely controlled perspective view and this allows end users to get more accurate data for their models and simulations leading to better predictions. The use of satellites may be beneficial while determining the inter-operability of ports as different operations including shipping lines, their cargo and handling requirements, weather patterns, berth availability, speed, distance, and many other parameters can easily be calculated and transmitted remotely. The satellites also provide the ability to create redundant systems where data may be stored at remote locations and transferred via satellites. They would also help in creating distributed systems which would reduce the burden on one particular system and increase efficiency leading to an enhancement of resilience.

On being questioned about the applicability and experience of the success with data sharing, the representatives from Catapult pointed in the direction of '*ResilienceDirect'* - a common information platform (Ordnance Survey, 2016a). ResilienceDirect is considered an important tool for ministers and is evidence of the success of a collaborative relationship between the Civil Contingencies Secretariat (CCS) and its partners (Oliver Letwin, MP, Minister for Government Policy, quoted in Ordnance Survey, 2016a). This tool is based on location data which is made available from the Public Sector Mapping Agreement (PSMA) and the tool is considered as secure and fully accredited to be used by emergency responders (ibid.). The tool helps in dealing with various types of disruptions and crises including natural and human. The *main advantages* of the tools are in overcoming challenges that are imposed by *coordinating responses and recovery, sharing information effectively and cutting across the different domains of processes and technologies that prevent information for being transferred* effectively (Ordnance Survey, 2016a). It is *free to use¸* and provides accurate location based (map) data, it is easy use as data is compatible on any device (as there are not digital certificates required so no technological barriers), it is also easy to use because the interface is claimed to be user friendly. The most important financial advantage is that it saves costs and it has saved about £760,000 (ibid.). *ResilienceDirect* claims (Ordnance Survey, 2016a) that it is the first time that real time information is available to responders (on a mobile or

laptop or on desktop computer) during a crisis or diruption is taking place and this data can integrate with any other third party datasets which can help in generating more accurate decisions and actions. Examples of successful case studies are given (Ordnance Survey, 2016b) from the Olympic Games 2012 in London. In the case study it is shown how map based data or location based data with GIS coordiantes (precise location obtained using geographical based information system) was used in real time for responding to crises.

According to Terry Howell, CEO of Myriad Optima Limited, "u*sing the mapping datasets available under the PSMA and GIS technology enabled significant cost reductions over traditional operating methods delivering approximately 145% return on investment over the 72 days of the Games operation alone*" (Ordnance Survey, 2016b). This high return on investment was a result of the advantage of using the Ordnance Survey data which was available for free for the public bodies that were members of PSMA and eligible for accessing data under the collaborative agreement (ibid.). With the use of technology such as *OS Master Map*, intelligence was developed with precise data in real time to respond to emergency events at the Olympic Games. A two way communication was made possible use voice based and text enabled modes of communication between the different operators (ibid.). The technology also allowed analysis to be conducted in both directions that is retrospectively by looking back at the events and looking forward that means predicting for the future (ibid.). It is suggested on the Ordnance Suvey website (Ordnance Survey, 2016b) that the system developed for the London 2012 Olympic games could be reused for other purposes requiring real time assimilation of information and decision making with the ability to capture data and carry out analysis using various kinds of maps (ibid.).

A quotation by Paul Netherton, ACC, Devon and Cornwall Policy (quoted in (Ordnance Survey, 2016a) states that "*ResilienceDirect has transformed the way that* ***local resilience forums*** *share work and good practice, dramatically improving information-flow, which is so critical in a major incident*". So, it is evident that ResilienceDirect is a tool which is enabler for information sharing.

In summary, a collaborative environment is better for information sharing and resilience. This was highlighted in the meeting with Catapult who acknowledged a collaborative environment as being useful for bringing out new ways or approaches leading to new developments i.e. leading towards creation of innovative technology. The innovation is being driven by collaboration between a diverse group of individuals, organisations from across different sectors including government, public, private, academic, professional bodies etc. These collaborations are bridging the gap of skills by placing people in different sectors and enhancing the skill set and knowledge base via knowledge transfer network (KTNs). And, it is through these networks that new products and solutions are driving businesses while attracting funding from different sources. This model has been promoted to the Department of Transport (DfT) as being useful for resilience particularly with the use of satellites. The advantages are that existing infrastructure, commodity of the shelf (COTS) products are being used thus saving costs and increasing efficiency. The disadvantages are that it is a slow process of change and difficult to convince people and make them aware of the different advantages of joining a knowledge network. Also, there are unanswered questions about what are the financial incentives for the companies participating in such networks. For example, if a product has been developed in collaboration (by exchanging people or skills) then how are the profits supposed to be shared and how are the agreements supposed to be met? This aspect of profit sharing and agreement building needs to be researched more intensely. However, at this stage it is evident that a collaborative environment appears to be conducive for the exchange of information and resilience in general.

### 6.3 Findings from participating in a meeting between DfT and Inoni Ltd.

The researcher participated in a meeting and observed the conversation between Department of Transport (DfT) and Inoni Ltd. on 26th April 2016 at the premises of DfT in London between 2pm and 4pm. There was one representative from Inoni Ltd. (the Managing Director), hereafter referred to as Inoni and a Policy Manager from DfT.

Inoni gave a brief outline of the work they were doing in regards to resilience and claimed to have a 'heads up' on business continuity planning and resilience of business in general. They presented a case study of the work they have done

with the Port of Immingham in the UK. Their work was a result of the failure of the Port of Immingham due to the largest tidal surge faced in 60 years which was seen in December 2013. According to the Managing Director of Inoni, the Port of Immingham is strategically important as it feeds the supply chain of the UK economy including acting as a gateway for the energy supplies (for example coal and biogas for the power stations). Because of the tidal surge, the entire port was flooded and the operations were suspended due to which the energy supply was cut off which threatened the entire supply chain of the UK. The Port of Immingham is also considered to be the largest in the UK based on tonnage of cargo being handled and the busiest in the UK. This made it very important for addressing the future of the operations as resilient as possible. An audit was conducted by KPMG for the Port of Immingham and it was found the port is strategically very important serving important functions for the UK economy. There were flaws found in the business continuity plans and emergency response measures which were lacking in detail and not considered appropriate to ensure the resilience of business operations. After the Audit report was generated by KPMG, a high level board discussion was conducted with the Associated British Ports (ABP), the group which owns the Port of Immingham, and the head of IT at ABP suggested that work be would be carried out with Inoni, given their previous successful experience in resilience. So, for the resilience work, Inoni was hired to work with the Port of Immingham based on the recommendation of ABP's head of IT. Another reason for hiring Inoni was their previous experience of creating a collaborative environment in which learning and planning is done in a collegial level by transferring knowledge between peers rather than in a hierarchical manner. A collaborative model was thus acknowledged as a method to enhance the business continuity or resilience. The collaborative model included understanding the significance of crisis management and then moving to understanding the impact analysis. These were coupled with regional plans and functions in order to deal with energy crisis and capturing the responses to contain the crises.

A mapping behaviour pattern was employed by Inoni in which the behaviour pattern of various roles was captured, i.e. roles which were considered important to respond to different crises. This involved creating role cards in which information was presented in an abstracted format. This meant giving out

information which was purposeful and precise to deal with the specific crises in a specific manner. So, employees could carry out the role mentioned in the role card with minimal training. For this a checklist was created with the associated behaviours which were the responsibilities of the person associated with the role card. In this manner behaviour patterns were established and documented. Inoni acknowledged that resilience may be a new term but is an old concept in terms of behaviour patterns.

Frequent examples were given around the loss of energy or power to explain the implementation of the business continuity plans and their importance. These explanations were associated with a two way process of local agencies dealing with risks in a corporate risk management style.

Resilience was quantified and measured in terms of resistance, sensitivity, return on investment and recovery. And resilience is considered the average resistance, return on investment and recovery. A service level model was generated and the lead and lag times were calculated for each process, leading to the capability and maturity model being developed for resilience. The advantage of this kind of model was the short time to implement and take actions. And, follow up could be done via workshops that could be conducted using online tools such as Webex that provided the capability of the running a presentation (just like a normal classroom presentation), with voice over the internet (VoIP). So, this means that the follow up workshops could be carried out remotely i.e. geographical distance did not matter. The consideration of resilience as an average on one hand seems to be quantitative and logical. However, the problems with average is their sensitivity to outliers and or missing data acting as outliers or unclean data (noisy or wrong data) acting as outliers. And, average is deeply affected by outliers (Agresti & Finlay, 2014, p. 44). So, this could result in skewed data (i.e. leaning towards a particular direction) which could raise doubts about the validity of the analysis.

Inoni claimed to have developed a software which acts as an information capturing and sharing tool. This software can be used to identify the silos in the company and that this is useful for business continuity planning. But, to identify silos by using the software is difficult because according to the Managing

Director of Inoni "*You need a terrier to get the information".* This meant that it is easy to get the software but it is more difficult to get the information to populate the software and use it to make the right kind of analysis. So, the big question is whether the software can achieve the resilience? And if information is important for the software, then what is the reliability of the software being secure? These questions need to be answered with more research into the reliability and validity of the software being tested for the data of ports.

During the meeting, Inoni tried to demonstrate the software but it crashed due to unexplained technical reasons. This raised questions about the reliability of the software, however, that is for the end user to decipher and determine after localised testing of the software (which follows the general software development lifecycle). When asked questions about the redundancy of the system (i.e. what are backup options?), Inoni replied that the system has only three backups with data from previous two months being backed up. The alarming acknowledgement was that the system is still prone to virus attacks (like any other system) and that there is no way around it. A question which occurs at this point is if ABP is dependent on a software system and if a terrorist organisation hacks the system then will the resiliency fail? This question was not answered and needs to be researched more in detail.

When asked about the methodology of Inoni's resilience model, the answer was that the methodology has been taken from Operational Resilience using CERT resilience model of the Carnegie Mellon University (USA) (Carnegie Mellon University, 2010). The templates, available on the website of the CERT resilience model (ibid.), resembled Inoni's software interface and the diagrams and concepts used to draw the plans also shared appearance. Reference was also given to a website called *Continuitycentral* (ContinuityCentral.com, 2016) that talked about business continuity, enterprise risk and resilience. One of the articles (Clark, 2016) on the website talked about the over-optimistic perspective of business continuity plan and the dependence on the task force being available in the time of crisis. This raised a question whether the role cards which Inoni was suggesting were reliable because as specific names were linked to different role cards, it is questionable whether those people will be available in the time of crises.

In defence of its software, Inoni claimed to represent the software in the shape of a sphere where the core is always protected and only the surface of the sphere takes the impacts. This represents a UNIX type of computer system where the core is always protected.

Silos, according to Inoni, were identified by showing mind maps of the entire business. Inoni showed a gigantic paper based diagram which was hand drawn and it claimed to have taken the shape after its discussion with the head of IT services of ABP.

There are several drivers of resilience according to the Inoni and these included awareness of threats and the consequences on the business operations; the negative consequences of the price of insurance premiums increasing which meant that the budgets would be affected. Resilience could be driven by a personal appetite for ensuring that operations run. Resilience could be enforced upon by the Government with new laws that would force compliance and hence make the uptake of resilience efforts mandatory for businesses.

Inoni, however, agreed that awareness about resilience and its adoption could also be achieved by small scale, inexpensive tools which are supplemented by workshops. This meant that the basic aim is to increase communication by collaboration in identifying the threats, drafting the appropriate actions and then disseminating this information possibly via workshops that would ensure a homogenous understanding irrespective of background or education or prior training. This seems to be related to the other two meetings with the Flood Group and Catapult (both considered above) in which workshops were highlighted as being important for raising awareness about resilience, sharing information and moving forward in the direction of a systematic resilience.

According to Inoni, resilience is interconnected with flexible infrastructure (which includes things like buildings, machines, berths, cranes, wires, pumps etc.) and human resilience along with seeing the bigger picture, all based on sharing information. This is diagrammatically shown below.

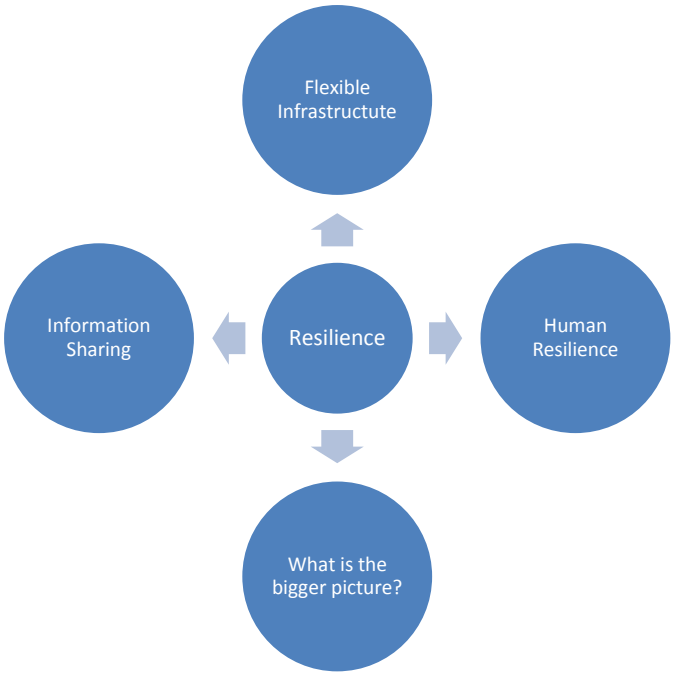



**Figure 11 Resilience as depicted by Inoni Ltd.**

Source: Diagram self-drawn by researcher based on field notes

As of April 2016, Inoni claimed to be focussing on doing case studies with 8 ports in the UK all of which are ABP ports. All these ports are big ports (in terms of volume of cargo being handled) including Immingham, Southampton, Felixstowe, Dover etc. The discussion revealed that at the national level there is a need to find out about the tolerance level and the challenge is to find out the maximum tolerable period of disruption (MTPD or MTPOD). The stating point is information gathering about ports, what they have in terms of existing assets and what are the issues, the proceeding on to predictive models and using the findings to plan for eventualities. For planning, a common platform is being created where stakeholders are involved to identifying risks and measuring the risks. But the challenge is to make the stakeholders comfortable and trust each other. Inoni's focus is shown in the diagram below:

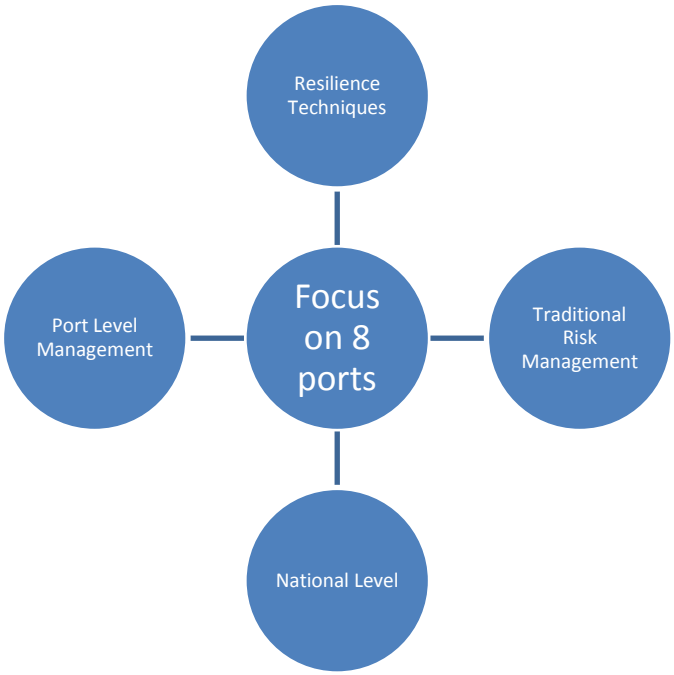



Figure 12 Inoni Ltd's focus in the UK

Source: Diagram self-drawn by researcher based on field notes

## 6.4 Findings from participating in meeting with Researcher from University College London (UCL) and DfT

In a meeting with researcher from University College London (UCL) working on port resilience and the DfT at University of Nottingham on 6th May 2016 from 9:30 to 10:45am, there was discussion around a perspective on what is the bigger picture of the problem of resilience. It was shown by the researcher from the UCL that according to their findings, the diagram looks like a group of concentric circles representing different levels of organisations involved in the Maritime or Ports sector (see diagram below).

