CLIMATE CHANGE ADAPTATION BY PORTS: THE ATTITUDE AND PERCEPTION OF CHINESE PORT STAKEHOLDERS

by

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Abstract

It is well-known that climate change poses a severe risk to human activities and lives and the awareness is increasing rapidly since the beginning of the 21st century. Hitherto, existing research focuses on the importance of the effective development and implementation of climate change adaptation plans and strategies. As an essential transportation node of global supply chains, ports and their surrounding organizations or their stakeholders are vulnerable to the impacts posed by climate change, notably sea-level rise, and storm surge, that without appropriate measures can cause significant losses to the global economy. Thus, there is an urgent need for a better understanding of the attitudes of port stakeholders in climate adaptation strategies so as to facilitate the application of climate adaptation strategies. However, the attitude and perception of port stakeholders towards such plans and strategies remain unclear. This thesis addresses such deficiency by investigating 20 ports in China and interviewing nine Chinese port stakeholders. What it aims is to understand their attitude and perception of climate change adaptation plans and strategies and offer a better understanding of adaptation and mitigation strategies. During the investigation, we asked about the impediments and the impact of context, systems and some other factors on the implementation of adaptation strategies. The findings suggest that most of the port stakeholders, in general, aware of climate change impacts and agree that some measures are necessary. Nevertheless, inadequate knowledge and policy support remain major barriers for them to implement climate change adaptation plans and strategies effectively. Further, other factors affecting respondents' attitude are partly revealed. This study offers an overview of the attitude of port stakeholders in China toward adaptation strategies. In addition, it can be considered as a model for further study about the perception

of other economic sectors toward the impacts posed by climate change and adaptation strategies.

Keywords: Climate change; Port; Adaptation; China; Attitude; Organizational perspective

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Chapter 1: Introduction

The issue of climate change has rapidly drawn attention in public, policy designing and implementing, media and academic field due to its significant impacts on human lives and society, thus becoming a major topic in recent research since 21st century (Adger et al.,2007; Moser and Ekstrom, 2010; National Research Council, 2010; Smith, Vogel and Cromwell, 2009). Existing studies show that over the past century, the climate of the Earth has undergone significant changes and 'global warming' is identified as one of its major characteristics (Wu and Ji, 2013). Multi-dimensions of society are involved and affected: transportation, agriculture, electricity generation, land-use changes and some other aspects (Hall and Wreford, 2012; Stern, 2006). Such impacts cause the significant economic loss and even loss of life in many countries, including China (National Development and Reform Commission, 2016; Wu and Ji, 2013). Indeed, economic loss is generated due to poor infrastructure replacement or repair, and other operational maintenance (Ng et al., 2013, 2016).

Hitherto, many previous literatures address some climate change research questions, notably on aspects of the climate change impacts (e.g., IPCC[1], 2014; Lemmen et al., 2008; Prowse et al., 2009), nature of the vulnerability at the background of climate change (e.g., Kelly and Adger, 2000; Patwardhan et al., 2007), and impacts[2] on the marine system (e.g., Hallegatte et al., 2011; Harley et al., 2006). They point out that climate change has triggered

[1] IPCC refers to Intergovernmental Panel on Climate Change
[2] The word 'impacts' in the following paragraphs refers to 'impacts posed by climate change'.

great concern by governments around the world and is a major problem that must be addressed effectively. Understanding such, it is necessary and urgent to take some actions, and two kinds of strategies are introduced: mitigation and adaptation (Ng et al., 2013). For example, some adaptation measures have been adopted to prevent New York City's infrastructure from affected by the sea-level rise and global warming population at risk maps in their emergency response plans to respond to more frequent heat waves due to global warming (City of Chicago, 2008, p40; Zimmerman and Faris, 2011). Some mitigation strategies have already been adopted and reduced greenhouse gas (GHG) emissions (Zimmerman and Faris, 2011). Although some progress has been made in analyzing climate adaptation strategies, still, it remains at the embryonic stage (Berrang-Ford et al., 2011).

Although climate change impacts worldwide, coastal regions are one of the most vulnerable areas. Coastal regions can provide variously and a massive amount of essential goods and services through its marine systems, including fisheries and biological diversity, mineral resources and other entertainment chances (Scavia et al., 2002). The impacts on the coastal regions could generate a significant economic loss. Sea-level rise and storm surge (triggered by more frequent flooding and hurricanes) already impact coastal regions significantly, such as erosion of beaches and some port facilities (Burkett and Davidson, 2013).

Marine supply chain, as one of the services provided by the coastal regions, is crucial to global economic growth (Ng et al., 2016; Gillen, 2001). Ng and Liu (2014) argue that

maritime transport occupies the largest amount of the world's business volume, which is more than 80% of the global cargoes, and thus any negative impacts would also affect ports and supply chains. Understanding such, the potential risk of the negative impact of climate change on the marine supply chain is worth to be studied. Besides the traditional functional function of ports, as transfer station for cargos or passengers (Messner, Becker and Ng, 2015; Talley, 2017), ports also serve as crucial nodes to transportation and global supply chains that play essential roles in international commerce due to their ability to provide access for companies in different countries to implement trade (Becker et al., 2013). Ports connect hinterlands and distant lands along the trade path, which plays critical roles to facilitate the economy in these areas. In addition to these fundamental roles of the ports, Messner et al. (2015) argue that port authority or management agency not only in charge of the management of daily operation within the ports but also perform institutional functions. Understanding such, the crucial roles that ports also play in the community and society go without saying (Burroughs, 2005; Messner et al., 2013; Messner et al., 2015). A considerable economic loss would be generated due to the negative impacts on ports' operation (Becker et al., 2013; Ng et al., 2013). There is still a scarcity of research investigating adaptation strategies on ports, terminals, and even transport in general (Ng et al., 2013). Previous literature mentioned the climate change impacts on ports (Becker et al., 2013; Ng et al., 2013). As pointed out by Ng et al. (2013) and Becker et al. (2012), the negative impact of climate change can severely affect local and global operations and plans. Specifically, the severity of the outcome of climate change impacts remains uncertain, but some measures need to be implemented so as to respond to such impacts as soon as possible. In this case, Ng et al. (2013) argue that many questions dealing with climate change impacts,

including the managers' awareness toward climate change impacts, have yet been addressed adequately. Indeed, few investigate the decision makers' attitude from a perspective which considers port stakeholders as organizations about climate adaptation strategies and their implementation, especially from an organization's decision-making perspective. To be more specific, we cannot confirm whether port stakeholders are aware of the situation until there is a thorough understanding on their attitude and perception on adaptation to climate change impacts and adaptation measures. To be effective, a sharp awareness of port stakeholders on the issue is pivotal, and the attitude also needs to be well understood. Understanding the attitudes of port stakeholders from the organizational decision-making perspective can offer useful insights on what the attitude of the port stakeholders is when the implementation of climate adaptation strategies is considered as a decision. In addition, to what extent the factors are supposed to influence the decision-making process and the attitude of port stakeholders towards climate adaptation strategies. Hitherto, such understanding is still inadequate as this issue has yet been comprehensively investigated due to the traditional emphasis of climate change adaptation on the physical/engineering components (Becker et al., 2012; Ng et al., 2013). Thus, improving our understanding of the attitude of port stakeholders from the organizational decision-making perspective can offer useful insight to fill up a research gap and help better understanding climate change adaptation. To consider the adaptation strategies implementation as advanced needs for ports stakeholders, Maslow's hierarchy of needs is applied in this thesis to address the reasons behind the attitude of the port stakeholder. Based on previous literature, researches give more attention to the situation of adaptation strategies in developed countries than developing countries, due to lower vulnerability and

greater adaptive capacity (Adger et al., 2007; Moser and Ekstrom, 2010). Thus, this thesis focusses on the port stakeholders in China and more reasons for selecting port stakeholders in China will be elaborated more in the following chapters.

Understanding such, this study tries to:

(a) draw an overall picture of the attitude and perception of port stakeholders towards impact posed by climate change adaptation strategies;

(b) identify and analyze the major factors that influence the attitude of port stakeholders towards climate change impacts and climate adaptation strategies;

(c) understand the knowledge and perception of Chinese port stakeholders towards climate change impacts and climate adaptation strategies;

(d) provide some insight suggestions for policymakers and port stakeholders;

(e) call more attention for practitioners and researcher to adapt to the impacts.

To tackle the problem of adaptation strategies, this thesis addresses the research question: Why the port stakeholders find it challenging to accommodate to the impacts posed by climate change? To better understand this research question, secondary research questions are developed as 1) to what extent decision makers in ports are convinced that adaptation strategies are imperative to cope with the negative impacts of climate change on ports in the foreseeable future? 2) How do the port stakeholders consider adaptation strategies, the following impacts and the barriers through adaptation strategies implementation process? The first secondary research question is addressed by a survey, which aims to provide an overview of the decision makers in ports to adaptation strategies. The latter

secondary research question is addressed through a case study focus on the port stakeholders in China, analyzing the reasons behind the perception of the port stakeholders. The rest of the thesis is structured as follows. Chapter 2 consists of the literature review and research framework. Chapter 3 discusses the research methodology rationale and design details. Chapter 4 analyze the survey results. Chapter 5 discuss the results of the case study in China. In the end, the last chapter consists of the discussion, conclusion, limitation and concluding remarks where further research directions are also discussed.