Discussing the diagram (diagram shown below): at the core (Level 0) is the actual port and its operator (an example being the port of Southampton, Immingham with consultants such as ABPMer). These are surrounded by Level 1 which involve the port operators (such as ABP group and others). Level 2 is surrounding level 1 and level 0 which includes regulators, coordinators and other stakeholders (such as the DfT, Defra, DECC etc.) This is shown in the diagram below.

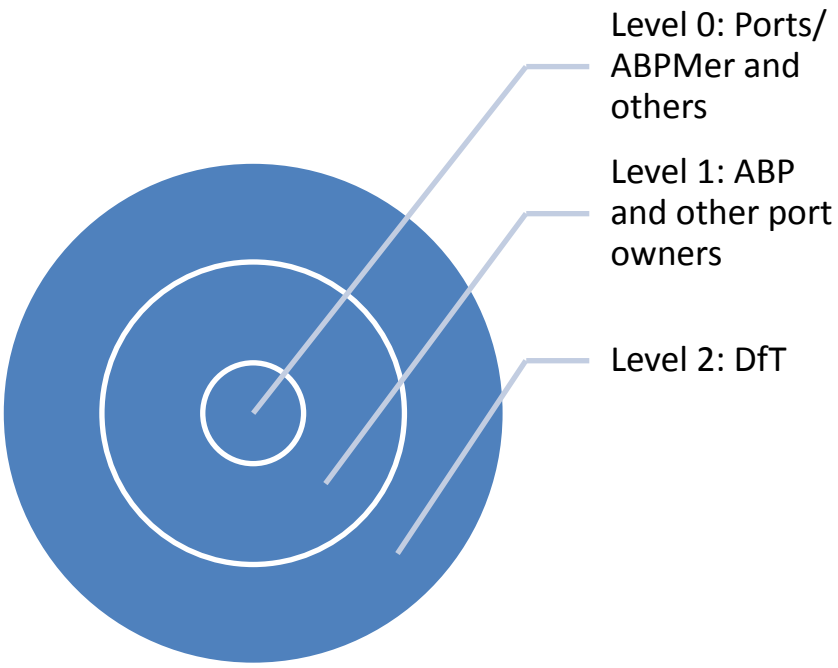



Figure 13 Third party view of levels of association of stakeholders

Source: Diagram self-drawn by researcher based on field notes

The problem according to the UCL researcher is that with different organisations involved at different levels, information may or may not be shared effectively and it has been seen that there is a problem of data protection which acts as a hindrance to sharing information. The challenge therefore is to overcome the barrier of data protection and share information that would possibly lead to better resilience. Another challenge with multiple operators and stakeholders at different levels is identifying the financial incentive or benefit for them for sharing information.

## 6.5 An Analysis of Resiliency as a project at Massport

The following is an analysis of: Massachusetts Port Authority's (Massport) resilience project which is on making the Boston Harbour resilient. As this is a project based in the USA it provides an international input to the research for the UK. The project was presented as part of a lecture (UNOLS, 2016) on implementing resilience the Green Boats and Ports for Blue Waters, between April 5-6, 2016, at the URI Graduate School of Oceanography.

The Massport's Program manager of Resilience explained during one of her presentations that it was more incumbent upon them to make things resilient because they could have more military land for search and rescue operations

when needed in times of disruptions due to climate. They looked at resiliency in different ways at Massport, by doing a lot of greening of ports and harbours (possibly as they had received a million dollars FAA grant to create a sustainability plan for Massport). But, they are focussed on how to address the impacts. They define resiliency as a system to withstand a major event with an acceptable period of time while creating a balance between the costs of hardening versus the risk. Their formal definition is "*the ability of a system to prepare for disruptive events, recover within a reasonable timeframe with minimal damage, and sometimes emerge even stronger"* (Massport, 2016a).

According to Massport (Massport, 2016b), resiliency is associated with climate change and addressed in two ways:

**Table 7 Two ways of Resiliency at Massport**

Source: (Massport, 2016b)

| Two ways of Resiliency at Massport (USA) | |
|---|---|
| Addressing Impact | Reducing Impact through Sustainability |
| Hardening critical infrastructure, retrofitting existing facilities | Green House Gas (GHG) reduction – Leading by example |
| Providing redundant facilities | Sustainability Management Plan |
| Incorporating resiliency into new projects | Sustainable Design Guidelines |
| Workforce Cross Training | MEPA/NEPA compliance and project mitigation |
| | Collaboration with agencies and institutions |

Their process was for six months in which they defined their goals (Massport, 2016c). Their goals included engaging stakeholders within Massport (i.e. intra network) authority as well as the neighbours and those businesses that relied on Massport (i.e. inter-network). A task force was put together for all of their facilities. And, then a focus group was created that looked at the threats and the impact on facilities and what kind of responses i.e. what they were going to do about it. They defined a process called '*Ferra'* in association with the US Department of Homeland Security. They claim that the flow of tasks, within the

process, is based on common logical sense but they acknowledge that to identify the threats is time consuming. This means the process of finding which facilities could be damaged and the extent of damage is time consuming. The Massport project claims that every facility operator they spoke to claimed that their facility was most important and should be given priority. So, this became a topic of subjective nature where interpretations of different operators led to different priorities. The task of finding out the extent of damage is also subjected to the tight budgetary controls as the narrow amount of money meant to narrow down what is most important to be protected and why. This is the main challenge of getting consensus on what is to be protected within a limited budget.

They divided the threats into natural (resulting due to acts of nature), technological (resulting from failures of structures and systems) and human-caused threats (resulting from international actions of one or more adversaries). Out of these, Massport project claims that human-caused threats are looked in more detail by corporate security and emergency preparedness departments in the USA. This is because these departments were created and given more power after the terrible event of 9/11 in New York City. For example, the Technology department was given $300,000 to look at their redundancies and they reported saying they did not have a lot so then later more million dollars were given to co-locate a facility away from the point of threat which gave them more redundancy (i.e. duplication of systems that would kick-on in the case of a failure) (UNOLS, 2016).

Natural disasters have been emphasised in Massport's resilience program. Massport self-proclaimed *silos of excellence* work against natural disasters. The silos include 'utilities', 'fuel systems', 'transportation', 'human capital' and what they were going to do with their buildings in case of natural disasters. Massport's resilience programme is based under the department of capital programmes and that is the source of Massport's project funding. With emphasis on natural disasters, Massport's *top priorities* include *the protection of buildings*. So, they utilised probability to look at the natural causes that had the highest probability of occurring and also had the largest predicted impact. They identified that, in the US, *storms* have the highest probability of occurrence and have the highest impacts (UNOLS, 2016).

Massport utilised external consultants to develop programmes including the *Disaster Infrastructure Resilience Planning (DIRP)* at a cost of half a million dollars along with the goal of understanding Massport's vulnerability to climate and development of short term and long term strategies for resilience. A climate study was conducted for the local area of Boston (including Logan and its airport) and they looked at the data for the last 150 years (from 1853 until 2013) to identify the occurrence of hurricanes (storms) and their individual category (i.e. the strength and intensity of storms). They also looked at the time and situations when the storms hit i.e. what were the tide levels, the sea level rise projections. These data were correlated with the data predictions from National Oceanic and Atmospheric Administration (NOAA, 2016) and Intergovernmental Panel on Climate Change (IPCC, 2016) and they identified which facilities would be flooded in the event of a category 2 storm (lower strength) and category 3 storm (higher strength). Massport found that all facilities would be flooded in case of a category 3 storm. Also, they found that with predictions from climate change by NOAA and IPCC, there are more chances of hits by category 3 and higher intensity storms. So, the probability of facilities being flooded is increasing with increasing time (UNOLS, 2016). This is depicted in the figure below:

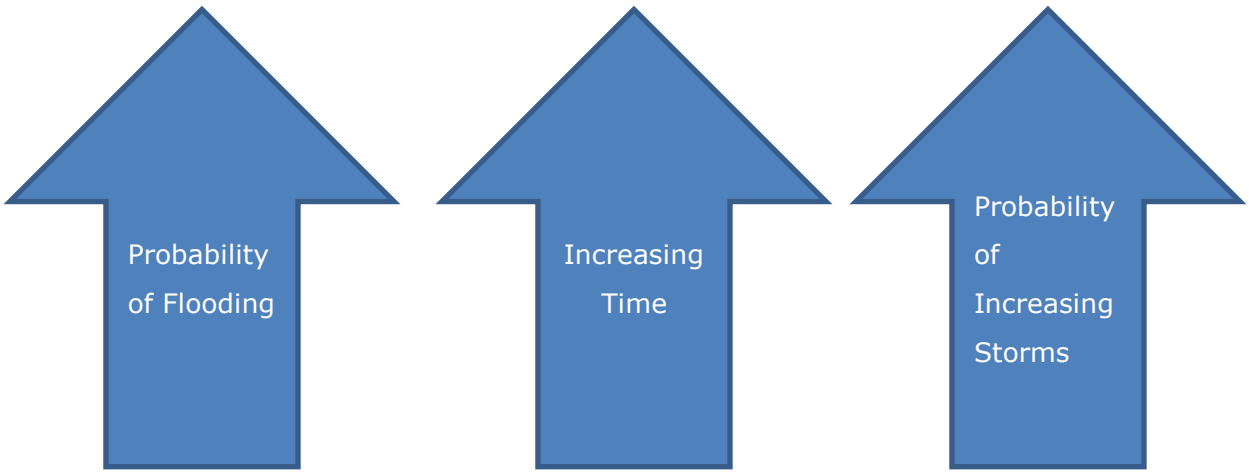



**Figure 14 Direct proportionality between intensity of storms, time and flooding.**
Source: Self-Drawn by author based on lecture (UNOLS, 2016)

But, instead of basing all their engineering and architecture on the above model, Massport decided to use another modelling which was more probabilistic in

comparison (UNOLS, 2016). This was because of a higher resolution with data based on every 15 meters predicting the occurrence and eventuality of a storm hitting. This new modelling was a result of grants and advice from the US Department for Transportation to do a different kind of research based on modelling which is more probabilistic with higher resolution and probability (i.e. high prediction and accuracy).

Detail of every facility that was to be protected was given to the modellers and was taken into consideration. This was the method of higher probabilistic accuracy. They also claim to have done a flood risk model for 2030 and for 2070 which produced probabilistic elevation estimations for flood prevention constructions for the future. The probabilistic model also helped in creating new guidelines which were incorporated as mandatory and to be used by architects, engineers and other tenants of the lands owned by the port authority. So, any external user (for example an outsourced company or a third party) who builds on the port authority's property has to then follow their guidelines. (UNOLS, 2016)

With the new design principles one key measure taken into consideration is that all the life line systems have been put on higher floors to prevent from being affected by flooding. Further, all the tenants at the port meet on a regular basis at various project stages with the Project Manager on a conceptual level, 30% completion, 60% completion and final submission stages of their respective projects. And, these regular meetings ensure that resilience guidelines are being followed and implemented in the correct manner (UNOLS, 2016).

Massport claims that definitions are important (UNOLS, 2016), for example, Critical Facilities are defined as by the ability for the military to land, their top priority, and by the ability of the port to get back to recovering followed by getting back to business as usual. For example, a terminal is considered as a low priority as they would not be open for business. They would not have recovered as the military would not have completed their task of recovery (ibid.).

They do a risk based prioritization in which the probability of flood is first considered followed by the consequences of that flooding and lastly by the depth. For example, if there was an important asset which was flooded by only

4inches then the response would be different to if the flooding was 4feet. So, a list of assets was produced with the assets belonging to different tiers. This was based on probabilistic modelling and its criticality score. Then the investments were prioritised with the amount it would cost to make the assets hardened (i.e. resilient). For example, the fish pier at Boston was considered for flooding and probabilistic flood lines were drawn by consultants to indicate where the water would come from. This helped in decision making as another offer of converting the fish pier into offices was abandoned after seeing the danger of flooding. This process of flood risk modelling was continued for all their fish pier facilities and it was decided that the flooding would be allowed up till the first floor (in the model). The amount of investment was also calculated with an estimation of the cost of resilience of piers (UNOLS, 2016).

Massport's other example of making 'things' resilient is that of Conley Terminal (a terminal in the port of Boston) which followed a similar process of using a probability model to estimate the extent of damage and the cost of resilience. By looking at the berthing terminal, machinery such as cranes was also considered apart from buildings. While considering cranes things like electrical supplies and mechanical systems were considered for being water tight or flood proof. So, in summary both the capital improvements and operational improvements were considered (UNOLS, 2016).

Operationally, to cover the time gap between the conceptual phase and the completion of permanent hardening, temporary measures of resilience (hardening) were put in place to minimise damage. A student project at North Eastern University identified 47 different types of barriers out of which one barrier was chosen and invested upon. The barrier was called 'aquafence' and it helped protect buildings and involved sealing electrical conduits, installing water level sensors, purchasing temporary water pumps and installing ground anchors for the aquafence. An example of barriers in places with high wave action, pavement anchors would be installed for keeping things in place (UNOLS, 2016).

While creating plans for resilience, Massport, (UNOLS, 2016) considered safety as the first concern followed by minimising the disruption and maximising speedy recovery. There are documents which are 87 pages long addressing pre

flood and during flood and post flood periods. Documentation is considered as very important to understand and implement the procedures in case of disruption. Specific plans are drawn with clear specification of facility, the responsible department and the actions that needs to be taken in a case of disruption. These documents are adaptive in the sense that they would be changed every year indicating that resilience may be an ongoing process.

Input for resilience planning was also taken from the Massachusetts Emergency Management Agency (MEMA). This was achieved by participatory workshops, (action research) which were all day events, where questions were asked about what they would do in different situations. By showing the flood models and flood operation plans things were put on the drawing board. And then suggestions were taken about missing data, missing situations and missing eventualities and wrong interpretations or wrong understanding and calculations. Flood forecasting reports were generated and simulations were carried out and these were considerably accurate. For example, a simulation drawn on September 29 was carried out with a dummy hurricane which matched the path of the actual hurricane which hit on 1st October. Luckily the intensity of the hurricane was not high, but Massport claim that they were ready. But, Massport also acknowledge that the time to act may be considerably short even with an accurate prediction of the path of a hurricane (UNOLS, 2016).

The programme manager attributed the success of the resilience project to a strong political will, a good amount of resources (finance included) (UNOLS, 2016). The Massport is quite lucky because they have the freedom to do what they want in their facilities with their strategic plans which is summarized in the table below (taken from Massport's website (Massport, 2016d)). The table shows the sample activities and the anticipated outcomes as determined by the Massport Project and it is classified in different categories.

**Table 8 Massport's strategies for resilience (Massport, 2016d)**

| Massport's Resiliency Program Strategies (Massport, 2016d) | | |
|---|---|---|
| | **Sample Activities** | **Anticipated Outcomes** |
| **Strategic Convening** | 1. Engage in Massport | 1. Key decision-makers' |

| | | |
|---|---|---|
| | Strategic Planning focussing on resiliency<br>2. Create a Task Force of partnering agencies with common goals<br>3. Sit on external committees at federal, state, and local level | understanding s of threats and resiliency mechanisms are strengthened<br>2. Effectively share knowledge and collaborative planning<br>3. A more resilient MPA and region |
| **Research and Planning** | 4. Climate "Disaster and infrastructure Resilience Plan"<br>5. Analyse resilience capacity for other threats (i.e. earthquakes)<br>6. Design guidelines for future construction | 4. Informed decision-making<br>5. A balanced composite cost and risk plan<br>6. Guidelines and standards integrated into best management practices |
| **Design Resiliently** | 7. Execute infrastructure-specific designs and specifications<br>8. Implement standards for existing assets<br>9. Issue RFP's for design and development | 7. Existing facilities are hardened for intense storm events, sea-level rise, and other unplanned events<br>8. Resilient construction is incorporated into all MPA assets |
| **Education and Training** | 10. Provide education and tools for staff, consultants, contractors, and key stakeholders<br>11. Present lessons | 9. Staff, stakeholders, and future leaders informed about preparedness and resiliency<br>10. Replicable models of |

| | | |
|---|---|---|
| | learned at conferences<br>12. Create accessible resources such as library, website, etc. | research and design excellence |
| **Operational Preparedness** | 13. Develop ground transportation plan for staff to reach work during disruptive events<br>14. Update the continuity of operations plan<br>15. Update the IT data recovery plan | 11. Cross-cutting operation training for resilience<br>12. Less disruption, quicker recovery after an emergency or disaster<br>13. Adequate funding in budget for resiliency |

In summary of the above case study of Massport, *resilience* which is referred to *resiliency* by Massport, *can be understood in relation to the hardening of existing facilities to have the ability to bounce back to a state of normalcy post a disruption*. But, this is limited to storms and hurricanes and flooding at the Boston harbour which is shared by the Massachusetts port and Logan airport (Massport, 2016a).