Chapter 2: Literature review and Theoretical Framework

2.1 Climate change and impact in China

The impact posed by climate change has already caused significant economic loss and even loss of life in the worldwide including China. The common strategies to alleviate the impact posed by climate change are mitigation and adaptation strategies. Today, China is undergoing a period of rapid industrialization and urbanization. The economic development and demand for improving living standards thus mean high demand for energy (National development and reform commission, 2016). The increasing energy consumption is one of the reasons caused global warming and climate change. Beside the necessity of mitigation, most areas in China is also suffering from the negative impact posed by climate change. These impacts would increase the vulnerability of the ecological environment of China and raised frequency and intensity of natural disasters as well as cause economic loss. Understanding such, it is urgent to take some measures to alleviate to the negative impact posed by climate change and to minimize the risks of climate change in the foreseeable future.

The climate change in China is noticeable. Data proved that, in the past century, the annual average temperature in China has increased 0.5 ° C ~ 0.8 ° C. This increase even slightly higher than average global temperature increase in the same period and the impact of global warming is especially significant in recent 50 years (The State Council of the People's Republic of China, 2007). Other than the temperature increase, sea-level rise is another observable phenomenon. Over the past 50 years, the sea level in the coastal areas in China

has risen at an average annual rate of 2.5mm, slightly higher than the global average increase (The State Council of the People's Republic of China, 2007). The impact posed by climate change can be illustrated in several fields. First, The high temperature, drought, pests and other caused by climate change have already reduced agricultural production locally, which caused problems to agricultural production and food safety (National development and reform commission, 2016; Ren et al., 2013). Based on historical data and forecasting, the average temperature in China will have an increase between 2020 to 2030, which can cause a decrease of 5%~10% of the agriculture production (National development and reform commission, 2016; Ren et al., 2013). Second, the impact posed by climate change also caused significant changes in water resources. The areas are affected by the climate change include several aspects: quality, quantity, and distribution of water resources and the explorations and utilization (Ren et al., 2013). Other than the impact on the water resources, the frequency of the extreme weather also increased. The extreme weather includes extreme heat, drought, heavy rain, hail, and typhoon. The risks posed by these extreme weather are enormous, based on the report in 2008, resulting direct economic losses caused more than 3100 one hundred million yuan (Ministry of Environmental Protection of the People's Republic of China, 2008). Furthermore, these extreme weather events also threaten human health and cause epidemics. The sea level rise and its impact on the coastal area are another field, which is one of the major concerns for the port operation, shipping system and global supply chain. Nowadays, China has already become one of the world's most important cargo throughput and container throughput generator (Peng, 2012; Wang, Ng, & Olivier, 2004). It is also proved by the data. In 2010, the container throughput of China's ports reached 146 million TEU, accounting for 26% of

the global container throughput (Peng, 2012). Additionally, the growth of the port development is rapidly in recent years (Wang et al., 2004).

2.2 Why focus on China?

Our focus on China is highly relevant. First, Wu and Ji (2013) argue that the topic of adapting to climate change impacts by Chinese ports is extremely limited. Even among similar research, they mainly focus on extreme weather effects on port planning, construction, and operations. Second, previous research indicates that the attitude and perception of port stakeholders on climate change diversify between different continents (e.g., Becker et al., 2012; Ng et al., forthcoming). Given the importance (and growth) of China in recent decades, whether Chinese ports are adapting to climate change impacts effectively can pose huge impacts on the global economy and social welfare. Indeed, there is a need to understand whether the conventional 'western' approach can/should be implemented in the Chinese context and, if not, what should be done.

Indeed, ports play a significant role in promoting the development of both domestic and foreign trade in China. They also facilitate transport networks integration (Meng, 2014). At present, more than 90% of the volume of the foreign trade of goods transport is undertaken by Chinese ports (Wu and Ji, 2013). Chinese ports undertake most domestic bulk cargo shipment (Meng, 2014; Wu and Ji, 2013). Meanwhile, the development of Chinese ports needs nearly USD 15 million in the construction, renovation, expansion, and maintenance of port infrastructures (Wu and Ji, 2013). In this case, climate change

influences many countries and regions around the world. In China, there is data suggesting that, in forthcoming decades, climate change will lead to rising sea levels, falling the level of water of rivers and lakes, more frequent and severe storm surge, increasing extreme temperature and weather (Chen and Yao, 2010; National development and reform commission, 2016; Wu and Ji, 2013), and likely to pose huge impacts on port facilities and operations. Such extreme weather could generate considerable economic loss (Wu and Ji, 2013). Understanding such, the port stakeholders in China are worth to be investigated.

2.3 Adaptation and Mitigation

Adaptation and mitigation are two different kinds of strategies to respond to the impact of climate change. Mitigation refers to 'an anthropogenic intervention to reduce the sources or enhance the sinks of GHG' (Klein et al., 2007, Section 18.1.2, p.750) and the Intergovernmental Panel on Climate Change (IPCC) defines the climate adaptation as "Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects…" (Klein, R. J. et al., 2007, Section 18.1.2, p.750). In addition, the National Research Council report defines adaptation as strategies to adjust in either environment or human society to the climate change and generate opportunities while moderate the harm. The activities of adaptation include anticipatory, which happens before the impacts are observed, and reactive measures, which is after the impact of climate change (Lemmen, Warren, Lacroix, and Bush, 2008). More specifically, mitigation addresses the problems caused by climate change from its origins, whereas adaptation strategy is used to develop resilience to tackle the already existing (or predicted) impact of climate change. Mitigation

strategies are widely used by ports since they appear to gain favorable public image more easily than adaptation measures.

Risks and opportunities both existed in adaptation strategies (Giuliano et al., 2016; Zhang and Ng, 2016). The adaptation strategies in the circumstances of climate change are identified in the previous section. To be more specific these strategies are used to moderate the harm caused by the climate stimuli and meanwhile generate opportunities (Klein et al., 2011). The World Bank (2010) classified adaptation strategies into two categories, namely, private and public based on the initiating economic sector. Adaptation measures can be further categorized as planned adaptation and spontaneous adaptation (World bank, 2010). The former kind of strategies refers to adaptation which is the outcome of public policy decisions. As for spontaneous adaptation, it can be called as autonomous or spontaneous adaptation, which means that it is adopted by communities or social organizations spontaneously based on existing policy framework but without the specific policy as regulation (World bank, 2010). Besides these two classifications, both long- and short-term strategies are included in adaptation strategies (Becker et al., 2013). Both long- and short-term plans involve hard (e.g., changing equipment position and withdraw management and enhancing transportation standards and soft (e.g., improving evacuation of critical situation, including adaptation into strategic plan, learn from the spearhead in this field) options for adaptation (Becker et al., 2013; World Bank, 2010). The relatively high capital investments, typically contained in the hard ones, are usually more likely to be chosen by the management team (Becker et al., 2013; World bank, 2010). Such capital investments include labor, materials, and finance. A major reason is that soft options are more prone to

be affected by the social environment and institutional capital, while the hard components work in almost all settings (Becker et al., 2013; World Bank, 2010). However, the cost of soft interventions is relatively low, while there have been studies indicating that an adaptation plan without soft interventions is unlikely to address the problem comprehensively (e.g., Becker et al., 2013; Ng et al., forthcoming) and effectively combining the two stated options would be pivotal.

From previous literature, adaptation strategies can be applied to coastal areas (Becker, Inoue, Fischer, and Schwegler, 2012) and inland areas (Ng et al., 2013). Second, the studies of adaptation strategies are discussed and analyzed from different aspects, including the policymakers' perspective related to government regulations (e.g., Urwin and Jordan, 2008), social perception or individual awareness (e.g., Grothmann and Patt, 2005), and decision-makers' perception of adaptation strategies (e.g., Becker et al., 2012; Ng et al., forthcoming). To be more specific, government policies can be considered as guidelines for climate adaptation planning. Adaptation strategies in developing and developed countries are usually studied separately (Adger et al., 2003; Preston et al., 2011). In this case, Daniel and Cole (2008) argue that developing countries are more likely to encounter the brunt of the negative consequence followed by climate change. The limits in capacity, which varies from regions and populations, should also be considered carefully when adaptation strategies are developed and implemented (Adger et al., 2009; Patwardhan et al., 2007).

On the other hand, mitigation strategies mainly focus on the source of the global warming.

Mitigation measures can alleviate the risk posed by human-induced global warming considerably (IPCC, 2014). According to its definition (see section 1), the effectiveness of mitigation strategies can be only proven in the long term, and some experts even worry that most mitigation strategies would ultimately fail (e.g., Becker et al., 2013). In addition, the extent that the impacts will be alleviated by mitigation strategies is difficult to predict (IPCC, 2007). Various factors are able to influence the process of the implementation of mitigation strategies, including the lag of decades between emissions and the impacts and policy challenges. Swart et al. (2003) argue that mitigation measures can be classified into two categories. The first group includes technological strategies, while the other group includes some varieties in economic structure, social organization, or individual behavior (Nyong, Adesina, and Elasha, 2007; Swart et al., 2003).

It has been commonly reached an agreement that both mitigation and adaptation measures should be adopted to achieve a successful strategy (Biesbroek, Swart, and van der Knaap, 2009; Bosello, Carraro, and De Cian, 2010). Mitigation strategies are indispensable for alleviating the future possible irreversible and severe outcomes caused by climate change. Mitigation strategies mainly focus on the source of the global warming and can alleviate the risk posed by human-induced global warming considerably (IPCC, 2014). However, the consequences caused by climate change cannot be eliminated entirely only by adopting mitigation. According to some reports and historical data, in the short-term or mid-term, the temperature increase is unchangeable (Bosello et al., 2010; Hamin and Gurran, 2008; Watson, Zinyowera, and Moss, 1996). Notably, by World bank (2010), the annual global mean average temperature will rise 2.5 to 7 degree over preindustrial levels by the end of

the century, without any mitigation strategies or reduce the greenhouse gas emission substantially. Even though the number of the increased temperature seems not significant, the only increase of 2 degrees can increase the probability of non-reversible or devastating impacts (World Bank 2010). Understanding such, it is almost impossible to only apply the adaption measures to deal with the impact with this magnitude (Hamin and Gurran, 2008; Swart and Raes, 2007; World bank, 2010). In this situation, mitigation is indispensable to manage climate change. Understanding such, the consequences that come along with the increased temperature is inevitable, as well as the consequences along with the doomed temperature increasing. This implies that the effectiveness of mitigation strategies can be only proved in the long term and some experts even worried that most of the mitigation strategies would ultimately fail (Becker et al., 2013). Because of the limitation of mitigation strategies, adaption strategies are essential to reduce the unexpected outcomes due to climate change at the same time.

Biesbroek et al. (2009) highlighted that mitigation and adaptation should not be considered as two fundamentally different ways to the same issue. Instead, integrating mitigation and adaptation and trade-offs between these two strategies are supposed to be paid attention. However, adaptation and mitigation strategies usually are treated separately. Notably by Swart and Raes (2007), this difference can be identified by the Working Group structure of the IPCC. They also argued that adaptation received little attention at the climate change discussion and long-term mitigation draws more attention than short-term adaptation. Comparing with mitigation, which focuses on reducing the impact posed by climate change from its origins, adaptation emphasis on increasing the vulnerability of the facilities or

environment to the consequence caused by the negative impact posed by climate change. Different sectors in society focus on one of the strategies over the other one due to the different function. At international level, Mitigation is mainly considered as a matter of national government or global problem, whereas adaptation strategies, in the context of a regional economy and society, are more paid attention by managers in natural resources organizations and individuals or companies (Tol, 2005; AMICA, 2008), aiming at local problems (Swart and Raes, 2007). There is no doubt that individuals or companies will take some mitigation measures, but few of them conduct these measures initiative (Tol, 2005). To be more specific, the governments provided the incentives and education for the individuals and companies to mitigate their emissions. For mitigation, the main approaches to achieve this strategy are reducing greenhouse gas emission. Meanwhile, several approaches can be made for the adaptation strategies to be accomplished. For example, moderating the exposure to climate change, reducing the vulnerability or enhancing the capacity to adapt to the impact. Adaptation is the organizations or governments manage to adapt to the unavoidable events, such as the extreme weather. At the same time, mitigation is needed to eliminate the unmanageable (Klein et al., 2007).

As mentioned in the previous paragraphs, a trade-off is needed for these two strategies, because these two strategies are supposed to affect each other through costs and benefits at an aggregate level (Kane and Shogren, 2000). Swart and Raes (2007) argue that an optimum balance between these two strategies should exist theoretically. They believe that ultimately more mitigation leads to less adaptation needed. A similar question is put forward by Tol (2005). However, the balance or integration of mitigation adaptation

remains unsolved. There are several approaches for the Adaptation to be accomplished. For example, moderating the exposure to climate change, reducing the vulnerability or enhancing the capacity to adapt to the impact. Adaptation is the organizations' or governments' initiatives to address (likely) unavoidable events, such as extreme weather. At the same time, mitigation is needed to eliminate the unmanageable (Klein et al., 2007). Understanding such, more mitigation might ultimately lead to the reduced need for adaptation. According to the World Bank (2010), the annual global mean average temperature would rise between 2.5 and 7 degrees over pre-industrial levels by the end of this century without any mitigation strategies or reduce the greenhouse gas (GHG) emission substantially. Even though the stated temperature rise does not seem significant, it could increase the probability of non-reversible/devastating impacts (World Bank, 2010). Indeed, both mitigation and adaptation are required to address short- and long-term needs. However, as mentioned in the previous paragraph, the adaptation strategies are not treated as same as mitigation in some countries. In this thesis, to understand the importance of the adaptation and the attitude of the port stakeholders towards climate change adaptation, the author used the mitigation to compare with the adaptation strategies.

2.4 Reason for the selected theory

This thesis studies the attitude of port stakeholders toward climate change adaptation strategies. Two kinds of theories are chosen. The Maslow is used to analyze the reason behind the attitude towards climate change adaptation. The other two theories are used to infer the hypothesis. The Maslow theory can be used to analyze the intention of the port

stakeholders when speaking of the implementation of adaptation strategies. The intention of this study can be summarized as a question: Does the port stakeholders believe that it is necessary to implement adaptation strategies? The result of this question can be considered as a decision for the port stakeholders. Understanding such, we believe theories related to the decision-making process can be applied. Most theories related to the decision-making process were considered, some explain the motive to decide. (Cognitive Dissonance (Festinger, 1962)) . Some theories analyze the thinking process of decision-making. (unconscious thought theory (Dijksterhuis and Nordgren, 2006)) Some theories are used to explain the whole decision-process which used to explain how decision-makers make decisions from step to step. (the image theory (Beach, 1990)). After reviewed all these theories, two theories are identified as most suitable in the context of climate change.

2.5 Maslow's hierarchy of needs

This thesis investigates how the port stakeholders consider the adaptation strategies and the reason behind the attitude. The adaptation strategies can be considered as a kind of need for the port stakeholders. Maslow (1943) raised a theory to describe the human's motivation to reach different goals. These needs are divided into five stage, including terms "physiological," "safety," "belonging and love," "esteem" and "self-actualization." Based on this theory, only when the lower level need is fulfilled, then the human will pursue higher level need. It is not easy to only be considered the port stakeholders as human and classify the different needs of the port stakeholders. In further research, studies classify the different levels of needs can be investigated. This theory argues that only when lower needs

are satisfied, then the higher-level need will be pursued. Therefore, in this thesis, the normal operation and profit-making can be considered as the basic needs for the port stakeholders and the adaptation strategies are considered as a higher-level need for the port stakeholders. Based on this theory, the author proposes that when the basic needs of the ports are satisfied, the port stakeholders will consider implementing adaptation strategies further.

2.6 Ambiguity effect theory

Ambiguity effect is first described by Ellsberg (1961) who defines it as a cognitive bias of decision-makers. The bias is caused by a shortage of information in the decision-making process. The missing piece of information can also be considered as "ambiguity." Ambiguity effect means that people tend to make decisions or choose options whose outcome is known or a positive consequence, rather than options whose outcome is unknown (Ellsberg, 1961; Frisch and Baron, 1988). One examination for ambiguity effect is that people have an instinct to avoid any choices where information is missing (Ritchie, 2011). In addition, the missing information can be considered as the information that the decision-makers have yet to obtain. In turn, this leads them to search for missing information. However, the missing information is not accessible (Frisch and Baron, 1988; Ritov and Baron, 1990). In the climate change context, the port stakeholders have bounded rationality, so we presume that bias exists in the decision-making process. Substantial impact in the future is difficult to estimate. Understanding such, the impacts posed by climate change can be considered as the required information to decide whether to implement climate adaptation strategies or not in the circumstance of climate change,

which is consistent with the definition of ambiguity effect. Based on the definition of ambiguity effect, if the impact of climate is severe to the port stakeholders, the port stakeholders are supposed to believe that some strategies are necessary for their ports. We apply this theory to this study and presume the port stakeholders as a group of decision-makers. According to this theory, we presume the known outcome as the economic loss which causes by the climate change impact. Based on the ambiguity effect and the definition of climate adaptation (see Section 1), we can propose the first hypothesis, as follows:

H_1: The port stakeholders believe the adaptation strategies are necessary when the impact of climate change will cause an economic loss on ports or terminals

2.7 Hyperbolic discounting

Hyperbolic discounting is used as an alternative model to exponential discounting which is used to explain a scenario that people prefer a reward which comes sooner than later because the value of the later reward is increasingly discounted depending on the length of delay (Frederick and Loewenstein, 2002; Green and Myerson, 2004). The difference between exponential discounting and hyperbolic discounting is that the latter does not only explain the scenario as mentioned above but also explains that when all the choices appear to generate long-term benefits, then the more considerable benefit(s) will be chosen (Ainslie, 1974). In addition, in hyperbolic discounting, the rate that the valuations fall in the earlier delay period is slower than, the more extended delay periods. However, the rate of falling valuations is constant in exponential discounting (Thaler, 1981). Also, Laibson

(1997) points out that hyperbolic discounting is about to explain people's temporary preferences for smaller rewards which happens sooner instead of larger ones that happen later.