## 6.6 How does Resiliency work in the UK?

In the UK, flooding is being given a major focus following several cases of flooding in recent years. One of the strongest cases for learning port resilience is the port of Immingham which was flooded in December 2013 (Grimsby Telegraph, 2014). The flooding was due to a tidal wave which entered the narrow estuary of Humber. The estuary is considered as one of the busiest commercial shipping waterways in the UK and due to the flooding it was badly affected. The flood effect is considered bad because the power to the port was lost, with the power sub-stations being affected by the water and this negatively affected the terminal activities. As this port is a major handler of coal which feeds into one of the major coal fired power stations (Drax), the supply of electricity to the UK's national grid was at risk. Another impact of the flooding was the stoppage of terminal activities as the warehouses were flooded so cargo

and cargo operations were affected along with the shipping trade. The flood affected the operation for about three days but luckily there was no reported loss of life (Grimsby Telegraph, 2014).

As a result of the above flooding at Immingham, it was predicted that there would be more investment for flood resilience in the UK (Grimsby Telegraph, 2014).

It is acknowledged by the Humber Port Director (Grimsby Telegraph, 2014) that an engagement with the Environmental Agency (EA) and the Department of Transport (DfT) has led to the acknowledgement that the Port of Immingham and places like it are important for the UK economy and should be protected in other words made resilient. But, there are negatives where the acknowledgement for positive work to mitigate disaster is not done. For example, a thank you card was delayed to the Port of Grimsby where the docks were lowered which prevented the water from flooding major ports. This work was highly commendable but the acknowledgement was delayed. This means that the motivation for positive work may be affected by the delay in acknowledgement by the political or government agencies.

The tidal surge flooding at Immingham could be considered as a trigger for the thought of Resilience of ports in the UK. This is also acknowledged by Grainger & Achuthan (2014).

## 6.7 Findings from Conferences in the UK

Generally it is seen that papers or ideas or concepts being presented or talked about at conferences give an indication of the latest developments in a field (UACES, 2016; Inc., 2013). With this idea conferences were searched to give an indication of the latest discussion and from the point of view resilience, a conference is being held, titled *Flood & Coast 2017, Risk Resilience & Response in a Changing Climate*, at Telford UK between 28-30 March 2017 convened by the Environment Agency (EA). The topics of interest include developments on floods and coasts, emergency planning, response and it is interesting to note that the topics on infrastructure resilience are related with community resilience which indicates a strong focus on community in the UK.

## 6.8 Findings from a specific case of containerisation

Containerization is highlighted as an important mode of transportation for world trade by (Lee & Song, 2016) (Levinson, 2006).

Planning issues in maritime container transportation include competition and cooperation, pricing and contracting, network design and routing, ship scheduling and slow steaming, empty container repositioning and safety and disruption management. For example, the Bill of Lading is still printed on paper (Lee & Song, 2016, p. 2). But, is this a problematic process in the event of a natural disaster and in terms of transferability? The issues highlighted appear problematic as they affect each other and hence have to be considered in combination with each other – complex problem of simultaneously considering issues together.

Alliances do exist in the shipping world as indicated in the literature and these are considered as important and popular. But, this is a contradictory statement when considering resilience of trade through sea ports. Because, *if alliances are so popular and implemented on a large scale, then why is there a question on resilience and determining capacity transferability? Why have alliances not provided the necessary and sufficient conditions for overcoming barriers to communications among stakeholders?* A possible answer is provided via economics by blaming the world economic downturn since 2008 leading to an overcapacity in transport services (Lee & Song, 2016, p. 2). This could be an interesting observation breaching the assumption that operations are enhanced by alliances.

**Is container port / terminal productivity important for port resilience?**

When considering real-time resilience, port congestion appears to be a big culprit causing 65.5% delays in schedules (Notteboom, 2006). So, is container port / terminal productivity important for port resilience? It could be if studies by (Kim & Lee, 2015); (Bierwirth & Meisel, 2010).

**Incoterms**

There was indication until the year 2013 (Fransoo & Lee, 2013) that very little academic work has been done on Incoterms which are important for establishing

trade agreements between consignor and consignee. This could be important if resilience of ports is considered from an economic perspective.

**Is Ship Scheduling important for Resilience? / The Impact of Ship Scheduling on Port Resilience**

Ship Scheduling may be considered important for resilience due to the presence of various uncertainties at ports (Lee & Song, 2016, p. 18). These include port access and terminal operations broadly covering the ship deployment, schedule design, speed selection, and dynamic routing and scheduling (Lee & Song, 2016, p. 17). All these are important factors for planning resilience of ports particularly in terms of natural disasters. Quantitative studies indicate the development of new scheduling algorithms however these are limited to liners.

But, what is not clear with scheduling algorithms is their standardisation and implementation in a standard way. This could be a potential gap in the research like all major grand challenge problems which is to identify and implement the most standard way of adopting a scheduling algorithm.

Slow steaming which is running ships at slower than intended speeds is considered to be beneficial for shipping industry by catching up on delays and improving service reliability. The question is whether service reliability is the same as port resilience or a sub-set or super-set of service reliability. This is because ports and ships are integrated systems and not differentiated in strategic terms. This could imply that service reliability is a concept linked with an unknown relation but an important relation. If this could be counted as a case then in case of a disruption slow steaming could be utilised to transfer the ships to alternative locations. The slow speed would buy extra time and save costs by restricting operational costs and emissions. Although the concept of the slow steaming has been operationalised since the year 2008 due to global economic recession, but the applicability of slow steaming for the purpose of port resilience has not yet been determined. This is attributed by a proposal of further research by Lee & Song (2016, p. 21) on "how to spread the benefits along the container shipping lines". This could relate to disseminating information and getting an agreement on spreading the benefits of slow steaming. The interesting phenomena is that even with big alliances in the

shipping world, the suggestion for further research for a eight year old concept of slow steaming is stuck in a silo. Is this a result of communication gap between stakeholders?

**Lack of support from Historical Data**

Most of the studies in the literature show only models without the lack of historical studies. For example, Bayesian models are implemented and simulations based on probabilistic methods are applied to predict disruptions and their consequences; port capacity and scheduling; speed optimizations among other supply chain affecting parameters. However, these are not real world data or historical data that could provide precise implications. It could be argued that some of the effects from a historical perspective are no longer applicable given the advances in technology and modern science. However, a simple concept of running a ship at slow speeds does not seem to be a new concept at least in the history of shipping. Since the time of Vasco da Gama, wind speeds have been taken advantage off to increase speeds. However, there is lack of historical data to suggest whether slowing down speeds have been utilised as a concept in relation to service reliability.

**Effect of Alliances**

Service Quality and Reliability are predicted as key issues by the mergers and acquisitions of key shipping lines and their associated alliances (Notteboom, 2004). This is attributed to the limited cooperation of members of the global alliances which are limited to shipping operations. So, most of the players are more concerned with decisions on type or size of ship or number of ships in operations, selection of ports and sequencing and scheduling of ship sailing. Alliances do not seem to consider the sharing of profit or loss, pricing, management or marketing or other functions such as executive functions (Panayides & Wiedmer, 2011). The following table which has data listed from Alphaliner lists the major alliances, their members and their market share. Although the top 10 players are involved in the alliances, it is worthy to note that cooperation is non-existent in reference to 'resilience'.

**Table 9 Alliances and market share**

Source: (Alphaliner, 2016)

| Name | Members | Market Share (%) |
|---|---|---|
| **2 M** | 1. Maersk<br>2. MSC | 27.94 % |
| **Ocean Three Alliance** | 1. CMA<br>2. CGM<br>3. CSCL<br>4. UASC | 14.65 % |
| **CKYHE** | 1. Cosco<br>2. K-Line<br>3. Yang Ming<br>4. Hanjin<br>5. Evergreen | 16.46 % |
| **G6** | 1. Hapag-Lloyd<br>2. NYK<br>3. OOCL<br>4. APL<br>5. MOL<br>6. HMM | 17.14 % |

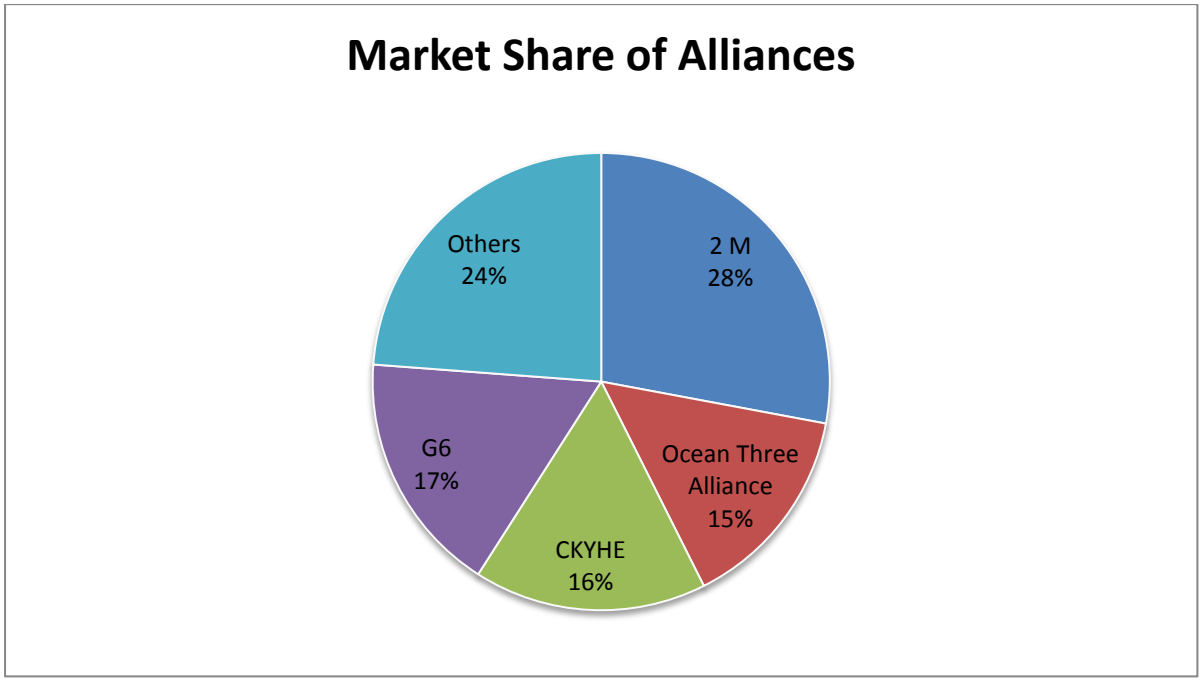



**Figure 15 Pie chart showing Market share of alliances**

Source: Self-made with data obtained from (Alphaliner, 2016)

**Table 10 New alliances**

Source: Data from (Alphaliner, 2016)

| Name | Members | Effective from |
|---|---|---|
| **Ocean Alliance** | 1. CMA<br>2. CGM<br>3. COSCO Container Lines<br>4. Evergreen<br>5. OOCL | April 2017 (Subject to Regulatory approval) |

Alliance Members are still competitors. And, if they are also the stakeholders in port operations then they are part of the resilience planning. So, it is difficult to address the competitive needs simultaneously with alliance needs. Self-interest takes over as priority defeating the purpose of alliances. This is a philosophical problem – the individual or the collective!

Considering specific cases for example of containerisation and alliances further exposed the philosophical problem of resilience. The figure below indicates the opposing nature of cooperating or operating with competitive nature of alliance members with opposing self-interests that may oppose the purpose of any alliances. This could be one of the reasons for the possibility of non-sharing of information among members of alliances. However, Port Resilience on a National Level is a collective problem where the individual interests take lesser of a priority for the benefit of a nation.

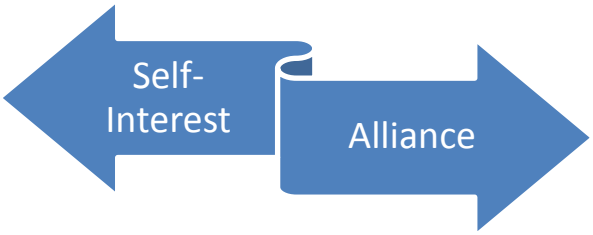



**Figure 16 Showing diverging nature of Self-Interest and Alliances**

A failure of services ultimately contributes to the failure of Port Resilience as a concept. So, it is important to show that Port Resilience is a collective problem

which needs to be addressed in a collective manner. Port Resilience is a problem that is beyond the normal self-intersts of stakeholders. So, if this is a problem then the competition between alliances will also be problematic in a cascading manner. This is shown in the following diagram:

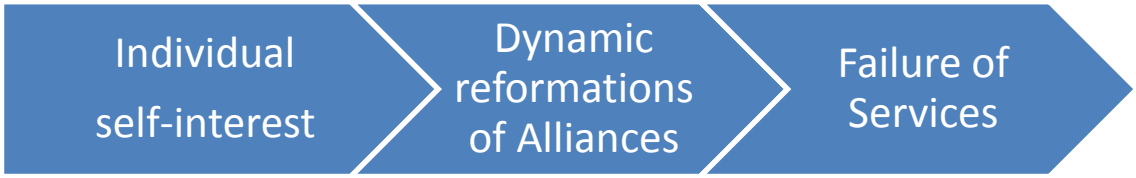



**Figure 17 Showing relationship between failure of service and self-interest**

Source: Self-drawn based on ideas from field notes

### Lack of Clarity of Vision and Mission

Alliance members may not always have a common goal which could be due to blurry vision and mission for the alliance. This could be due to complex multiple relationships between port authority's functions and other stakeholders (as depicted in the diagram below).

### Port and Terminal Competition and Cooperation

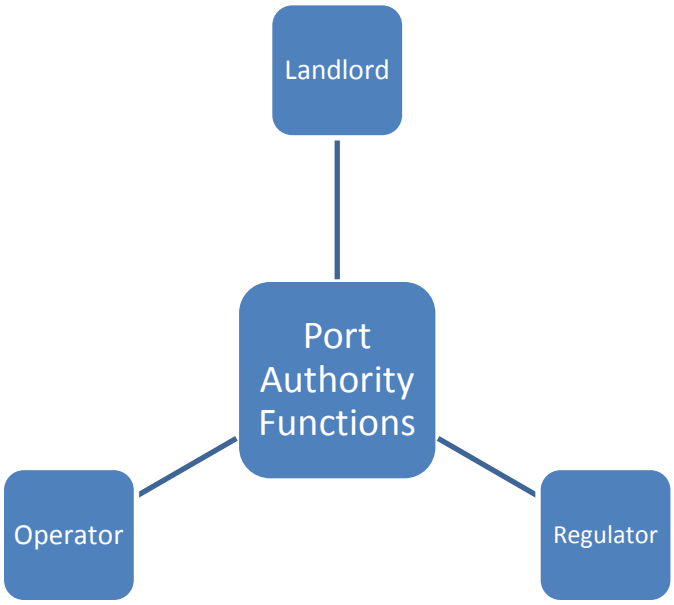



**Figure 18 Relationship of port functions**

## 6.9 Summary

In summary, some studies consider the optimizations problems in a multi-objective manner (Mansouri et al (2015), Song et al. (2015) and Wong et al. (2015) cited in Lee & Song (2016)). However, these studies use only quantitative analysis to support the production of knowledge. What is lacking is an interpretive approach where the purpose is not only to use mathematical modelling but to use the human experience to coproduce the knowledge. This coproduction of knowledge could stem from individual narratives that could be derived from samples within silos. A common pattern could then be highlighted to bridge between silos leading to awareness. This awareness could then cascade into positive developments between individual stakeholders to collectively decide on how distribute the benefits of slow steaming and scheduling. However, the complexity remains on communication which may be restricted due to competition among individual stakeholders. Confidentiality may also be coupled with competition to form a barrier to breaking these silos.