Hyperbolic discounting has been applied in a wide range of areas, including lapses in willpower, health insurance, consumption choices over time, saving for retirement, borrowing on credit cards, procrastination, addiction, and other personal finance decisions (Ainslie and Monterosso, 2003; O'Donoghue and Rabin, 1999, 2000). In addition, hyperbolic discounting has been used to explain the divergence between privacy attitudes and behavior (Acquisti and Grossklags, 2004).

In the context of climate change, we consider rewards as the benefits or returns after the implementation of climate adaptation strategies. Based on the definition of climate adaptation strategies (see Section 1), we understand that such adaptation strategies should reduce the vulnerability of port facilities that be considered as the benefits after implementations. In this regard, Ng et al. (2016) argue that ports need to develop long-term plans so as to enhance resilience to climate change impacts. Indeed, the adaptation strategies are usually long-term plans, and thus the effectiveness of adaptation strategies largely depends on whether adaptation strategies can reduce the vulnerability substantially in the long term. Are there any benefits in the long term that would create incentives to port stakeholders to seriously consider the importance of climate adaptation strategies? Based on the definition of hyperbolic discounting, port stakeholders should believe that adaptation strategies are necessary only when they believe that such strategies can generate

benefits in the future[3]. In addition, the benefits are considered as reducing the vulnerability of ports. In this case, we can propose the second hypothesis, as follows:

H_2: Port stakeholders believe that adaptation strategies are necessary when the adaptation strategies would reduce the vulnerability of ports to climate change in the long term.

2.8 Port stakeholders and factors that influence attitude

The port stakeholders are composed of various groups which are illustrated in the previous chapter. The implementation of climate adaptation strategies is considered as a decision for port stakeholders. As mentioned, in this study, we investigate the attitudes of port stakeholders from the organizational perspective. In this regard, we can identify two kinds of decisions that exist in the management decision process, namely strategic decision, and tactical decision. The former involves decisions that are related to department, facility, and companies' vision and long-term plans (Bacharach, Bamberger, and Mundell, 1995; Rubin, Pruitt, and Kim, 1994). The author considered the decisions about implementation of climate adaptation strategies from the managerial decision-making context and thus considered adaptation strategies as strategic decisions.

As strategic decisions can be considered as the further plan or direction of the entire company, different factors can affect the final decision in organizations, including port stakeholders (Simons and Thompson, 1998). Rajagopalan (1993) classifies three categories

[3] The benefit is considered as a larger reward in the long-term than that in short-term and that the adaptation strategies cannot reduce the vulnerability of ports or the effect is not apparent is considered as a small benefit

of factors that influence strategic decisions: environmental factors, organizational factors, and decision-specific factors. In this case, Hambrick and Mason (1984) add individual characteristics as another category. Individual characteristics include environmental dynamism, environmental opportunity/threat, environmental heterogeneity and uncertainty (Nooraie, 2012), national culture, and national economic conditions (Rajagopalan, 1993; Simons and Thompson, 1998). As the general environment in this study is climate change impacts, the opportunities, threats, and uncertainty in this context can be summarized as opportunity and risk after the implementation of climate adaptation strategies. Simultaneously, the factors related to national culture and economic condition include government policies and other organizational support. The internal organizational factors refer to organizational slack, structure and power, and performance (Nooraie, 2012). Also, in general, personal characteristics can be considered as management team characteristics. This is because, in most organizations, decisions are undertaken by a group of people rather than just one single individual. Nooraie (2012) illustrates some major factors in these categories, which include risk propensity, personal education and experience, group consensus, ages, cognitive complexity and diversity, and the need for achievement. The category of decision-specific factors focuses on the nature of the issue. Therefore, the author does not focus on the individual perspective, but from the organizational perspective.

2.9 Research framework

Figure 2.1 provides an overview of the research framework used in this study. The study process is divided into four stages. In the first stage, the respondents' perception of the

impact of climate change on ports or terminals is identified. Then, the current measures in the port stakeholders surveyed are investigated. In the third stage, two situations of the vulnerability with and without climate adaptation strategies are presented. The factors that may influence the attitude of port stakeholders will be tested in the last stage.

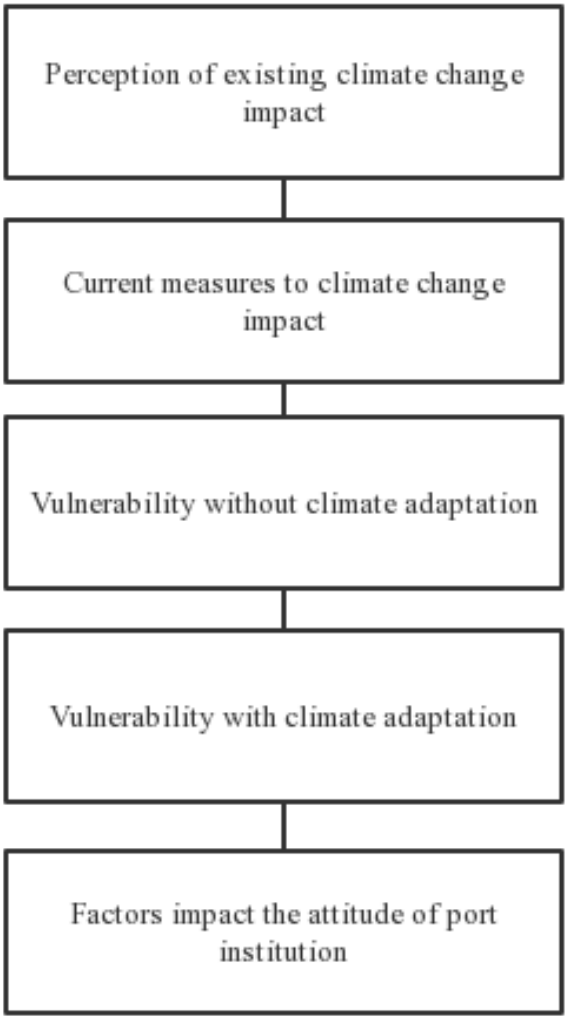


Fig. 2.1 Research Framework

2.10 Port stakeholders

The individuals or groups who will directly be influenced by the risks posed by the climate change impact and who are responsible for implementing and sustaining the adaptation

strategies should be considered by the port stakeholders. (NRC[4], 2010). In addition to this, the port stakeholders can also be divided into internal and external stakeholders. Messner, Becker, and Ng (2015) put forward this classification, and the attitude from different groups of port stakeholders can be different towards climate change, which could be helpful to understand their attitude from various aspects. The internal port stakeholders refer to the stakeholders that are involved in the operation management of ports or terminals. A broad range group of stakeholders can be considered external port stakeholders. The organizations which have business relationships with ports or terminals can be classified as economic or contractual stakeholders, which include other shipping companies (e.g., logistics companies, shipping agency, and truck companies). The stakeholders that are involved in making policy for ports are public policy stakeholders, including related government departments and environmental and emergency agencies. The academic and technical stakeholders include the organizations which do related research and can be consultants to the port operation management. The environmental stakeholders include the organizations that can be impacted by the port operation (e.g., the environmental groups which protect the environment). Different groups of stakeholders would analyze the climate change issue from their perspective. Understanding the attitude toward climate change adaptation from these diverse aspects can help to understand the reason behind the attitude. For example, the environmental stakeholders probably mainly focus on the green ports and the cost that to implement the adaptation strategies is less important to them. On the other hand, the cost may be an essential factor to the management team of the ports.

[4] NRC refers to National Research Council.

Chapter 3: Methodology

3.1 Related research

To our best understanding, this is the first research to solve the attitude of the port stakeholders in China on adaptation in the circumstances of climate change. Thus, we believe that the study is a valuable reference for further researchers in studying port stakeholders and other economic divisions, including other transportation and energy infrastructures. In fact, a few similar pieces of research have been done before. Among them, Becker et al. (2012) conducted a survey studying the perception of port administration in developed and developing countries. They received 89 responses from different ports focusing on questions related to port planning horizon, climate change strategies, and the attitude of the port administration toward climate change impacts. They found that sea-level rise was considered as the major impact posed by climate change. In addition, many respondents argued that the climate change brought negative impact to respective ports. Some other works of literature also did similar studies. For example, a survey was conducted by Texas A&M University and indicated that half of the respondents believe the climate change impact their ports (Bierling and Lorented, 2008). In addition, Ng, Chen, Cahoon, Brooks, and Yang (2013) investigated the ports in Australia about the impact posed by climate change and adaptation. This study focused on how port stakeholders are considering the impact posed by climate change and climate adaptation strategies.

3.2 Survey and Interview

A questionnaire was designed to collect data on the attitudes of 20 port stakeholders in China on climate change adaptation strategies. The rationale to choose the survey for data collection is that it can offer an overview of the research questions. Additionally, limited data can be accessed from the database due to the relatively new topic. To enhance our understanding of the survey results, after the survey, nine in-depth interviews with relevant personnel were also conducted.

3.3 Sample and distribution

The snowball sampling technique was used for the selection of relevant potential respondents. We started with the senior management officers of the port stakeholders of respective ports in China. The questionnaires and the interview were delivered face-to-face to ensure the response rate. As this study aims to acquire an overview of the attitude of port stakeholders, following the process by (Zhang and Ng, 2016), the respondents are titled as a port president, operation manager, and director of the strategy and business development.

3.4 Selected climate impacts

Various climate impacts on ports exist. Understandably, this study is not able (nor desirable) to cover all the aspects of climate change impacts. As mentioned, sea-level rise and storm surge are identified as the most significant climate change impact on ports (Becker et al.,

2012; Hallegatte et al., 2011; Ng et al., 2013; Yang et al., 2017). Also, further study suggests that the top-2 climate change impact concerns ranked by respondents are sea-level rise (about 52%) and storm impacts (about 45%) (Becker et al., 2012). Thus, we chose sea-level rise and storm impacts as the factors for further analysis

3.5 Questionnaire design

This survey is designed to test two hypotheses. In the first one, the independent variable (IV) is the time. The time duration will be ten years from now. The dependent variable (DV) is the severity of the impact of climate change. For the second hypothesis, IV is whether to implement climate adaptation strategies or not. DV is the extent of the impact of climate change. Adaptation plans are corresponding to each climate change impact. We developed a scoring system based on the possible consequence of climate change impact with and without the implementation of climate adaptation strategies in ten years. We assigned three evaluation standards – timeframe, the severity of the occurrence and the likelihood of an event occurring for each possible consequence with and without implementation of climate adaptation strategies (Ng, Yang, and Cahoon, 2013). Each of the evaluation standards has a score scale that ranged from 1 to 5.

3.6 Data Analysis: Statistical test

In this study, we compared two groups of ordinal variables. The extreme value could influence the results, and so calculating mean for the statistical test was not meaningful.

Understanding such, sign test was used to identify the difference between the median. SPSS was used as the computational package to apply the sign test (Lehmann and D'Abrera, 2006).

3.7 Interview design

From the above, we found that some research gaps are present: do port stakeholders in China recognize the impacts posed by climate change on respective port and terminals operations and other activities? What plans, and actions are being implemented in respective ports or terminals so as to assure effective mitigation and adaptation strategies? How do port stakeholders balance between mitigation and adaptation strategies? These issues can be summarized as follows:

- Major climate change variables that affect the port stakeholders.
- Climate impacts on supply chains
- Impact posed by climate change on operation or business activities of port stakeholders
- Climate adaptation plans.
- Comparison between adaptation and mitigation strategies

One should note that getting access to information about climate adaptation strategies among Chinese port stakeholders was difficult, while secondary data related to climate adaptation strategies were insufficient too. This might be explained by the fact that: 1) adaptation strategies are yet to develop in most port stakeholders in China, thus limiting the information that can be obtained; 2) updated information on business activities and

research may not be developed at the same pace; and 3) specific institutional constraints limit the availability of such data.

Understanding such, the best approach in conducting the study is through in-depth case study, with the objective to explore and understand unrevealed data so as to explain complex phenomenon that is otherwise difficult to be explained by other (especially quantitative) means (Baxter and Jack, 2008; Feagin et al., 1991; Gray, 2014; Yin, 1981). To collect the necessary data, we conducted ten semi-structured, in-depth interviews with relevant industry professionals coming from nine port stakeholders. The case study design was therefore restricted to one private wharf, six ports, and two other port stakeholders. Within this restricted sample, we aimed to cover different ports and port stakeholders whose activities spanned a range of geographic locations. These ports and ports stakeholders located along the Chinese coastline, including HongKong International Terminals, Jiuzhou Port, Jiangmen Port, Guangzhou shipping company, Fuzhou Port, Zhoushan Port, Shanghai Port, Guangzhou port, Zhuhai Port office. One private wharf, six ports situated in different regions of China were chosen for exploratory studies. In addition, two port stakeholders are studied for understanding the overview of the impact posed by climate change on port stakeholders in China and their attitude toward the measures of mitigation and adaptation in a more comprehensive way. We aim to investigate the perception of these port stakeholders understand, forecast, plan, and implement strategies that address the impacts posed by climate change in their operation and other activities. The connection with the shipping lines and nodes is also studied. These port stakeholders were chosen because they were closely related to the port operation and so the

implementation of adaptation strategies would strongly affect their operation and interests. For example, one participant was from the shipping agency. The operation of ports was closely connected to their business. Each interview lasted for about an hour, including four over the phone and six face-to-face interviews. Six main issues have been discussed, as follows:

(1) The historical and current impact posed by climate change on ports and in their districts

(2) The impact posed by climate change on supply chain

(3) The adaptation to response to impact posed by climate change

(4) Comparison between mitigation and adaptation strategies

(5) The forecast about climate change

(6) Factors or barriers when implementing the adaptation strategies

Chapter 4: Survey Result

4.1 Analysis of Survey result

The results describe how port stakeholders consider climate adaptation strategies which cope with sea level rise and storm surges, current measures to deal with climate change, and the recognition of the port stakeholders, as well as the port stakeholders' attitude toward climate adaptation measures and mitigation strategies. We first provide an overview of the basic information of the ports and the general response from the ports surveyed. Next, we discuss the current climate change planning in these ports. In addition, we will verify the hypothesis. Finally, we will discuss the characters of the ports that correlate with the attitude of port stakeholders to the climate adaptation strategies.

4.1.1 An overview of the response and basic information from the port stakeholders surveyed

We assess the port stakeholders' perception of the severity of climate change impact by asking the situation of current emergency strategies response to the impact posed by climate change. Port stakeholders are asked to assess the climate change impacts from different aspects.

It is found that all the surveyed port stakeholders have emergency plans. In this case, most

respondents have read them, and most port stakeholders have a particular emergency department, and this suggests that, from the strategy level, all the surveyed ports have an intention to respond to climate change impacts. Regarding implementation, 85% and 45% of the respondents report that they have routine horizontal plane monitoring and routine flood monitoring, respectively. Additionally, respondents who report that they do not know or do not have routing horizontal plane monitoring have the same answer with routing flood monitoring. We also asked the frequency of the response exercise of flood and typhoon (Fig.4.1).

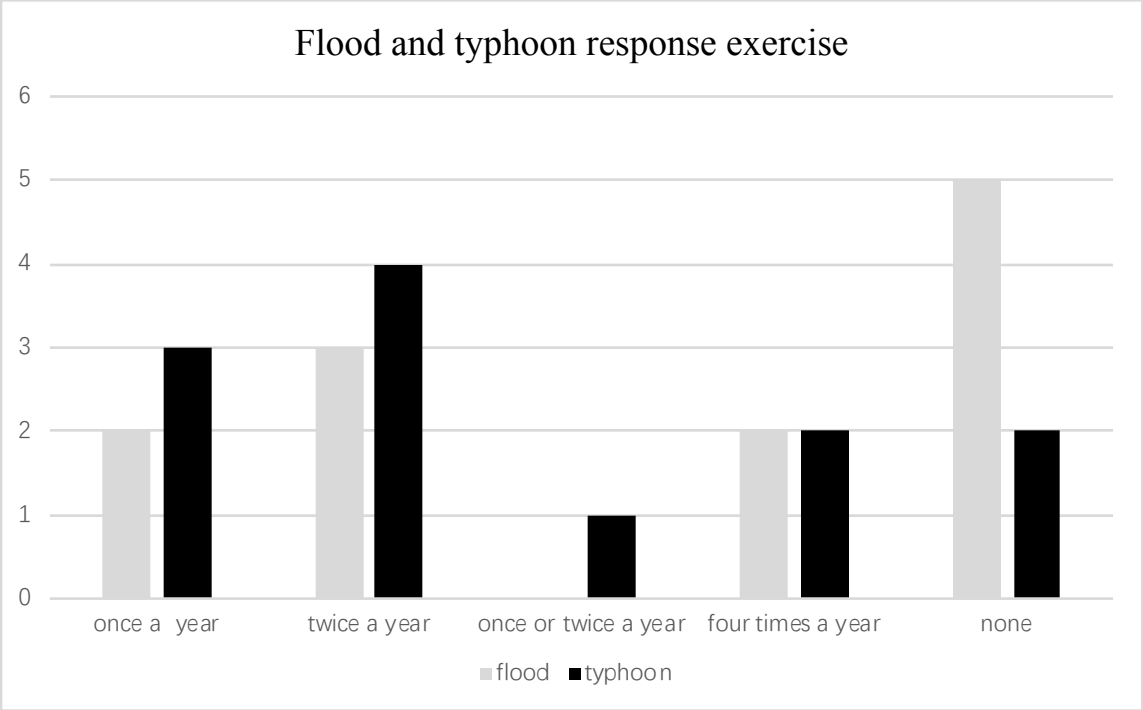
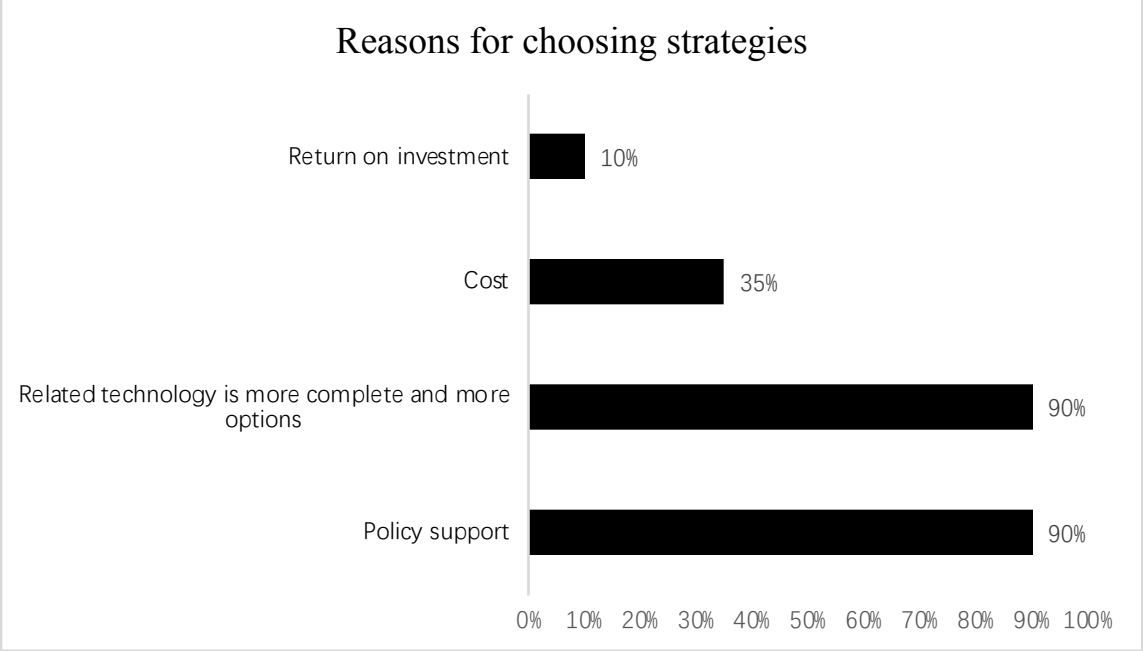