# Chapter 7 Discussion

## 7.1 Literature

In this dissertation, the literature (in Chapter 2) indicated that 'port resilience' does not have a standard definition at the moment but with on-going developments a standard definition may start to emerge in the near future. The problem of defining port resilience is further complicated by the consideration of what is a port. A holistic approach may be considered to determine the ability of the port to function as well as its wider impact on the community and the national supply chain. Various examples are cited ranging from natural disasters for example the largest tidal surge (in the last 60 years) at the port of Immingham (December 2013) to potential threats from terrorism. But, to supplement the determination of port resilience, the literature shows very limited research has been conducted.

The extant literature indicates that most of the research has been done using quantitative techniques and these have been limited in scope to determine via simulations the predictions of disruptions or their consequences. They have not tried to understand the deeper meaning of what is resilience. However, it has been acknowledged in the literature that resilience is a philosophical concept which has deeper meaning and much remains to be explored.

## 7.2 The absence of Port Resilience in everyday language indicated by Corpus Linguistics

An innovative analysis by using corpus linguistics also indicated that port resilience does not exist in common everyday language. This indicates that port resilience may not have penetrated the common conversations in the wider social context. In simple words, people are not yet talking about port resilience to the same extent as (for example) reducing carbon foot print or climate change or earthquakes or tsunamis. Corpus linguistics is based on the philosophy that the usage of words in everyday language indicates the impact of a concept. So, corpus linguistics supplements the findings from the literature review that there are slow or little developments in this field. Although the findings show that port resilience is absent from everyday language, but, in criticism, it is acknowledged that corpus linguistics analysis is preliminary at this

stage of research and is limited to global corpora of English language. It is also acknowledged that there may be hidden discourses for example discourses from the internal meetings of stakeholders or government meetings which are not yet available in the public domain. It is also acknowledged that these hidden discourses may offer a new direction in defining the wider scope of port resilience and in finding out the inner workings of the stakeholders. But, these hidden discourses are difficult to access given data protection and the extremely limited time which was available to complete this dissertation for the degree of MRes. Going beyond the justification and limitations of using corpus linguistics, the term resilience was found to be associated with a variety of fields ranging from natural sciences to social sciences and health.

## 7.3 Port Resilience has varying interpretations or lost in translation!

Resilience is lost in translation as is indicated by the Participant Observations (in Chapter 6) in meetings with DfT, its stakeholders and with other third parties (including private consultants such as Inoni Ltd. and Catapult). In Chapter 6, *findings from the field*, it was indicated that technology is helping to develop resilience of ports but this is limited to securing the buildings and infrastructure.

## 7.4 Silo culture is both an enabler and barrier to Information Sharing and Resilience

The findings also indicated that information sharing is related to the issue of resilience with companies indicating that they are trying to increase the sharing of information using software and common platforms. Information sharing's relation to resilience is also indicated by various research projects that have indicated the development of common sharing platforms (e.g. in the European Union) and the development of common language. However, problems in communications are also indicated with information sharing acting as both an enabler and a barrier to resilience. These problems may be attributed to the culture of the individual or the organisation or stakeholder and one such cultural problem is working in isolation or the silo culture. Although some companies (e.g. Catapult) claim to have overcome the problem of silo culture and there are other companies (e.g. Inoni Ltd.) that claim to have utilised silos to identify silos, this issue is problematic due to its subjective nature. It is subjective because the interpretation of a silo could be taken in a positive or negative

manner, for example, there are companies like Inoni Ltd. which claim to have silos of excellence which they are referring to as expertise or specialised streams for solving problems. However, it is the same company which finds silos in other companies using their software and this is contradictory. The contradictory nature of the manner in which silos are considered is problematic and more research needs to be conducted. In simple words, silos may be good or bad depending on which context they are being considered and this is the reason for their subjectivity. For resilience this subjectivity of silos acts as a barrier due to hindrance in information sharing.

## 7.5 Collaboration – a possible way forward?

A collaborative environment is indicated as being the way forward for achieving resilience by most of the findings from the different participatory meetings and the literature. It supplements the discussion about information sharing but also addresses the culture to some extent. This culture of collaboration also indicates a *holistic learning* culture for resilience.

## 7.6 Is a holistic approach by considering both human and material entities important?

The view of the actor (in Chapter 5), an actor being both human and material objects; could be important and considered via different relations between actors. By tracing actor movements in different networks, it may be possible to better understand how to maintain the integrity of a network. In other words, make a network more resilient. But, this relates to issues around *power and functions* which provide additional complications and may act as barriers to resilience. And, then there could be power issues as to who is dictating who? For example, at the Port of Southampton, it is the Dubai World Ports (DWP) on lease which may be following regulations, but, could they also be dictating regulations? This resembles organisational flaws identified in (Vaughan, 1990) which led to the NASA Challenger disaster.

## 7.7 Tacit knowledge, ageing workforce and physical proximity are important considerations affecting information sharing and resilience

The importance of tacit knowledge for resilience has been indicated with different literature and observations. This is based on the reasoning that

collaboration could be related to physical proximity between collaborators. So, as physical proximity increases between the collaborators, then the probability of loss of tacit knowledge also increases. This is important considering the ageing workforce in the UK and the potential danger of losing knowledge of experts as they retire.

## 7.8 Training and education lead to increased awareness and better communication

Training and education have been given importance throughout the literature and from the findings of the participant observation. Training and education is also being stressed upon by the government in the UK and there are groups dedicated to the facilitation of activities that would increase the level of training and education. Training and education also relates to the concept of the awareness and this is related to the concept of responding. Because resilience is the ability to respond to the unknown and that requires awareness which is further related to communication. This communication then cannot be considered in isolation and is related to the holistic approach. However, what was seen as a barrier to training, education and communication was delay due to personal commitments of participants. It was indicated that workshops may be delayed due to family commitments or distances.

## 7.9 Personal reflection

Reflexively, my mixed background in engineering and management, and my experience of working in many industries may have affected the analysis and discussion in this dissertation.

## 7.10 Discussion of findings based on research questions

The following sections are based on the four questions from Chapter 1 section 1.2 of this dissertation. I discuss and relate the overall findings to each of the research questions.

### 7.10.1 Research question1

*How can the UK's Maritime Transport sector and associated relevant stakeholders use information sharing to improve port resilience planning in the UK?*

My research via participant observations and interviews in Chapter 6 revealed that UK maritime ports sector is highly complex and largely privatised. The UK maritime sector and stakeholders of maritime ports in the UK could utilise information sharing for the purposes of Port Resilience planning by working towards a collaborative environment via workshops, participatory meetings, training and education. However, the participant observations also revealed that there are no standard ways of information sharing or collaborating between various private players throughout the maritime ports industry in the UK. And, there are no standard definitions for Port Resilience in the UK as was shown by the literature review in Chapter 2, using Corpus Linguistics analytics in Chapter 4 and via interviews and observations from the maritime industry in Chapter 6. Setting up workshops is also difficult because of the geographic distances and physical distances between people and resources in addition to financial constraints, family constraints and cost cutting, which affect the setting up of collaborations according to observations in Chapter 6. These findings are in-line with the findings from the literature review which had shown various purposes of using information sharing.

Interviews and observations with DfT (in Chapter 6) and third party vendors revealed that information sharing is possibly an enabler to resilience which is also associated with business process continuity among other contexts in the UK maritime transport sector. But, information sharing is affected by barriers to plan for resilience as indicated by the DfT. This is because the observations and interviews revealed that the UK Ports Sector is highly privatised which means that information sharing between competing stakeholders can be difficult due to business competition. The DfT acts as central coordinating agency for the UK ports sector and stakeholders. The DfT acknowledges that information sharing is important to plan for resilience, however, it is difficult to achieve with competing stakeholders and lack of financial incentives.

Observations at the Cabinet Office as part of the DfT team revealed that information sharing is being developed on a wider scale through developments of e-platforms such as ResilienceDirect (Chapter 6). However, these e-platforms are yet to be customised for the purposes of Port Resilience. And, more emphasis is being placed by UK Government Efforts at the moment on coastal flooding and tidal surges. There are workshops being conducted to disseminate

information about e-platforms. However, these e-platforms are in early stages of development and the DfT has to plan on how to utilise e-platforms and incorporate them for information sharing between stakeholders for Port Resilience planning. So, my research has shown that even with developing technology it is difficult to implement information sharing for achieving port resilience planning and more research is required on developing collaborations between different stakeholders in a complex and privatised sector.

### 7.10.2 Research question 2

*What are the barriers to information sharing in port resilience planning?*

There are several barriers to information sharing as shown in Chapter 2 on literature review. These barriers included technological barriers such as the lack of a common technical platform to share information in a standardized manner or non-technical and related social issues including problems in adaptability to new technology by end users. There is a long list of non-technological barriers such as silos, lack of trust, confidentiality, communication, adaptability, poor training and education, legal barriers, financial barriers, multiple contexts and definitions, etc. (listed in Chapter 2 section 2.9) that cascade from the distributed nature of maritime industry and the involvement of various stakeholders for port resilience planning as revealed from the literature review and participant observations.

Participant Observations in Chapter 6 revealed that these barriers include varying attitudes and behaviours of stakeholders with varying visions to achieve resilience due to varying definitions. The varying definitions of resilience thus acting as a barrier and the lack of Port Resilience in every day common language was supplemented by using Corpus Linguistics in Chapter 4.

Non-standardized ways of working in a largely distributed and highly privatised maritime industry with lack of understanding or misinterpreting the causes and consequences of disruptions to operations was revealed by observations at the Cabinet Office and DfT.

Observations and interviews with third party vendors indicated the distribution of operations in various specialisations and privatisation leads to the creation of silos and the silo culture acting as a barrier to information sharing; lack of

resources or limited resources; poor training; legal obligations; commercial sensitivities between competing stakeholders leading to lack of information sharing; lack of clarity in what information or data is to be shared; due to lack of meta-data. The above barriers were also found in the literature review.

The importance of considering barriers to information sharing from non-human entities as shown in Chapter 5 revealed that the definition of holistic could be a barrier to planning. And, most of the above barriers were also found to exist in the ports sector as revealed by the participant observation with the DfT, UK Cabinet Office and third party vendors.

Combining the findings from the field via participant observation and the literature review shows that there are common barriers and patterns to be found such as cultural issues, lack of proximity of people and ageing workforce which may be causing a loss of tacit knowledge. Cultural issues may include language of communication, ways of working and defining and classifying things. Ageing workforce means that senior people in the ports sector are retiring and this lack of proximity is leading to loss of tacit knowledge leading to varying visions and varying contexts of resilience, thus acting as barrier to sharing information and planning for resilience of maritime ports.

While the literature hinted that there are several cultural issues, but, participant observations and interviews further revealed that language and communication seem to be the major issues leading to either creation of a silo culture in which humans are working in a specialist area and do not interact with other specialists or the removal of a silo in which there is enhanced communication and sharing of information between all participants. So, my research has also revealed that silo culture has its own philosophical debate about being good or bad for planning. This is because the literature indicated the philosophical debate about silo culture, but, it was the interviews and observations that also suggested the silos are good and bad. For instance, while some third party companies operating in the UK ports sector are talking about removal of silos, it’s the same companies that are taking advantage of the silos (or specialist departments) to achieve their business goals. This debate about the silo culture causes confusion about barriers in general and there appear to be no straight answers as to whether the classification of a barrier will be a barrier at all for another person or

another context. My research indicates that classification of elements as barriers or enablers is difficult due to the interpretive nature of classification and understanding. However, for the purpose of this research and with discussions within the DfT, it is promoted that cultural issues and lack of physical proximity along with senior and experienced people retiring from important positions is leading to loss of information due to lack of sharing and thus affecting the resilience planning for ports.

### 7.10.3 Research question 3

*Is data privacy a barrier to information sharing and thus a barrier to port resilience planning?*

Confidentiality of data has been found as a major barrier along with the above mentioned barriers to information sharing and thus for planning of resilience as shown in the literature in Chapter 2. Confidentiality is a barrier because it prevents the flow of information between stakeholders which is essential for the purposes of planning. This is because planning for ports involves multiple stakeholders. My observations at the DfT, Port Authorities and interactions at the Cabinet Office and with other third party vendors in Chapter 6 revealed that commercial sensitivities, varying attitudes, difference in perspectives and legal obligations among others might cause individual stakeholders to class data as confidential and keep it private by not sharing it. Interviews and observations with third party vendors also revealed a lack of trust between stakeholders in the highly privatised maritime industry. Therefore, data privacy or confidentiality of data is a barrier to information sharing and thus a barrier to port resilience planning. This was indicated by the literature and confirmed via interviews and observations from within the ports industry. For example, the UK Information Commissioner's Office (ICO) as indicated in Chapter 2 considers confidentiality to be a barrier and relates it with data privacy and suggests new ways to handle data confidentiality for better information sharing. Also, participant observations and interviews with the DfT and Cabinet Office and third party vendors suggested that maritime stakeholders may not willingly share information due to commercial sensitivities as they may be competitors or the stakeholders may not share information because of lack of credit or financial incentives. Also, the cause and consequences of disruptions may be interpreted in several ways leading to data being classed as confidential and not shared as a safeguard.

However, this needs to be further confirmed in future Action Research cycles as my participant observations showed that with retiring people, new employees, new stakeholder dynamics, the opinions, definitions, overall vision and processes for planning resilience are constantly being changed. Also, with the Brexit in the UK, there are changes which are happening with new policies on data and its sharing. Again, for the purpose of this MRes dissertation it is promoted that confidentiality acts as a barrier to information and thus affecting port resilience planning, however, further research is to be conducted in future Action Research cycles to understand data privacy and its association as a barrier to planning for resilience.

### 7.10.4 Research question 4

*How to remove barriers to information sharing between stakeholders to improve port resilience planning?*

Meetings with the DfT, participant observations at their premises and at the Cabinet Office revealed that currently DfT along with stakeholders of the maritime port sector are conducting workshops and stressing on training and education to improve upon port resilience planning. There are talks to establish common standards of sharing information via technological tools such as *ResilienceDirect.* This tool would bridge the divide in a complex and highly privatised sector and enable better cooperated planning by providing a much needed common electronic platform to share information.

However, the interviews with DfT revealed that ResilienceDirect is yet to be discovered by the DfT and its stakeholders and the details about how to use it are yet to be determined. Although the establishment of common information sharing tools such as ResilienceDirect is a positive step, it is on wider central government level and not customised for Port Resilience planning. Also, the establishment of common standards is a difficult and time consuming process as indicated in the literature and observations. This means that the time frame for carrying out activities is unclear and given the unstable political status of the UK with the recent Brexit, it is yet to be determined how new policies would either be created or affect the existing operations. The literature indicated that technology solutions, simulation and modelling tools are good solutions to overcome barriers to information sharing. But, my research via observations

suggests that the current assumption in the UK maritime industry is that education, training and workshops along with the development of electronic platforms such as ResilienceDirect could act as a positive step to remove barriers to share information. However, the effectiveness and impact of the above solutions is to be determined by further observations in future Action Research cycles. Also, Corpus Linguistics in Chapter 4 has revealed varying contexts and definitions of resilience and Actor Network Theory in Chapter 5 showed that holistic solutions including non-human actors could be included for developing solutions. These complex but important revelations make it difficult to comment at this stage on the success or failure of ResilienceDirect or other e-platforms as a tool to remove barriers to information sharing for port resilience planning. Further research is to be conducted in this direction in the remainder of the PhD programme following this MRes phase within future cycles of the Action Research.

## 7.11 Discussion of methods and approaches

The main method of Action Research has been used for this dissertation as an overarching umbrella over other methods including a Literature Review, Corpus Linguistics, Interviews, Participant Observation and Document Analysis. These methods have provided the opportunity to answer the research questions by exploring to a large extent and understanding the deeper meaning of Port Resilience, Information Sharing and their relation.

### 7.11.1 Discussion about Action Research

Action Research was demanded by the project sponsors and thus was implemented as a method of choice.

But, the literature review further provided evidence that Action Research has been successfully incorporated in the area of Port Resilience for example by Arnaboldi and Spiller (2011) to understand the micro-dynamics of stakeholder collaborations. This gave further confidence to approach this research using Action Research.

Action Research was advantageous as it provided the flexibility to conduct this research with multiple inputs from the project stakeholders and proved to be mutually beneficial to the project sponsors and the research candidate. As

mentioned in the research methodology section in Chapter 3, Action Research has been used for various information systems projects and for Port Resilience particularly for stakeholder collaborations. This was beneficial to identify user requirements at the start of the project, define the scope and have tangible deliverables which could be reported, renegotiated and adapted in liaison with the stakeholders. The DfT (project sponsor), ESRC (project sponsor) and other stakeholders including Port Operators, Industry bodies, Research Institutions such UCL (London) and my research supervisors provided rich input to the development of this research project. This helped to clarify and specify the research questions to meet real world requirements that are of national importance to the UK.

But, Action Research has the disadvantage of long time durations or delays in the project or non-completion. This could be due to non-agreements or disagreements between project stakeholders causing severe delays. The impact of an Action Research may also be seen after a considerable amount of time. Since this was an MRes project dissertation which is a sub-set of a larger four year PhD programme, the Action Research method did not display any success or failure as a bench mark would be possible only after completion of this MRes phase and an actual measure against the bench mark would be possible after completion of the actual PhD programme. To overcome the potential danger of delays in the future project due to long time durations, it is suggested that continuous communication needs to be maintained between the project stakeholders in order to re-iterate the scope of the project, its ongoing findings and future progress to ensure on-time completion. This suggestion is based on findings from the literature in Chapter 2 and observations from the maritime sector in Chapter 6 on how successful projects have involved continuous communication to establish the scope, goals, directions, and overcome barriers.

### 7.11.2 Discussion about Corpus Linguistics

Corpus Linguistics was used as a research method in Chapter 4 that supplemented the literature review (Chapter 2) by confirming the new development of Port Resilience, the lack of its use in everyday language and the lack of a standard way of defining resilience. This supplementary evidence to the literature review provided reason to conduct primary research within the maritime industry with the methods of Interviews and Participant Observations

to understand the definition and context of Port Resilience in the UK. Corpus Linguistics method used different reference corpora that lists words used in everyday English vocabulary on a global level. The reference corpora are updated every day, having more than a billion words. By comparing against enormous lists of words, Corpus Linguistics helped my research by addressing the variation in language being used to define Port Resilience and Resilience in general. Although, Corpus Linguistics did not answer the research questions directly, but, it certainly showed that language and its variation is a barrier to the concept of Resilience. This variation in language was also noticed in the literature review during the participant observation and interviews mentioned in Chapter 6.

One of the advantages of Corpus Linguistics is that it utilises a mixed method approach of quantitative and qualitative approaches to first establish the scope of a word or phrase via statistical means and later approaches to find the deeper meaning by establishing the context of usage. As mentioned above, any word or phrase may be traced in global corpora, which are large texts that are regularly updated containing the most common words used in everyday language. Custom corpora may also be created for example using confidential information contained in e-mails or text messages which may provide more specific list of words not available in the public domain.

In specific cases such as this research, where variation of language may exist, Corpus Linguistics acts as a suitable method to answer research questions based on pattern analysis. This reduced the bias of the researcher while providing a triangulation of methods.

However, Corpus Linguistics has disadvantages as the method is dependent on the availability of texts which is a problem. The method is also dependent on the type, size and style of corpora which could act as a limitation on the findings. The lack of availability of texts could be due to data protection and confidentiality i.e. legal issues and commercial sensitivities. Therefore, Corpus Linguistics may not provide definite answers to the research questions. But, it provides an indication that language variation could act as a barrier to Resilience and that Port Resilience has not yet made an impact in everyday language so it is still in early stages of development.

### 7.11.3 Interviews, Document Analysis and Participant Observations

Within the umbrella of Action Research, Participant Observations and open - ended Interviews were conducted with various officials from the Department for Transport, Cabinet Office, Association of British Ports and third party vendors such as Catapult and Inoni. This was supplemented by analysing documentary information from a case study of Massport from USA.

The advantage of using Participant Observations, Interviews and Document Analysis was to gather rich information from within the maritime industry and to explore and understand the deeper meaning of how information is being shared to achieve resilience of maritime ports and identify barriers and solutions to information sharing and Port Resilience planning. These research methods provided the flexibility to explore the inner workings of the UK Government via the DfT, the Cabinet Office, third party vendors and thus explore the inner networks, requirements, assumptions and expectations; the style of communications and routine operations that support planning for the resilience of UK maritime ports.

Participant Observations helped in exploring the ideas discovered in the literature review particularly attempting to answer the research question 1 about how is information sharing being used and research question 3 on how is confidentiality acting as barrier to information sharing. These methods further supplemented the findings from the Literature and Corpus Linguistics that there are many contexts surrounding resilience and there are various definitions and assumptions by which stakeholders operate.

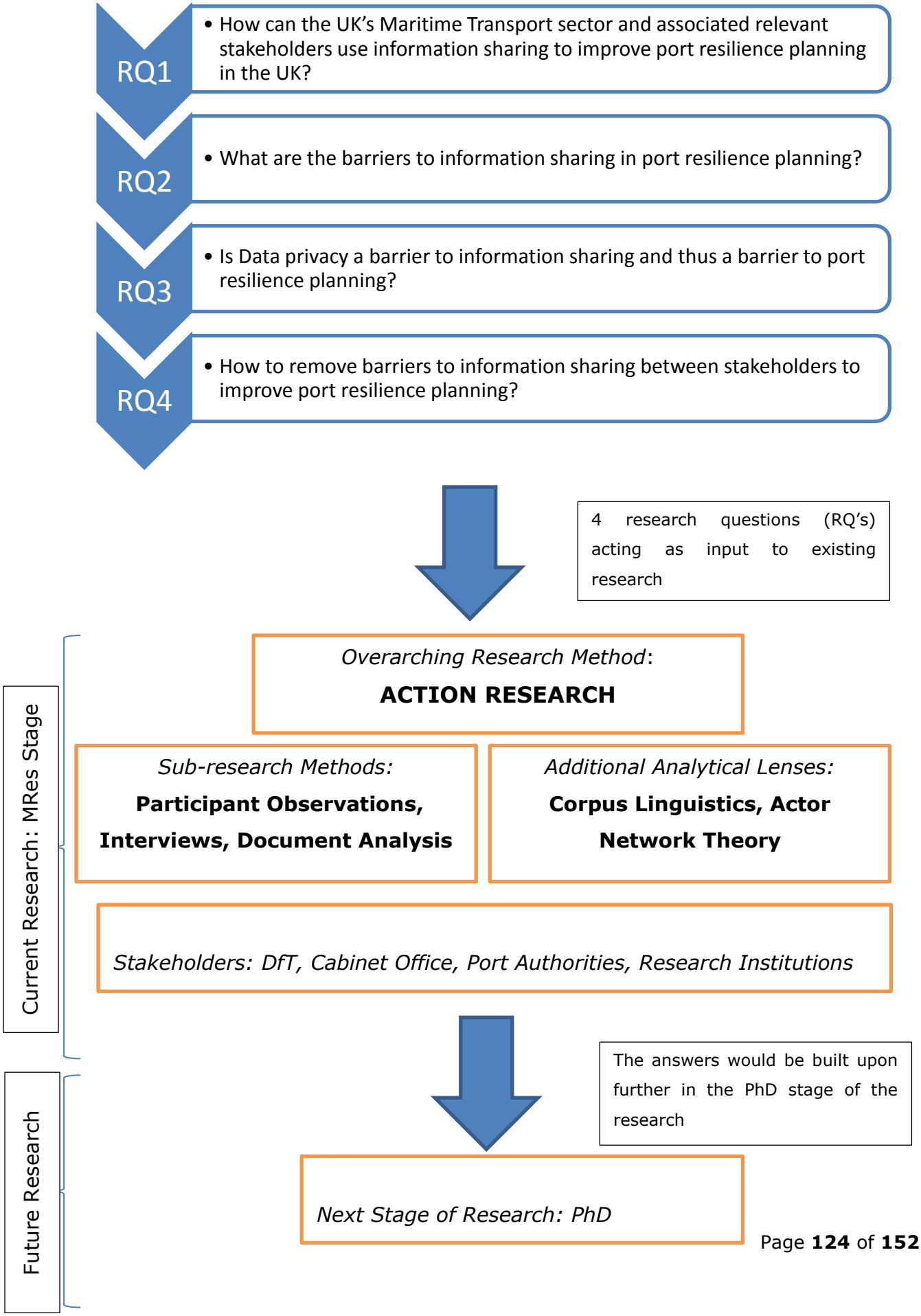
But, it was difficult to conduct Participant Observations and interviews due to the data protection requirements of the DfT, Cabinet Office and lack of time for this dissertation as it was carried out along with several full-time taught modules in the University. For instance, interviews could not be recorded at the Cabinet Office and I depended on taking notes. Some of the documents shared during meetings by the Cabinet Office were taken back and no copies were given due to confidentiality rules of the UK Government. The response to interviews may have been affected as the officials were not used to being interviewed and may have responded under pressure. This means that the research questions need to be readdressed in the next phase of the research. The findings from this MRes

dissertation would be discussed with the officials from the DfT as developing policies following Brexit may generate new responses to offer a different direction or confirm the existing direction of research.

In summary, the above methods acted as different lenses for analysis. The methods may not have answered the research questions directly or completely, but, the methods provided important learnings to undertake a multi-disciplinary approach to the complex problem of information sharing for Port Resilience within a complex network of stakeholders. The methods provided an exploratory initiative to establish what is going on in the maritime ports industry with regards to Port Resilience planning. While the overarching Action Research method ensured that the research progressed in complete agreeance with the project stakeholders, it was the sub-methods of Interviews, Document Analysis and Participant Observation that provided an exploratory approach to get rich data to better understand how information is being shared in the ports sector for planning resilience of ports.

The next page shows a diagram illustrating the last point showing how the four research questions that are part of this existing research are subject to different research methods and analytical lenses to provide answers or direction towards future research under the overarching method of Action Research.

Figure 19 The research process (Source: Self-drawn)



# Chapter 8 Conclusion

This dissertation has utilised Action Research as an overarching research method under which it has conducted a Literature Review along with Participant Observations, Interviews, Document Analysis and used innovative techniques of Corpus Linguistics while considering a new perspective with Actor-Network Theory with a new holistic inclusion of human and material objects to refine and attempt to answer the research questions of how to use information sharing for Port Resilience planning, the barriers and possible solutions to overcome the barriers. The findings have indicated that information sharing is being advocated in the UK maritime industry to improve Port Resilience planning but more details are yet to be uncovered. Confidentiality of data is a primary concern acting as a barrier for information sharing. And, culture, proximity, tacit knowledge along with an ageing workforce may act as further barriers to information sharing for Port Resilience planning. This research has suggested that as physical proximity increases, there are more chances of loosing tacit knowledge, so, proximity may have a role to play as a barrier to information sharing but this needs further research. Collaborations, workshops, education and training may act as possible solutions and enablers to information sharing. But, collaborations and other solutions are subjective due to changing policies and politics such as Brexit. A change in the workforce at the policy level shows a change of psychology and behavioural patterns may be affecting sharing of information along with issues in stakeholder dynamics such as trust and financial incentives in a highly privatised maritime sector. And, planning for resilience is a philosophical riddle because it is planning for the unknown which is a riddle that may or may not be resolved. What could be resolved is effective communication between the various stakeholders that could be faced with the unknown. And, there appears to be collaborative effort among stakeholders to face the unknown than face it in isolation with the development of new collaborations, training and technological e-platforms supplemented via UK government initiatives. However, more research is needed via further Action Research cycles to assess the impact of these initiatives to determine their success or failure and improve the planning for Port Resilience.

## 8.1 Limitations of research

It was difficult to conduct this research due to time and word limitations, confidentiality and security issues with maritime industry and ports. And, the pressure from taught modules prevented a wider access to data, or the creation of more sophisticated searches or the building of a customised corpus for further comparison. However, these limitations are hoped to be overcome in the next stage of research which is the start of the PhD program as this MRes project was year 1 of the 4 year PhD program.

## 8.2 Recommendations for future research

Future research may involve data that could be obtained through more detailed interviews and discourses from the maritime industry. A customised corpus could also be built using stakeholder communications and documents. Grammar based analysis could be utilised and compared to reference corpora for deeper understanding of the term Port Resilience.

## Bibliography

ABP (2016) *Associated British Ports.* [Online] Available at: http://www.abports.co.uk/ [Accessed 28 08 2016].

Achuthan, K. (n.d.) *Improving Port Resilience.* [Online]
Available at: https://www.ucl.ac.uk/resilience-research/people/achuthan/mars
[Accessed 25 06 2016].

Achuthan, K., Zainudin, N., Roan, J. & Fujiyama, T. (2015) *Resilience of the Food Supply to Port Flooding on East Coast,* London, UK: Defra.

ADB (2013) *Asian Development Bank.* [Online]
Available at: http://www.adb.org/sites/default/files/project-document/79845/46495-001-dpta.pdf
[Accessed 26 11 2015].

ADB (2015) *Asian Economic Integration Report 2015: How can Special Economic Zones Catalyze Economic Development?.* [Online]
Available at: http://www.adb.org/sites/default/files/publication/177205/asian-economic-integration-report-2015.pdf
[Accessed 12 06 2016].

Agresti, A. & Finlay, B. (2014) *Statistical Methods for the Social Sciences.* (4th ed.). Harlow, Essex: Pearson.

Ajzen, I. & Fishbein, M. (1975) *Belief, attitude, intention, and behavior: An introduction to theory and research.* Reading, MA: Addison-Wesley.

Alderton, P. (2008) *Port Management and Operations.* (Reprinted 2008 ed.). London: informa.

Allen, D., Karanasios, S. & Norman, A. (2014) Information sharing and interoperability: the case of major incident management. *European Journal of Information Systems,* Volume 23, pp. 418-432.

Alphaliner (2016) *Alphaliner - Top 100.* [Online]
Available at: http://www.alphaliner.com/top100/
[Accessed 30 08 2016].

Amsterdamska, O. (1990) Surely You Are Joking, Monsieur Latour!. *Science. Technology, & Human Values,* 15(4), pp. 495-504.

Arnaboldi, M. & Spiller, N. (2011) Actor-network theory and stakeholder collaboration: The case of Cultural Districts. *Tourism Management,* 32(3), pp. 641-654.

Atkinson, P. (1992) *Understanding ethnographic texts.* Newbury Park, CA and London: Sage.

Avvenuti, M. et al. (2016) A framework for detecting unfolding emergencies using humans as sensors. *SpringerPlus,* 5(1), pp. 1-23.

Bahadur, A., Ibrahim , M. & Tanner, T. (2013) Characterising resilience: unpacking the concept for tackling climate change and development. *Climate and Development,* 5(1), pp. 55-65.

Baker, P. (2006) *Using Corpora in Discourse Analysis.* London and New York: Continuum.

Baskerville, R. & Myers , M. D. (2004) Special issue on action research in information systems: making is research relevant to practice. *MIS Quarterly,* 28(3), pp. 329-335.

Baumgardner, S. & Crothers, M. K. (2009) *Positive psychology.* pper Saddle River, NJ, US: Prentice Hall/Pearson Education.

Becker, A. & Caldwell, M. (2015) Stakeholder perceptions of seaport resilience strategies: A case study of Gulfport (Mississippi) and Providence (Rhode Island). *Coastal Management,* 43(1), pp. 1-34.

Benton, T. & Craib, I. (2011) *Philosophy of Social Science - The philosophical foundations of social thought.* (2nd ed.). Basingstoke: Palgrave Macmillan.

Bhamra, R., Dani, S. & Burnard, K. (2011) Resilience: the concept, a literature review and future directions. *International Journal of Production Research,* 49(18), pp. 5375-5393.