Fig.4.1 Flood and typhoon response exercise

Respondents report a high frequency of typhoon response exercise than response exercise. Almost half of them indicate that they do not have flood response exercise. The frequencies of response exercise of flood and typhoon are nearly the same in the same port stakeholders,

except some only have typhoon response exercise.

Mitigation to climate change is vital to most of the operations of the ports that we have surveyed. To realize the extent of the importance of the adaption strategies to port stakeholders, we compare them with respective mitigation strategies. In this study, we focused mitigation strategies on energy conservation and GHG emission reduction. 60% of respondents feel that mitigation strategies are more important while the rest believe that adaptation strategies are more critical. To figure out what lead to the attitude of the respondents towards these two kinds of strategies, we asked them to choose some reasons to support their choice (Fig.4.2).



% with respondents (n=20)

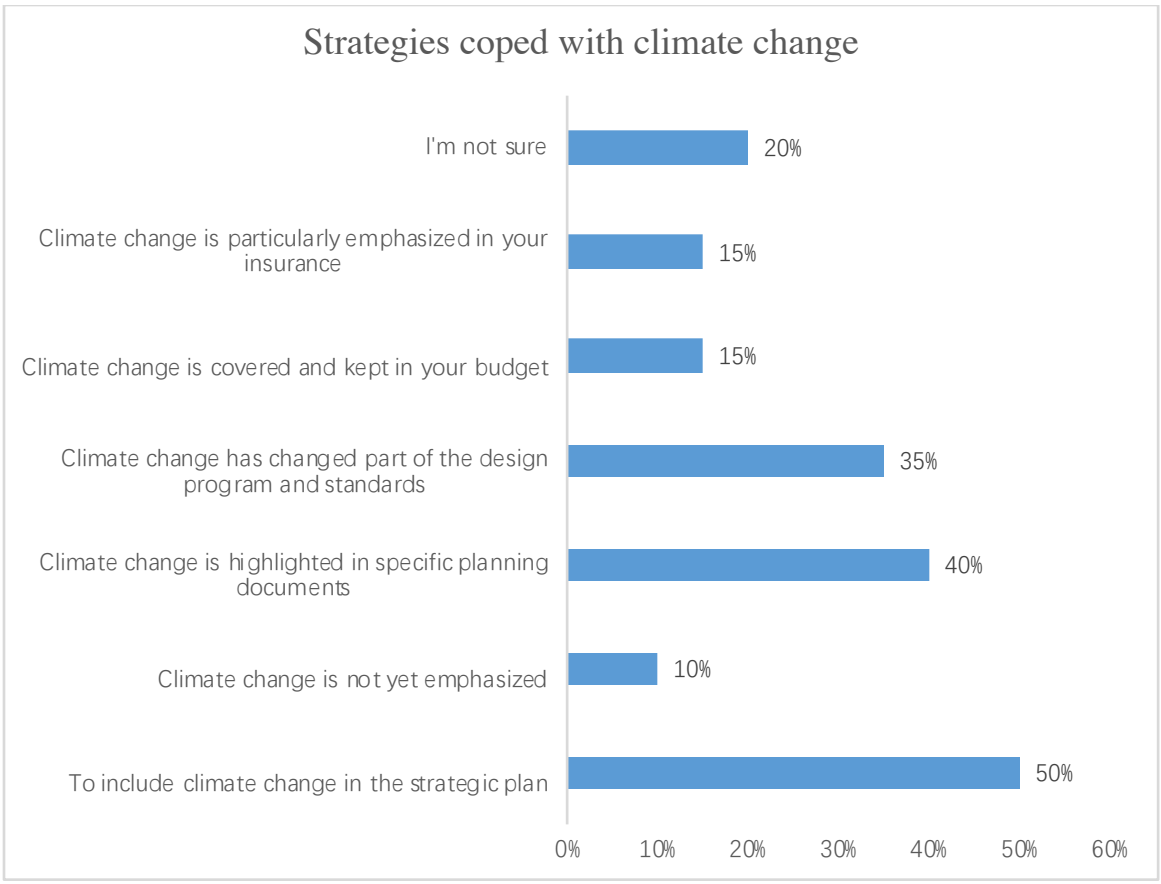
Fig.4.2 Reasons for considering which strategies are more important

As indicated in Fig. 4.2, the majority of respondents believe that policy support and related

technology are reasons for them to choose the strategy. Besides, they believe that they can have more options if they receive policy and technological support.

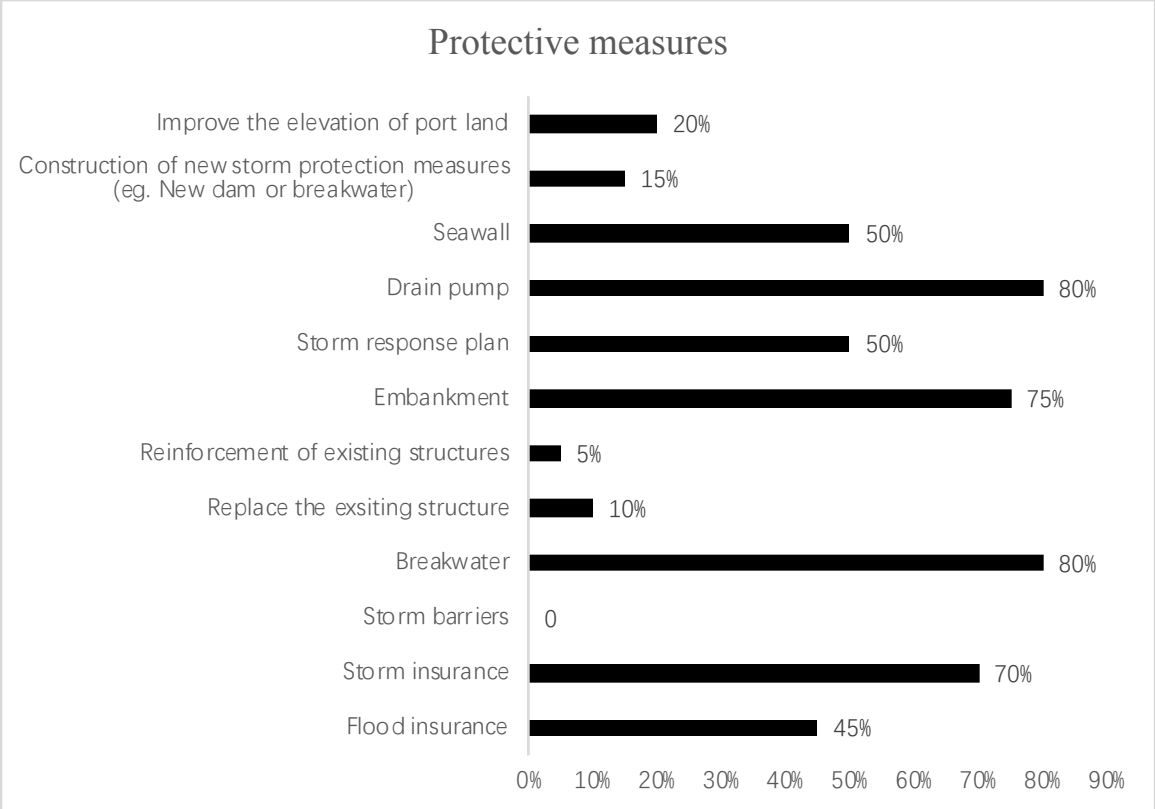
4.1.2 The current climate change planning in these ports

To understand that how ports respond to current climate change and impacts, we ask respondents the strategies that they used to deal with the risks and impacts on their ports (Fig.4.3). Only half of the port stakeholders have included the issue of climate change in their strategic plans, and this strategy is relatively common for the port stakeholders to deal with the impact of climate change among all the options. In addition, we also asked respondents about the current protection measures they used (Fig.4.4). A majority of the port stakeholders implements drain pump (80%) and Breakwater (80%) stakeholders, and none of the port stakeholders implement storm barrier.



% with Respondents (n =20)

Fig.4.3 Strategies coped with climate change



% with respondents (n=20)

Fig.4.4 The protective measures for current port item

4.1.3 Port stakeholders' attitude toward climate adaptation strategies and hypothesis verification

The sign test is conducted 38 times for each factor regarding SLR and storm surge, as 14 adaptation measures are addressing ten impacts and each adaptation measure has three parameters (timeline, the severity of consequence, and likelihood).

H_1: The port stakeholders believe the adaptation strategies are necessary when the impact

of climate change will cause an economic loss on ports or terminals of port stakeholders

Fig. 4.5 is the example of one of the outputs. The two-tailed test is used to evaluate if the difference between current and future. The *p*-value in this figure indicates the positive differences. The *p*-value in Fig. 4.5 is 0.453 which is higher than 0.05; then we should accept the null hypothesis. Fig. 4.5 means that the severity of the consequence of high waves in the future is not significantly different from that in the current situation. Similar comparison analysis is conducted about other climate change impacts due to sea-level rise and storm surge. All the *p*-values are more than 0.05, which means that respondents believe there is no significant difference of severity of the consequence of the climate change impact between current and future. Therefore, H_1 is rejected.

Sign Test

Frequencies

		N
F1aC - risk1sea1	Negative Differences[a]	2
	Positive Differences[b]	5
	Ties[c]	13
	Total	20

a. F1aC < risk1sea1

b. F1aC > risk1sea1

c. F1aC = risk1sea1

Test Statistics[a]

	F1aC - risk1sea1
Exact Sig. (2-tailed)	.453[b]

a. Sign Test

b. Binomial distribution used.

Fig.4.5 An example of SPSS output of current and future comparison

H_2 *the port stakeholders believe the adaptation strategies are necessary when the adaptation strategies would reduce the vulnerability of ports to the climate change in the long-term*

We analyze the results of the consequence in the three evaluation standards differently. Fig.4.6 is an example of the comparison between with and without climate adaptation strategies in the future. The two-tailed test is used to evaluate if the difference between with and without climate adaptation strategies in the future. The *p*-value in Figure 4.6 is

0.22 which is more than 0.05, and thus we should reject the null hypothesis. The null hypothesis in Figure 4.6 means that the severity of the consequence of coastal erosion with the strategy of protecting the coastline and developing the beach nutrition plan is significantly different from that without the strategy. Similar comparison analysis is conducted about other with and without climate adaptation strategy to cope with the impact due to sea-level rise and storm surge. Only three *p*-values of all the results are less than 0.05. The significant results are from the severity of consequence of coastal erosion and port facilities damage due to storm surge and the likelihood of port facilities damage due to storm surge. In an overall, the surveyed port stakeholders think that most of the climate adaptation strategies cannot make any significant difference to climate change impacts on the ports except these three adaptation strategies. This indicates that port stakeholders' perception of climate adaptation strategies can be the main barrier to the effective implementation of climate adaption strategies in ports. In addition, this suggests that the port stakeholders believe that the adaptation strategies are not necessarily due to no significant difference between before and after the implementation of adaptation strategies. Therefore, H_2 is accepted.

Sign Test

Frequencies

		N
V1cC - F1cC	Negative Differences[a]	2
	Positive Differences[b]	11
	Ties[c]	7
	Total	20

a. V1cC < F1cC
b. V1cC > F1cC
c. V1cC = F1cC

Test Statistics[a]

	V1cC - F1cC
Exact Sig. (2-tailed)	.022[b]

a. Sign Test
b. Binomial distribution used.

Fig.4.6 An example of SPSS output of with and without adaptation strategy comparison

4.1.4 The factors that has impact on the attitude of ports stakeholders to the climate adaptation strategies

In an overall, according to survey results, respondents believe that there is no significant difference before and after implementing climate adaptation strategies. Thus, based on the factors that impact strategic decisions motioned above, we tested if these factors could influence the attitude of port stakeholders toward adaptation strategies.

To realize the environmental factors' impact on respondents' attitude, we asked respondents

about other organization (e.g., local universities, non-profit organizations, and teams of scientists) and policy support and technology impact. Fig.4.7 is an example of comparison between with and without adaptation strategy to cope with high waves concerning timeframe. For port stakeholders that accept other organizations' support, none of the *p*-values is significant. For port stakeholders who do not accept other organizations' support, after improving the standard of port construction, the likelihood of the land access to ports or terminals is less than without improvements. This dimension is the same as one of the significant aspects of the attitudes of port stakeholders in general.

Sign Test

Frequencies

		N
V1aT - F1aT	Negative Differences[a]	2
	Positive Differences[b]	1
	Ties[c]	6
	Total	9

a. V1aT < F1aT
b. V1aT > F1aT
c. V1aT = F1aT

	V1aT - F1aT
Exact Sig. (2-tailed)	1.000[b]

a. Sign Test
b. Binomial distribution used.

Fig. 4.7 an example of SPSS output

For respondents who believe that there is policy support, only two of all the indicators of statistical significance is less than 0.05 (two-tailed). For those who do not think there is policy support, only one of the *p*-values is significant. Two p-values are less than 0.05 with technology impact and none without technology impact. In addition, these two significant aspects are the same as the aspects regarding policy support. Only one respondent believes

adaptation is more accessible does not choose technology support.

To understand the factors related to internal organizations, we analyze the impact of the cost and return of climate adaptation strategies. The analysis process is similar to environmental factors' analysis process. Fig. 4.8 is an example of comparison without considering the cost as an obstacle between with and without adaptation strategy to cope with high waves in terms of timeframe. Two *p*-values are significant and are in the same aspects of climate impact as policy support and technical support.

Sign Test

Frequencies

		N
V1cC - F1cC	Negative Differences[a]	0
	Positive Differences[b]	6
	Ties[c]	1
	Total	7

a. V1cC < F1cC

b. V1cC > F1cC

c. V1cC = F1cC

Test Statistics[a]

	V1cC - F1cC
Exact Sig. (2-tailed)	.031[b]

a. Sign Test

b. Binomial distribution used.

Fig. 4.8 is an example of SPSS output.

Considering the impact of the factor that long the duration of investment return, three

significant statistical indicators exist. One of the *p*-values (considering the impact of the factor that long the duration of investment return) falls in the same kind of climate impact as one of the significant *p*-values in general attitude (without considering any other factors including environmental and organizational factors).

4.2 Discussion and recommendation

The port stakeholders in China, a country with the largest number of ports in the world, are unique and deserved to be studied in detail (Gao and Sun, 2002). The To the end of the last century, the number of the ports whose the annual throughput is more than 40,000 tons is more than 2000 (Gao and Sun, 2002). In addition, the external ports approved by the Chinese government is 134 (Gao and Sun, 2002). Both Gao and Sun (2002) and Zhang (2000) point out that the main difference between Chinese ports and other ports in western countries in terms of management is that most ports in China are centrally managed, whereas many ports in other nations are decentralized or under district management. As mentioned earlier, five semi-structured, in-depth interviews were conducted to help understand the survey results. Based on the information collected, we manage to highlight such differences. Quoting an interviewee:

'Most major ports in China are centrally managed by the central government, especially those foreign trade ports."

In addition to the management difference, some other aspects are different between port

stakeholders in China and other nations. Based on Becker et al. (2012) and Ng et al. (2013), a comparison is conducted to show the similarities (Table 4.1) and differences (Table 4.2) between the port stakeholders toward climate change and adaptation. The comparative results can be found in table 4.1.

	China	Germany and the United States
Impact posed by the climate change discussion and response exercise	Routine discussion about climate change and impact. Routine impact posed by climate change response exercise (e.g., Flooding and storm surge)	
Plan for climate change	Most have the strategic plan	
Climate change impact	Major impacts: Sea-level rise and storm surge	

Table 4.1 The similarity between ports stakeholders in China and Germany and the United States.

	China	Germany and the United States
Management	Most centralization	Most district management
Attitude toward impact posed by climate change	Impacts posed by climate change are not significant	Significant impact
Attitude toward adaptation	Most believe inefficient	Some believe adaptation strategies are necessary
Climate Forecasting	Mainly rely on Bureau of Meteorology	Rely on Bureau of Meteorology and have forecasting department

Table 4.2 The differences between port stakeholders in China and Germany and the United States.

The results offer useful insight on the general attitudes of port stakeholders towards the impacts posed by climate change, notably sea-level rise and storm surge, and climate adaptation strategies. In addition, the results verify some potential factors that have an impact on the attitude of port stakeholders.

The results indicate that port stakeholders believe the consequences of climate impacts on their ports or terminals will not become more severe. However, according to the Second National Assessment Report on Climate Change editing committee (2011), ports or wharfs face substantial climate change impacts. In the next three decades, the sea level is expected

to rise to 8-13 cm and even higher in some major Chinese cities and regions, such as Tianjin, Shanghai, and the shorelines along the Guangdong Province. Moreover, it emphasizes the impact of flooding and storm surge will weaken the ports' or wharfs' function.