Bichou, K. (2009) *Lloyds's Practical Shipping Guides. Port Operations, Planning and Logistics.* London: Informa.

Bierwirth, C. & Meisel, F. (2010) A survey of berth allocation and quay crane scheduling problems in container terminals. *European Journal of Operations Research,* Volume 202, pp. 615-627.

Birkenshaw, J. (2001) Why is knowledge management so difficult?. *Business Strategy Review,* 12(1), pp. 11-18.

BIS (2016) *Department for Business, Innovation & Skills.* [Online]
Available at: https://www.gov.uk/government/organisations/department-for-business-innovation-skills
[Accessed 28 08 2016].

Bloor, M. (1997) Techniques of Validation in Qualitative Research. In: G. Miller & R. Dingwall, eds. *Context & Method in Qualitative Research.* London: SAGE Publications Ltd., pp. 37-50.

Boucquey, N. et al. (2016) The ontological politics of marine spatial planning: Assembling the ocean and shaping the capancities of 'Community' and 'Environment'. *Geoforum,* Volume 75, pp. 1-11.

Branch, A. E. (2007) *Elements of Shipping.* (8th ed.). London and New York: Routledge.

Brinkmann, S. & Kvale, S. (2015) *Interviews - Learning the Craft of Qualitative Reserach Interviewing.* (3rd ed.). Los Angeles, London, New Delhi, Singapore and Washington DC: SAGE.

Bryman, A. (1984) The Debate about Quantitative and Qualitative Research: A Question of Method or Epistemology?. *The British Journal of Sociology,* March, 35(1), pp. 75-92.

Bryman, A. (2016) *Social Research Methods.* Oxford: Oxford University Press.

Cabinet Office (2012) *Formal Information Sharing Under the Civil Contingencies Act 2004: Revision to Emergency Preparedness,Chapter 3 (Information Sharing).* [Online]
Available at:
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/61026/Chapter-3-Formal-information-sharing-revised-March-2012.pdf
[Accessed 28 08 2016].

Cabinet Office (2013) *The role of Local Resilience Forums.* [Online]
Available at: https://www.gov.uk/government/publications/the-role-of-local-resilience-forums-a-reference-document
[Accessed 28 08 2016].

Cabinet Office (2015) *National Risk Register for Civil Emergencies.* London, Cabinet Office.

Callewaert, F. (2012) *Integrated fisheries Data Management Programme. Phase 1: Fisheries Control and Monitoring.* [Online]
Available at:
http://ec.europa.eu/dgs/maritimeaffairs_fisheries/contracts_and_funding/calls_for_tender/2012_22/communication_080313_annex2_en.pdf
[Accessed 29 08 2016].

Callon, M. (1986) Some elements of a sociology of translation domestication of the scallops and the fishermen of St Brieux Bay. In: J. Law, ed. *Power, Action and Belief of A New Sociology of Knowledge.* London: Routledge & Kegan Paul, pp. 196-229.

Carnegie Mellon University (2010) *Measuring Operational Resilience Using the CERT® Resilience Management Model.* [Online]
Available at:
http://resources.sei.cmu.edu/asset_files/TechnicalNote/2010_004_001_15203.pdf
[Accessed 28 08 2016].

Chalmers, A. (1978) *What Is This Thing Called Science? An assessment of the nature and status of science and its methods.* Milton Keynes: The Open University Press.

Chalmers, A. (1999) *What is this thing called Science?.* (3rd ed.). Buckingham: Open University Press.

Clark, R. (2016) *Are your business continuity plans over-optimistic when it comes to employee availability?.* [Online]
Available at: http://continuitycentral.com/index.php/news/business-continuity-news/1349-are-your-business-continuity-plans-over-optimistic-when-it-comes-to-employee-availability
[Accessed 28 08 2016].

COCA (n.d.) *Corpus of Contemporary American English.* [Online]
Available at: http://corpus.byu.edu/coca/
[Accessed 26 06 2016].

Collins, H. & Yearley, S. (1992) Epistemological Chicken. In: A. Pickering, ed. *Science as Practice and Culture.* Chicago: Chicago University Press, pp. 301-326.

ContinuityCentral.com (2016) *ContinuityCentral.com: Business continuity, enterprise risk and resilience updates.* [Online]
Available at: http://continuitycentral.com/
[Accessed 28 08 2016].

CPNI (2016) Centre for the Protection of National Infrastructure. [Online]
Available at: https://www.cpni.gov.uk/critical-national-infrastructure-0
[Accessed 29 07 2016].

Davies, C. (2008) Observing, Particiapting. In: *Reflexive Ethnography: A Guide to Reseraching Selves and Others.* London: Routledge, pp. 77-104.

DECC (2016) *Department of Energy & Climate Change.* [Online]
Available at: https://www.gov.uk/government/organisations/department-of-energy-climate-change
[Accessed 27 08 2016].

Deming, W. (1986) *Out of the Crisis.* Massachusetts: Massachusetts Institute of Technology.

Denzin, N. K. (1970) *The Research Act: A Theoretical Introduction to Sociological Methods.* Chicago: Aldine.

Denzin, N. K. & Lincoln, Y. S. (2011) *The SAGE Handbook of Qualitative Research.* (4th ed.). Thousand Oaks: SAGE.

DfT (2015) *Maritime Resilience and Security,* London (forthcoming): Department for Transport.

Drucker, P. (1977) *Management.* London: Harper & Row.

EC JRC (2016) *The Blue Hub.* [Online] Available at: https://bluehub.jrc.ec.europa.eu/ [Accessed 29 08 2016].

EEA (2014) *EEA Report No 8/2014.* [Online] Available at: file:///C:/Users/lixas78/Downloads/08%202014%20Adaptation%20of%20transport%20to%20climate%20change.pdf [Accessed 25 11 2015].

EMODNET (2016) *EMODnet Central Portal.* [Online] Available at: http://www.emodnet.eu/ [Accessed 29 08 2016].

EMSA (2016) *National Single Window for ship reporting - Prototype.* [Online] Available at: http://emsa.europa.eu/nsw.html [Accessed 29 08 2016].

EU Civil Protection Mechanism (2016) *EU Civil Protection Mechanism.* [Online] Available at: http://ec.europa.eu/echo/what/civil-protection/mechanism_en [Accessed 29 08 2016].

EU Customs Strategy (2016) *EU Customs Strategy.* [Online] Available at: http://ec.europa.eu/taxation_customs/general-information-customs/eu-customs-strategy_en [Accessed 29 08 2016].

EU Fisheries VMS (2015) *Vessel monitoring system (VMS).* [Online] Available at:

http://ec.europa.eu/fisheries/cfp/control/technologies/vms/index_en.htm
[Accessed 29 08 2016].

EUR-Lex (2008) *DECISION No 70/2008/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL.* [Online]
Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:023:0021:0026:EN:PDF
[Accessed 29 08 2016].

EUR-Lex (2013) *REGULATION (EU) No 1380/2013 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL.* [Online]
Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32013R1380
[Accessed 29 08 2016].

European Data Protection Supervisor (2014) *Preliminary Opinion of the European Data Protection Supervisor.* [Online]
Available at:
https://secure.edps.europa.eu/EDPSWEB/webdav/shared/Documents/Consultation/Opinions/2014/14-03-26_competitition_law_big_data_EN.pdf
[Accessed 26 08 2016].

European Data Protection Supervisor (n.d.) *Specific privacy statemet: Electronic Recording and Reporting System (ERS) - Data Exchange.* [Online]
Available at:
http://ec.europa.eu/fisheries/cfp/control/technologies/ers/documents/ers-specific-privacy-statement_en.pdf
[Accessed 29 08 2016].

EUROPOL EIS (2016) *EUROPOL Information system.* [Online]
Available at: https://www.europol.europa.eu/content/page/europol-information-system-eis-
[Accessed 29 08 2016].

EUROPOL SIENA (2016) *siena.* [Online]
Available at: https://www.europol.europa.eu/content/page/siena-1849
[Accessed 29 08 2016].

Forbes (2013) *The Silo Mentality: How to break down barriers.* [Online]
Available at: http://www.forbes.com/sites/brentgleeson/2013/10/02/the-silo-mentality-how-to-break-down-the-barriers/
[Accessed 02 12 2015].

Fransoo, J. & Lee, C. (2013) The critical role of ocean container transport in global supply chain performance. *Product Operations Management,* 22(2), pp. 253-268.

Frontex (2016) *EUROSUR.* [Online]
Available at: http://frontex.europa.eu/intelligence/eurosur/
[Accessed 29 08 2016].

Glaser, B. & Strauss, A. (1967) *The Discoverey of Grounded Theory.* Chicago: Aldine Publishing.

Godfrey-Smith, P. (2003) *Theory and Reality. An Introduction to the philosophy of science.* Chicago and London: The University of Chicago Press.

Google Ngram viewer (2013) *Google books Ngram viewer.* [Online]
Available at: https://books.google.com/ngrams/info
[Accessed 26 06 2016].

Gopnik, M. et al. (2012) Coming to the table: Early stakeholder engagement in marine spatial planning. *Marine Policy,* 36(5), pp. 1139-1149.

Gov.UK (2016a) *National Flood Resilience Review: Government action to tackle floods.* [Online]
Available at: https://www.gov.uk/government/news/national-flood-resilience-review-government-action-to-tackle-floods
[Accessed 27 08 2016].

Grainger , A. & Achuthan, K. (2014) *Port Resilience - A Primer.* [Online]
Available at: http://eprints.nottingham.ac.uk/2279/
[Accessed 26 11 2015].

Grainger, A. (2011) Trade facilitation: A conceptual review. *Journal of World Trade,* 45(1), pp. 39-62.

Grimsby Telegraph (2014) *FLOODS: Learning the lessons at Port of Immingham three months on.* [Online]
Available at: http://www.grimsbytelegraph.co.uk/learning-flooding-lessons-port-months/story-20791790-detail/story.html
[Accessed 27 08 2016].

Gummesson, E. (1991) *Qualitative Methods in Management Research.* Newbury Park: Sage.

Halpern, B. et al. (2012) Near-term prioritiesforthescience,policyandpracticeofCoastaland. *Marine Policy,* pp. 198-205.

Hart, C. (2014) *Doing a Literature Review. Releasing the Social Sicence Research Imagination.* (Reprinted 2014 ed.). London: Sage.

Hofstede, G. (1980) *Culture's Consequences: International Differences in Work-Related Values.* London and Newbury Park: SAGE.

Hofstede, G., Hofstede, G. J. & Minkov, M. (2010) *Cultures and Organizations: Software of the Mind.* Revised and Expanded (3rd ed.). New York: McGraw-Hill .

Hosseini, S. & Barker, K. (2016) Modelling infrastructure resilience using Bayesian networks: A case study of inland waterway ports. *Computers & Industrial Engineering,* Volume 93, pp. 252-266.

Hussey, J. & Hussey, R. (1997) *Business Research - A practical guide for undergraduate and postgraduate students.* New York: Palgrave.

ico. (2014) *Big data and data protection.* [Online]
Available at: https://ico.org.uk/media/for-organisations/documents/1541/big-

data-and-data-protection.pdf
[Accessed 12 06 2016].

ico. (2015) *Summary of feedback on Big data and data protection and ICO response.* [Online]
Available at: https://ico.org.uk/media/for-organisations/documents/1043723/summary-of-feedback-on-big-data-and-data-protection-and-ico-response.pdf
[Accessed 12 06 2016].

IPCC (2016) *IPCC.* [Online]
Available at: http://www.ipcc.ch/
[Accessed 30 08 2016].

Iridium (2016) *Iridium.* [Online]
Available at: https://www.iridium.com/
[Accessed 30 08 2016].

Ishikawa, K. (1985) *What is total quality control. The Japanese way.* London: Prentice-Hall International Inc.

Juran, J. (1990) *Juran on planning for quality.* New York: Macmillan.

Justice, V. et al. (2016) US container port resilience in a complex and dynamic world. *Maritime Policy & Management,* 43(2), pp. 179-191.

Kim, K. & Lee, H. (2015) Chapter 2 Container Terminal operation: current trends and future challges. In: C. Lee & Q. Meng, eds. *Handbook of Ocean Container Transport Logistics.* New York: Springer, pp. 43-74.

Kincheloe, J. (1991). *Teachers as Researchers: Qualitative Inquiry as a Path to Empowerment.* London: Falmer.

Kremer-marietti, A. (1998). *Comte, Isidore-Auguste-Marie-François-Xavier (1798–1857). In Routledge Encyclopedia of Philosophy. London: Routledge, Web.* [Online]
Available at: https://www.rep.routledge.com/articles/comte-isidore-auguste-

marie-francois-xavier-1798-1857
[Accessed 09 August 2016].

Latour, B. (1988) *The Pasteurization of France.* Cambridge, Mass.: Harvard University Press.

Latour, B. (1999) On recalling ANT. In: J. Law & J. Hassard, eds. *Actor Network Theory and after.* Oxford, UK and Malden, USA: Blackwell Publishers, pp. 15-26.

Latour, B. (2005) *Reassembling the Social. An Introduction to Actor-Network-Theory.* Oxford, New York: Oxford University Press.

Law, J. (1986) On the Methods of Long-Distance Control: Vessels, Navigation and the Portuguese Route to India. In: J. Law, ed. *Power, Action and Belief.* London: Routledge & Kegan Paul, pp. 234-263.

Lee, C.-Y. & Song, D.-P. (2016) Ocean container transport in global supply chains: Overview and research opportunities. *Transportation Research Part B,* Volume Article in Press, pp. 1-33.

Lee, N. & Brown, S. (1994) Otherness and the Actor Network. The Undiscovered Continent. *American Behavioral Scientist,* 37(6), pp. 772-790.

Levinson, M. (2006) *The Box: How the Shhipping Container Made the World Smaller and the World Economy Bigger.* Princeton, NJ.: Princeton University Press.

Lewin, K. (1946) Action Research and Minority Problems. *Journal of Social Issues ,* Volume 2, pp. 34-26.

Lilleoere, A.-M. & Hansen, E. H. (2011) Knowledge-sharing enablers and barriers in pharmaceutical research and development. *Journal of Knowledge Management,* 15(1), pp. 53-70.

Lincoln, Y. S., Lynham, S. A. & Guba, E. G. (2011) Paradigmatic Controversies, Contradictions, and Emerging Confluences, Revisited. In: N. K. Denzin & Y. S. Lincoln, eds. *The Sage Handbook of Qualitative Research.* (4th ed.). Thousand Oak, London, New Delhi and Singapore: SAGE Publications, Inc., pp. 97-128.

Loh, H. & Van Thai, V. (2015) Managing port-related suppy chain disruptions (PSCDs): a management model and empirical evidence. *Maritime Policy and Management,* pp. 1-20.

Marsur.info (n.d.) *Maritime Surveillance Networking.* [Online]
Available at: http://marsur.info/ [Accessed 29 08 2016].

Maslow, A. H. (1954) *Motivation and Personality.* New York: Harper & Row.

Massport (2016a) *Resiliency.* [Online]
Available at: https://www.massport.com/business-with-massport/resiliency/ [Accessed 27 08 2016].

Massport (2016b) *Resiliency and Climate Change.* [Online]
Available at: https://www.massport.com/business-with-massport/resiliency/resiliency-and-climate-change/ [Accessed 27 08 2016].

Massport (2016c) *Program Goals.* [Online] Available at: https://www.massport.com/business-with-massport/resiliency/program-goals/ [Accessed 27 08 2016].

Massport (2016d) *Program Strategies.* [Online] Available at: https://www.massport.com/business-with-massport/resiliency/program-strategies/ [Accessed 27 08 2016].

Maykut, P. & Morehouse, R. (1994) *Beginning Qualitative Research: A Philosophic and Practical Guide.* Lewes: Falmer Press.

McLaughlin, S., Paton, R. & Macbeth, D. (2008) Barrier impact on organizational learning within complex organizations. *Journal of Knowledge Management,* 12(2), pp. 107-123.

Melia, K. M. (1997) Producing 'Plausible Stories': Interviewing Student Nurses. In: G. Miller & R. Dingwall, eds. *Context & Method in Qualitative Research.* London: SAGE Publications Ltd, pp. 26-26.

MIT (n.d.) *Research* [Online]
Available at: http://ctl.mit.edu/research/port-resilience
[Accessed 2015 11 25].

Mumford, E. & Weir, M. (1979) *Computer Systems Work Design: The ETHICS Method.* London: s.n.

Munro, R. (2009) Actor-Network Theory. In: S. R. Clegg & M. Haugaard, eds. *The SAGE Handbook of Power.* London, Thousand Oaks, New Delhi and Singapore: SAGE, pp. 125-139.

Murphy, E. & Dingwall, R. (2003) Judging the Quality of Qualitative Research. In: *Qualitative Methods and Health Policy Research.* New York: ALDINE DE GRUYTER, pp. 171-204.

NCFRP (2014) *NCFRP Report 30 - Making the U.S. Ports Resilient as part of Extended Intermodal Supply Chain.* [Online]
Available at: http://onlinepubs.trb.org/onlinepubs/ncfrp/ncfrp_rpt_030.pdf
[Accessed 12 06 2016].

NOAA (2016) *Tsunami.* [Online]
Available at: http://www.tsunami.noaa.gov/
[Accessed 12 06 2016].

NOAA (n.d). *Port Resilience Planning Tool.* [Online]
Available at: https://coast.noaa.gov/digitalcoast/tools/port
[Accessed 25 11 2015].

Nonaka, I. & Takeuchi, H. (1995) *The Knowledge Creating Company.* New York and Oxford: Oxford University Press.

Notteboom, T. (2004) Container shipping and ports: an overview. *Rev. Netw. Econ.,* 3(2), pp. 86-106.

Notteboom, T. (2006) The time factor in liner shipping services. *Martime Econ. Logist.,* Volume 8, pp. 19-39.

NOW (2016) *NOW Corpus (News on the Web).* [Online]
Available at: http://corpus.byu.edu/now/
[Accessed 24 06 2016].

Oakland, J. (1995) *Total quality management : text with cases.* Oxford: Butterworth Heinemann.

Obama, B. (2010) *Executive order 13547: stewardship of the ocean, our coasts, and the great lakes. July 19 2010,* Washington, D.C.: US Government.

O'Donohue, R. (1989) The (even) bolder model: The clinical psychologist as metaphysician-scientist-practitioner. *American Psychologist,* Volume 44, pp. 1460-8.

Ordnance Survey (2016a) *ResilienceDirect: a common information platform.* [Online] Available at: https://www.ordnancesurvey.co.uk/business-and-government/case-studies/resilience-direct.html[Accessed 28 08 2016].

Ordnance Survey (2016b) *Managing incidents in real-time during the London 2012 Olympic Games and beyond.* [Online]
Available at: https://www.ordnancesurvey.co.uk/business-and-government/case-studies/newham-london-managing-incidents-london-2012.html [Accessed 28 08 2016].

Panayides, P. & Wiedmer, R. (2011) Strategic alliances in container liner shipping. *Res. Transp. Econ.,* Volume 32, pp. 25-38.

Patton, M. (1991) Qualitative research on college students: Philosophical and methodological comparisons with the quantitative approach. *Journal of College Student Development,* Volume 32, pp. 389-96.

Pauwelussen, A. (2016) Community as network: exploring a relational approach to social resilience in coastal Indonesia. *Maritime Studies,* 15(2), pp. 1-19.

Protezione Civile (n.d.) *EU Civil Protection Mechanism.* [Online]
Available at:

http://www.protezionecivile.gov.it/jcms/en/view_dossier.wp;jsessionid=ADC15EDDA9F82589B99BDD530907AB5B?contentId=DOS234 [Accessed 29 08 2016].

Ranghieri, F. & Ishiwatari, M. (2014) *Learning from Megadisasters : Lessons from the Great East Japan Earthquake.* Washington DC: World Bank.

Resh, W., Siddiki, S. & McConnell, W. R. (2014) Does the Network Centrality of Government Actors Matter? Examining the Role of Government Organizations in Acquaculture Partnerships. *Review of Policy Research,* 31(6), pp. 584-609.

Rialland, A. & Tjora, A. (2015) Future Internet enabled ship-port coordination. In: E. e. al., ed. *Maritime Port Technology and Development.* London: Taylor & Francis Group, pp. 217-225.

Ridely, N. (2011) *Knowledge Transfer Networks - Transport: A Discussion paper on the Needs and Activities of a Transport Systems Catapult.* [Online]
Available at:
https://connect.innovateuk.org/documents/2800720/3676373/Transport+Catapult+Need+%26+Activities.pdf/88991d71-4a06-48da-93dc-bcc18866a07d
[Accessed 28 08 2016].

SafeSeaNet (2016) *SafeSeaNet.* [Online]
Available at: http://www.emsa.europa.eu/ssn-main.html
[Accessed 29 08 2016].

Sayer, A. (2000) For postdisciplinary studies: sociology and the curse of disciplinary parochialism and imperialism. In: E. e. al, ed. *For Sociology: Legacies and Prospects.* Durham: Sociology Press, pp. 83-91.

Schwartz, P. & Ogilvy, J. (1979) *The Emerging Paradigm: Changing Patterns of Thought and Belief,* Menlo Park, CA: SR1 International.

Secretary of State for Transport (2014) *Transport Resilience Review - A review of the resilience of the transport network to extreme weather events.* [Online]
Available at:
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/335115/transport-resilience-review-web.pdf [Accessed 26 11 2015].

Senge, P. (1992) *The Fifth Discipline.* London: Century Business.

Shaw, D. (2007) Manchester United Football Club: developing a Network Orchestration Model. *European Journal of Information Systems,* 16(5), pp. 628-642.

Shaw, D. R. & Holland, C. P. (2010) Strategy, networks and systems in the global translation services market. *The Journal of Strategic Information Systems,* 19(4), p. 242–256.

Silverman, D. (1997) The Logics of Qualitative Research. In: G. Miller & R. Dingwall, eds. *Context & Method in Qualitative Research.* London: SAGE Publications Ltd., pp. 12-25.

Silverman, D. (2013) *Doing Qualitative Research.* (4th ed.). London : SAGE.

Statewatch.org (2014) *Data adrift on the high seas: work continues on connecting maritime surveillance systems.* [Online]
Available at: http://www.statewatch.org/news/2014/aug/cise.htm
[Accessed 29 08 2016].

Strauss, A. & Corbin, J. (1990) *Basics of Qualitative Research.* Newbury Park: Sage.

Stromberg, R. (1986) *European Intellectual History since 1789.* (4th ed.). Englewood Cliffs, NJ: Prentice-Hall.

The Wall Street Journal (2016) *The Wall Street Journal.* [Online]
Available at: http://www.wsj.com/articles/iranian-oil-shipping-companies-strike-2-4-billion-south-korean-ship-deal-1465289444
[Accessed 09 06 2016].

Transport Systems Catapult (2016) *Imagine Festival 2016.* [Online]
Available at: http://imaginefestival.co.uk/about/ [Accessed 28 08 2016].

Treleaven, L. (1994) Making a Space: A Collaborative Inquiry with Women as Staff Development. In: P. Reason, ed. *Participation in Human Enquiry.* London: Sage, pp. 138-162.

Trepte, K. & Rice Jr., J. (2014) An initial exploration of port capacity bottlenecks in the USA port system and the implications on resilience. *International Journal of Shipping and Logistics,* 6(3), pp. 339-355.

TST (2016) *Transport Security Policy.* [Online]
Available at: https://www.gov.uk/government/policies/transport-security
[Accessed 30 08 2016].

UK Vessel monitoring system (2016) *Commercial fishing and fisheries – statutory guidance: Vessel monitoring system devices.* [Online]
Available at: https://www.gov.uk/government/publications/vessel-monitoring-system-devices [Accessed 29 08 2016].

UNFCC (2014) *United Nations Framework Convention on Climate Change.* [Online] Available at: http://unfccc.int/kyoto_protocol/items/2830.php
[Accessed 26 06 2016].

UNOLS (2016) *04 Ms Robbin Peach - Implementing Resilience: Massachusetts Port Authority's Resilience.* [Online]
Available at: https://www.youtube.com/watch?v=OkOJIhKWlMc
[Accessed 27 08 2016].

Urciuoli, L., Hintsa, J. & Ahokas, J. (2013) Drivers and barriers affecting usage of e-Customs - A global survey with customs and administrations using multivariate analysis techniques. *Government Information Quaterly,* Volume 30, pp. 473-485.

Vaughan, D. (1990) Autonomy, Interdependence, and Social Control: NASA and the Space Shuttle Challenger. *Administrative Science Quaterly,* 35(2), pp. 225-257.

VMS Data Exchange (n.d.) *Specific Privacy Statement - Vessel monitoring system (VMS) - Data Exchange.* [Online]
Available at:
http://ec.europa.eu/fisheries/cfp/control/technologies/vms/documents/vms-specific-privacy-statement_en.pdf [Accessed 29 08 2016].

Volk, C. J., Lucero, Y. & Barnas, K. (2014) Why is Data Sharing in Collbaorative Natural Resource Efforts so Hard and What can We Do to Improve it?. *Environmental Management,* Volume 53, pp. 883-893.

Wajcman, J. (2004) *Techno Feminism.* (Reprinted 2006 ed.). Cambridge (UK) and Malden: Polity Press.

Welford, R. & Gouldson, A. (1993) *Environmental Management and Business Strategy.* London: Pitman.

Winch, P. (1990) *The IDEA of a SOCIAL SCIENCE and its RELATION to PHILOSOPHY.* (2nd ed.*).* London: Routledge.

Wood-Harper, T. (1985) Research Methods in Information Systems: Using Action Research. In: . E. Mumford , . R. Hirschheim , . G. Fitzgerald & T. Wood-Harper, eds. *In Research Methods in Information Systems.* Amsterdam: North-Holland, pp. 169-191.

Woodhouse, C. (2016) *Local.Gov.Uk.* [Online]
Available at:
http://www.local.gov.uk/documents/10180/7743588/Day+2+Keynote+5+Craig+Woolhouse.pdf/628c16c9-2bcb-4b2b-bd2a-eb1da175462c
[Accessed 27 08 2016].

# Appendix 1 – Screen shots of steps and findings

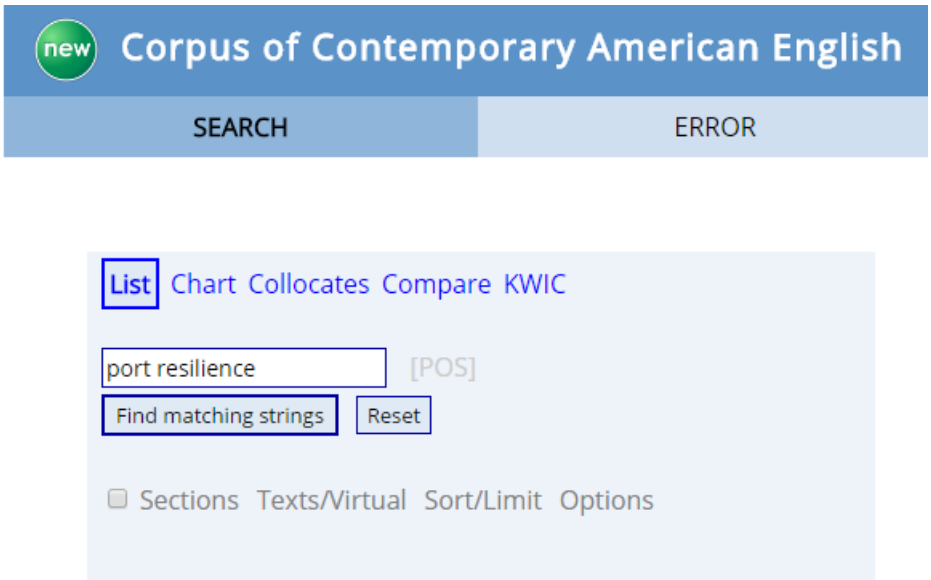



Figure 20 Showing inputting the term 'port resilience' in COCA

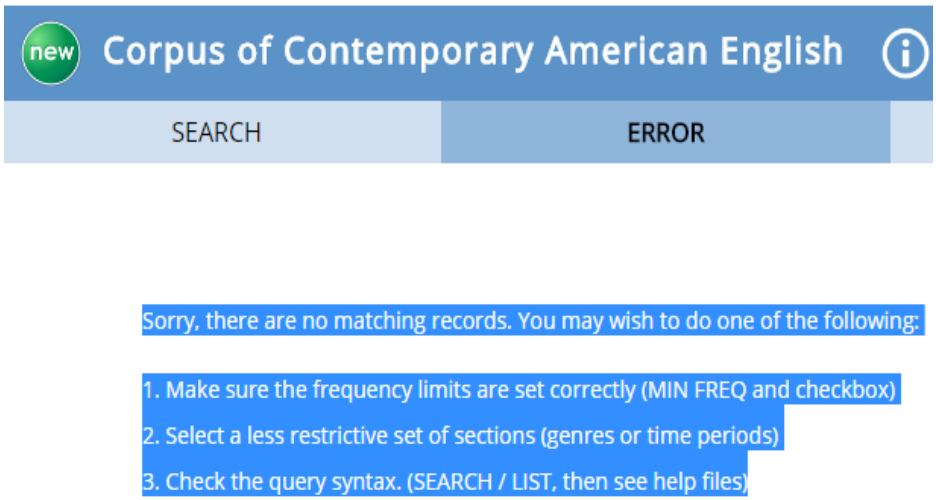



Figure 21 Showing zero reults in COCA for 'port resilience'

Corpus of Global Web-Based English (GloWbE)

SEARCH | FREQUENCY | CONTEXT | OVERVIEW

SECTION: Great Britain (2,727)
FIND SAMPLE: 100 200 500 1000
PAGE: << < 1 / 28 > >>

CLICK FOR MORE CONTEXT [?] SAVE LIST CHOOSE LIST CREATE NEW LIST [?]

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | GB G | smithschool.ox.ac.uk | A | B | C | The Guardian a review of the book' The Nature of Business: Redesigning for **Resilience** by Giles Hutchins. |
| 2 | GB G | thebusbybabe.com | A | B | C | a great season for us in terms of injuries. But the players have shown **resilience**. They have dug in and they are in the position they are now because |
| 3 | GB G | ...reers.guardian.co.uk | A | B | C | and then be realistic about what we can achieve while at the same time building **resilience** to deal with the things we can't. If we remain fixated on status |
| 4 | GB G | independent.co.uk | A | B | C | to deliver an outcome and I have to do it incredibly leanly with very little **resilience**'. # " G4S were literally hiring people and expecting to deploy them three |
| 5 | GB G | independent.co.uk | A | B | C | to this?' -- because it's doing different things with different levels of **resilience** that are not generally required in the private sector. # " We don't |
| 6 | GB G | kennedypearce.com | A | B | C | month; for the first rise this year. # The figures reveal the' **resilience**' of the employment market, despite the marginal fall in permanent placements, and |
| 7 | GB G | ftalphaville.ft.com | A | B | C | second emphasizes the endogenous nature of financial distress and describes financial stability in terms of **resilience** to shocks originating within the financial sy: |
| 8 | GB G | dailymail.co.uk | A | B | C | of a trend to' bubblewrap' children, meaning they do not develop the **resilience** needed to deal with adult life. # Parents, teachers, police and officialdom |
| 9 | GB G | london.anglican.org | A | B | C | they may live in more crowded conditions, with less developed infrastructures, and less **resilience** to cope. # Why is this our responsibility? Because the UK is still |
| 10 | GB G | london.anglican.org | A | B | C | link with the dioceses in Angola and Mozambique, in projects assisting adaptation and building **resilience** to the consequences of climate change. # And when dis |
| 11 | GB G | telegraph.co.uk | A | B | C | 's display was one of few positives for England. He praised the side's **resilience**: " Having gone a goal down, we showed fantastic character and determination. |
| 12 | GB G | teachingthinking.net | A | B | C | -- handling emotions so they facilitate the task in hand, being conscientious. # **Resilience** -- sustaining motivation, persevering in the face of set-backs, striving to i |
| 13 | GB G | bbc.co.uk | A | B | C | be some clarity. " # 1711: # You can not knock Everton's **resilience** under David Moyes. The 2-1 win at home to Sunderland today saw them come |
| 14 | GB G | odihpn.org | A | B | C | evacuation plans. The programme is an example of a successful religious/secular partnership, bolstering **resilience** in disaster-vulnerable communities. # Althoug |
| 15 | GB G | odihpn.org | A | B | C | be identified. Religion, though not always positive, can be a source of **resilience** for millions of individuals and communities -- a resilience that must be acknowled |
| 16 | GB G | odihpn.org | A | B | C | , can be a source of resilience for millions of individuals and communities -- a **resilience** that must be acknowledged if we are to help people in the midst of disast |
| 17 | GB G | telegraph.co.uk | A | B | C | only one Premier League game this season, but he has been encouraged by the **resilience** Wenger's side have shown. # " We've had two very positive away |
| 18 | GB G | golf-industry.com | A | B | C | dry patch; helping the absorption of top dressings without layering; and increasing turf **resilience**. # Few if any of these benefits are known to the average golfer. |
| 19 | GB G | ...nglicancommunion.org | A | B | C | " We urge governments to support agriculture systems that enhance soil productivity, build community **resilience** in the face of climate change and contribute to |
| 20 | GB G | housebites.com | A | B | C | our 20 best UK start-ups of 2011, we acknowledge the tenacity, creativity and **resilience** of these entrepreneurs, many of whom are not only employing good busi |
| 21 | GB G | independent.co.uk | A | B | C | and come up with the right answers. It's a chance to show our **resilience** and character, which I know we have in abundance. # " In both |
| 22 | GB G | ...coupleconnection.net | A | B | C | Radio 4 broadcast Together Against the Odds a series of interviews highlighting factors involved in **resilience** and relationship success. # This was of help to 100% |
| 23 | GB G | ftalphaville.ft.com | A | B | C | widens with the others, but not by much, likely because of the relative **resilience** of its economy. France isn't given as much of a benefit of the |
| 24 | GB G | guardian.co.uk | A | B | C | for 3 years in the early 80s. I was amazed at their hospitality and **resilience**, their living link with what I would call the best of humanity that goes |
| 25 | GB G | huffingtonpost.co.uk | A | B | C | the basis of an operational deployment with augmentations from regular forces - particularly on homeland **resilience** duties. # " This is a fundamental change in |
| 26 | GB G | dailymail.co.uk | A | B | C | against things that might impair your charisma potential. Practise these exercises to strengthen your **resilience** and expand your comfort zone: # Hold eye contac |
| 27 | GB G | ...ransitionnetwork.org | A | B | C | for it than to be taken by surprise. # Industrial society has lost the **resilience** to be able to cope with energy shocks. # We have to act together |
| 28 | GB G | ...ransitionnetwork.org | A | B | C | just a FEW of us. # This co-ordinated local response strives to rebuild the **resilience** we've lost as a result of cheap oil, to address issues of inequality |

Figure 22 Showing resilience in GB in GloWbe

corpus.byu.edu/glowbe/

Corpus of Global Web-Based English (GloWbE)

SEARCH | ERROR | CONTEXT | OVERVIEW

L - - - - 1 2 3 R * RE-SORT ?

CLICK FOR MORE CONTEXT [?] SAVE LIST CHOOSE LIST CREATE NEW LIST [?]

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | SG G | challenge.gov.sg | A | B | C | to deal with difficult issues , but it takes people with | resilience | and a good spirit to deal with it on a daily basis |
| 2 | US B | dailyprogress.com | A | B | C | Sullivan 's tone was warm and heartfelt , and she displayed | resilience | and a great sense of humor , " wrote Darden Dean Robert |
| 3 | US G | uncsd2012.org | A | B | C | and appropriate SIDS-tailored responses to building climate | resilience | and a Green Economy . The event is complimentary to UNDESA 's |
| 4 | GB G | ...gs.independent.co.uk | A | B | C | Germany who were 2-0 down , a team known for their | resilience | and ability to come back against the odds . A German fan |
| 5 | KE G | irinnews.org | A | B | C | time , we must invest in more long-term solutions to build | resilience | and break the cycle of hunger . " # Long-term solutions # |
| 6 | CA G | gov.nl.ca | A | B | C | the industry and its workers have demonstrated considerable | resilience | and dynamism . This is in spite of the historic events which |
| 7 | BD G | ...conomy.wordpress.com | A | B | C | , political turmoil and a low production capacity . The | resilience | and inherent strength of the economy , mainly due to its robust |
| 8 | AU B | ncie.org.au | A | B | C | and Torres Strait Islander excellence , contribution , | resilience | and innovation . it 's never in the abstract . I can |
| 9 | IE G | corkman.ie | A | B | C | . # It was a victory sourced primarily in courage , | resilience | and resolve . but Kildorrery also showed they are n't lacking |
| 10 | GB G | scvo.org.uk | A | B | C | graduate employment competition , having learned | resilience | and self-management . Employers see greater maturity , and |
| 11 | GB G | ...ransitionnetwork.org | A | B | C | the difficult moments we are living , building like this local | resilience | and strenghtening communities " . # You can also Read in Malaga |
| 12 | MY G | yourhealthblog.net | A | B | C | but it will not last long and do not have the | resilience | and strength as the original cartilage . # Another technique |
| 13 | US G | chomsky.info | A | B | C | But , on the other hand , it does have enormous | resilience | and very little challenge , limited enough and sufficiently |
| 14 | AU G | clubtroppo.com.au | A | B | C | 's far from clear . Ashwin Parameswaran at Macroeconomic | Resilience | argues that suppressed real rates can have " perverse and |
| 15 | NZ B | samadhisoft.com | A | B | C | how you were going to spend your days . # Our | resilience | as human beings amazes me . # As I drove back up |
| 16 | AU B | acer.edu.au | A | B | C | Aboriginal and Torres Strait Islander children who possess the | resilience | attributes of social competence , autonomy , mastery , optimism |
| 17 | GB G | ...ransitionculture.org | A | B | C | or people they do not know . # In communicating the | resilience | concepts of Transitions , be this to emergency planning |
| 18 | CA B | iisd.ca | A | B | C | undemocratic ones . # On Target 15 ( Ecosystems restored and | resilience | enhanced . . Sasha Alexander , Society for Ecological |

Figure 23 KWIC analysis of resilience

# Appendix 2 – List of collocates for Port Resilience for WebCorp corpus

**Table 11 Collocation of Port Resilience from WebCorp corpus**

| Word | L4 | L3 | L2 | L1 | | R1 | R2 | R3 | R4 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| **for** | 1 | 1 | 3 | 14 | | 2 | 0 | 1 | 2 | **24** |
| **to** | 0 | 1 | 3 | 0 | | 2 | 0 | 6 | 6 | **18** |
| **and** | 5 | 1 | 1 | 1 | | 4 | 3 | 2 | 0 | **17** |
| **the** | 2 | 2 | 1 | 6 | | 0 | 3 | 2 | 0 | **16** |
| **Sandy** | 1 | 0 | 8 | 0 | | 0 | 0 | 1 | 4 | **14** |
| **a** | 0 | 1 | 0 | 3 | | 3 | 2 | 2 | 2 | **13** |
| **Hurricane** | 0 | 8 | 0 | 0 | | 0 | 0 | 4 | 0 | **12** |
| **from** | 8 | 0 | 0 | 0 | | 0 | 4 | 0 | 0 | **12** |
| **Port** | 0 | 2 | 2 | 0 | | 2 | 2 | 0 | 2 | **10** |
| **Building** | 1 | 0 | 0 | 8 | | 1 | 0 | 0 | 0 | **10** |
| **Planning** | 1 | 0 | 2 | 0 | | 4 | 1 | 0 | 0 | **8** |
| **Operational** | 0 | 0 | 0 | 0 | | 6 | 1 | 0 | 0 | **7** |
| **Tactical** | 0 | 0 | 0 | 0 | | 0 | 6 | 1 | 0 | **7** |
| **Enforcement** | 0 | 0 | 0 | 0 | | 0 | 0 | 6 | 1 | **7** |
| **of** | 1 | 2 | 2 | 1 | | 0 | 0 | 0 | 1 | **7** |
| **on** | 1 | 1 | 0 | 0 | | 1 | 2 | 1 | 1 | **7** |
| **is** | 0 | 0 | 1 | 0 | | 1 | 3 | 2 | 0 | **7** |
| **in** | 1 | 1 | 0 | 0 | | 0 | 2 | 2 | 1 | **7** |
| **Threats** | 0 | 0 | 0 | 0 | | 0 | 5 | 0 | 1 | **6** |
| **Overcoming** | 0 | 0 | 0 | 0 | | 5 | 0 | 1 | 0 | **6** |
| **Resilience** | 1 | 0 | 1 | 1 | | 0 | 1 | 2 | 0 | **6** |
| **Maritime** | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 5 | **5** |

| Word | L4 | L3 | L2 | L1 | | R1 | R2 | R3 | R4 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| **MIT** | 0 | 0 | 0 | 2 | | 0 | 0 | 3 | 0 | **5** |
| **Lessons** | 0 | 0 | 0 | 0 | | 4 | 0 | 0 | 0 | **4** |
| **Project** | 0 | 0 | 1 | 0 | | 3 | 0 | 0 | 0 | **4** |
| **UK** | 0 | 0 | 0 | 2 | | 2 | 0 | 0 | 0 | **4** |
| **project** | 0 | 0 | 1 | 0 | | 1 | 2 | 0 | 0 | **4** |
| **climate** | 0 | 0 | 1 | 0 | | 0 | 1 | 1 | 1 | **4** |
| **are** | 0 | 0 | 2 | 0 | | 0 | 1 | 1 | 0 | **4** |
| **Research** | 1 | 1 | 0 | 1 | | 1 | 0 | 0 | 0 | **4** |
| **Security** | 0 | 0 | 1 | 0 | | 2 | 0 | 0 | 1 | **4** |
| **this** | 0 | 0 | 2 | 0 | | 0 | 1 | 1 | 0 | **4** |
| **Supply** | 0 | 0 | 0 | 0 | | 2 | 0 | 0 | 1 | **3** |
| **Achuthan** | 0 | 2 | 1 | 0 | | 0 | 0 | 0 | 0 | **3** |
| **A** | 2 | 0 | 0 | 0 | | 1 | 0 | 0 | 0 | **3** |
| **The** | 1 | 0 | 1 | 0 | | 0 | 1 | 0 | 0 | **3** |
| **ud** | 0 | 1 | 0 | 0 | | 0 | 0 | 1 | 1 | **3** |
| **News** | 1 | 0 | 1 | 0 | | 0 | 1 | 0 | 0 | **3** |
| **Tools** | 0 | 0 | 0 | 1 | | 0 | 0 | 1 | 1 | **3** |
| **More** | 0 | 1 | 1 | 0 | | 0 | 0 | 0 | 1 | **3** |
| **Resources** | 0 | 1 | 0 | 2 | | 0 | 0 | 0 | 0 | **3** |
| **about** | 0 | 0 | 1 | 2 | | 0 | 0 | 0 | 0 | **3** |
| **Search** | 1 | 1 | 1 | 0 | | 0 | 0 | 0 | 0 | **3** |
| **Center** | 0 | 1 | 0 | 0 | | 0 | 1 | 0 | 1 | **3** |
| **planning** | 0 | 0 | 2 | 0 | | 1 | 0 | 0 | 0 | **3** |
| **Nottingham** | 1 | 1 | 1 | 0 | | 0 | 0 | 0 | 0 | **3** |
| **Transportation** | 0 | 1 | 1 | 0 | | 0 | 0 | 0 | 1 | **3** |

| Word | L4 | L3 | L2 | L1 | | R1 | R2 | R3 | R4 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| **into** | 0 | 0 | 2 | 0 | | 0 | 1 | 0 | 0 | **3** |
| **primer** | 0 | 0 | 0 | 0 | | 0 | 3 | 0 | 0 | **3** |
| **Keywords** | 1 | 0 | 0 | 1 | | 0 | 0 | 0 | 0 | **2** |

Output produced Fri Jun 24 14:25:13 BST 2016. The results will be available at this location for the next 6 days.

Thank you for using WebCorp. Please provide us with your feedback on the tool.

---

**Post Search Options**

**Show URLs:** ☑ **Span:** 50 characters

**Show Collocates:** ☑ **Exclude Stopwords:** ☐

**Sort by:** Date - Latest First **Position:** 1

**Make all above options case insensitive:** ☐

**Filter by Date:** No filter **Range:** YYYY-MM- – YYYY-MM-

Reset Submit

Start a new search...

**Some results for query "Port Resilience" (Limited due to word count but available on request)**

**case insensitive,**

**using the Bing (Azure) API**

**4) http://scale.mit.edu/research/port-resilience**

Text, Wordlist, text/html, UTF8 (Content-type), 2016-06-24 (Server header)

9: Contact Us You are here Home > Our Research **Port Resilience** Research Center: MIT Center for Transportation &
10: (CSR)." In response, CTL has initiated the MIT **Port Resilience** Project, which will focus on developing
11: of Technology as the lead institution. The MIT **Port Resilience** Project builds upon CTL's deep and continuing
12: risk management, and supply chain security (see **Port Resilience** - Reports and Publications for relevant CTL

**9) http://www.joc.com/port-news/terminal-operators/building-port-resilience_20130827.html**

Text, Wordlist, text/html, UTF8 (Content-type), 2016-06-24 (Server header)

20: JOC › Port News › Terminal Operators Building **Port Resilience** James B. Rice, Jr. | Aug 27, 2013 9:51AM EDT
21: the public option these operators are increasing **port resilience**. Port News›Terminal Operators US Ports You are

**14) http://www.sciencedirect.com/science/article/pii/S036083521600019X**

Text, Wordlist, text/html, UTF8 (HTML source), 2016-06-24 (Server header)

34: Section 3 describes the contributors of **port resilience** used in this paper, and Section 4 provides the
35: and analysis of the Bayesian network for **port resilience**. Concluding remarks are given in Section 5. 2.

**16) http://www.utrc2.org/research/projects/port-resilience-overcoming-threats**

Text, Wordlist, text/html, UTF8 (Content-type), 2016-06-24 (Server header)

38: Scholar Seminar Series Event Gallery Resources **Port Resilience**: Overcoming Threats to Maritime Infrastructure

# Appendix 3 – N-Gram analysis

1. An N-Gram analysis (Google Ngram viewer, 2013) was carried out to find out the historical usage for the term '**Port Resilience**' (case insensitive) as shown below with zero results.

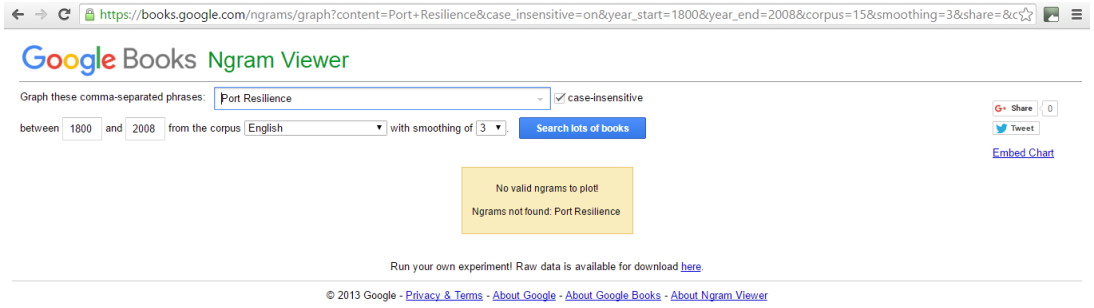



Figure 24 Ngram of Port Resilience

2. A case insensitive Ngram analysis was carried for '**Resilience**' as shown below. The term resilience has increased in usage after the year 1992. This could be due to Kyoto Protocol that mentioned resilience against climate change (UNFCC, 2014).

Figure 25 Ngram of Resilience

3. **Disaster resilience** was also explored using Ngrams. It was find out that the usage of Disaster Resilience has increased after the year 2000 as seen below.

Figure 26 Ngram of Disaster Resilience