One possible reason for this inconsistency may be the severity of climate change impacts in the future on these ports are not evident in the context of Chinese ports. Wu and Ji (2013) point out that the national climate change forecasting is mainly accurate for large areas and long-term climate change, but uncertainties still exist in specific areas. Another possible explanation is that the technology for climate change assessment is still in its embryonic stage that requires further development and improvement. At present, impact assessment and adaptation research on climate change are mainly concentrated in agriculture, water resources, terrestrial ecosystems, and coastal areas, and very few (if any) studies on similar topics focus on traffic and ports (Wu and Ji, 2013). Based on our analysis of the current climate adaptation plans and implementation of these plans, we found that many ports have overlooked the impacts of flooding and the response exercises. When impacts are not foreseeable easily or the extent of the severity of the extreme weather beyond that of the previous events, port stakeholders do not possess an accurate recognition of climate change and its impacts. As a result, the perception of climate impact assessment measures and the trade-offs between the costs and benefits of response measures may not be consistent among all ports and stakeholders. In this case, the ambiguity effect theory partially explains this situation. As mentioned, the ambiguity effect theory can be used to explain the attitude of the port stakeholders when they believe the economic loss of the impact posed by climate change is uncertain. More specifically, if decision-makers in port stakeholders believe that

the severity of consequence due to climate change will not cause a significant change in the future, they tend to feel that there is no need to implement any climate adaptation strategies or measurements. In the context of climate change, the ambiguity information or the missing information can be considered as the uncertain economic loss. According to the ambiguity effect theory, port stakeholders believe the adaptation strategies are not necessary. However, in the climate change context, climate change impacts are not the only factors when decision-makers consider climate adaptation strategies. Other factors which we analyze later can also impact the port stakeholders' attitude about adaptation strategies. Without considering other factors, the ambiguity effect theory can only partly explain this result. Understanding such, the limitation of the ambiguity effect in the context of climate change should be that only one primary factor is discussed. To improve this theory, a constraint should be added, which is when other factors are the same and certain. Despite the limitation of the ambiguity effect theory, this theory can also be applied in studying related climate change research.

The second hypothesis is concerned with the respondents' attitude towards the effectiveness of climate adaptation strategies. Our findings suggest that port stakeholders believe that most of the adaptation strategies will not reduce the vulnerability of respective ports or terminals. Considering the results from the first hypothesis, this result seems reasonable. In this case, the hyperbolic discounting can explain the attitude of port stakeholders towards climate adaptation. Because port stakeholders do not believe that adaptation strategies can reduce the vulnerability of the ports, they become unnecessary. Thus, we argue that the hyperbolic discounting can explain the attitude of port stakeholders

toward adaptation strategies. However, the result of the first hypothesis proves that the port stakeholders believe that the economic loss posed by climate change is uncertain. Understanding such, the reason that the port stakeholders believe the adaptation strategies cannot reduce the vulnerability of the port is that the strategies are useless or that the impact posed by climate change is uncertain cannot be solved according to hyperbolic discounting. Applying to climate change, the application of hyperbolic discounting should also add a constraint.

However, a few aspects are indicating that there is a significant difference between with and without climate change adaptations. First, two of the significant p-values fall in the parameter of the severity of consequences regarding sea-level rise and storm surge separately. In addition, two of them fall in the same climate adaptation strategy of storm surge, meaning that these two adaptation strategies can partly reduce the vulnerability from the decision-makers' point of view. One possible reason is that port stakeholders believe other adaptation strategies are not useful (in the context of their ports), and the other is that the decision-makers do not have adequate knowledge about climate change impacts on other aspects and corresponding adaptation strategies. In addition, other factors that can influence the general results are analyzed. Considering previous data analysis, only half of the respondents reveal that they include the potential impacts of climate change into their strategic plans, and even fewer are sure about the strategies coping with climate change or believe the climate change is not yet emphasized. In addition, comparing with plans coping with flooding, fewer measures adopted by port stakeholders deal with storms. This is an explanation for more significant p-values fall into the aspect regarding storm surge because

measures are implemented to respond to storm surge are not enough. This calls for more education and attention to employees and stakeholders in port stakeholders on the impacts posed by climate change.

The environmental factors included in this study are policy, other organization support, and technology. There is one significant p-value is consistent with the general view of port stakeholders and the other one fall into the parameter "likelihood" concerning storm surge. Given such difference, policy regulation or technology support can pose an impact on the attitudes of port stakeholders toward the adaptation strategies in terms of storm surge to some extent. A possible explanation is that adaptation needs to be implemented corresponding to the policy (Becker et al., 2012). In addition, technology decides the ability to implement adaptation strategies (Wu and Ji, 2013). An interesting observation is that none of the p-values are significant regarding the port stakeholders who accepted other organizations' support. However, one p-value is significant when the port stakeholders accepted other organization support. Both risk and opportunities exist in the implementation of adaptation strategies; one possible reason is that other organizations can provide more detailed, comprehensive, and professional analysis and suggestions for the port stakeholders. Afterward, the port stakeholders possibly believe more risks and less benefit after implementation with the support from other organizations.

For internal organizational factors, there is a different significant p-value in term of cost and investment return separately, compared with the general attitude. This suggests that both cost and investment return can influence the attitude of port stakeholders partially.

The previous analysis reveals that only 15% of the port stakeholders have budgets dedicated for climate change in annual budget plans. In other words, most have not budgeted for climate change and adaptation strategies. This is one possible reason explaining why port authorities believe the most climate strategies would not reduce the vulnerability of their ports because they do not even have minimal (if any) financial resources for adaptation strategies, thus depriving them the opportunity to even think about the issue. Respondents who believe there will be an investment return consider the adaptation strategies can reduce the vulnerability in one more aspect of climate change impact. This highlights the perception that investment returns can have an impact on the attitudes of port stakeholders towards climate adaptation strategies.

Chapter 5: Case Study

5.1 Major climate variables that affect the port stakeholders

The climate variables faced by different port stakeholders are slightly different from each other. In general, the significant climate variables are rainfall and storms, dry seasons, and high temperatures. Heavy rainfalls and storm surge create typhoon and flooding, while dry seasons can lower water levels. Finally, high temperature can cause difficulties in operating activities. In this case, dry seasons will only impact ports or terminals that are not 'deep-water' ports. Ports and terminals that are located in heavily polluted cities (e.g., Shanghai) mentioned that increasing intensity of haze is another significant concern. Heavily rainfalls and storm surge can lead to land inundation. Their views about these variables correspond to the report of Intergovernmental Panel on Climate Change by Hijioka, Lin and Pereira (2013) who note that the numbers of warm days and nights have increased in past decades and are expected to continue to increase in the foreseeable future, as is the heat wave frequency. Their views are consistent with the *Climate Change Assessment Report of China* that the annual average temperature increased by 0.5 ~ C - O.8 °C and over the coastal sea level annual average increase rate of 2.5 mm in the past five decades. The climate variables are mainly determined by the location of the ports or terminals.

The linkage between these climate variables and climate change remains unclear because the experiences of these variables do not refer that it is the consequence of climate change. Each port or terminal experience direct or indirect signals of the climate change (Berkhout, Hertin, and Gann, 2006). Both direct signals and indirect signals can be interpreted by the

port stakeholders to consider whether there is a change of the climate. For example, the direct signal can be a typhoon that experienced by port A and an indirect signal can be the policy that the government asks the ports or terminals to make some changes to respond to climate change. For the direct signals, the ports and terminals need to interpret themselves. To be more specific, most interpret work is done by the company who operate the ports (Berkhout et al., 2006). As for the indirect signals, the analytical work is unusually done by a third party. The assessment publications for other organizations, the policy guidance or regulatory standards form the government and the practical guidance in the field can be considered as the indirect signals (Berkhout et al., 2006). Pointed by Ng et al. (2013), the ports in Australia have developed some research project about climate change, and the ports in the east also have a climate change assessment biannually. Related questions were asked to understand the initiative of the port stakeholders in China about climate change and the impact. The investigated ports and terminals do not have an individual department for climate change analysis or assessment. The primary sources for them are the news, the report from the related organizations and the policy and regulation from the government. The further interview question is probing the necessity of related assessment. The common answer is negative. Quoting the words from an operation manager who come from Port of Zhuhai:

"The assessment or analysis of historical climate variables is not the major task for the port operation. These researches related to the climate change would be more efficient if done by a third party. The Chinese Meteorological Administration can provide accurate information about the climate."

The source of information related to climate change is relatively single for the ports or terminals in China. This also meant that, from the interviewees, the forecasting and assessment from the Chinese Meteorological Administration are reliable and no further improvement is needed to assess or analyze the climate variables themselves.

In terms of future impacts from climate change, most port stakeholders tend to focus on these impacts with anecdotal concerns, as well as reports or instructions from the Chinese Meteorological Administration on increased intensity and frequency of rainfalls or typhoons creating storm surge or inundation which might be lead to the damage of goods in containers, port infrastructures, and other facilities. On the contrary, lower water level or changes in tide are not treated as a real concern for deep-water ports and terminals (e.g., Hong Kong International Terminals). In general, port stakeholders in China expect hotter climates in most coastal regions with storm surges with higher extremes and frequencies. Still, the actual impacts remain mostly uncertain. In addition, most of them believe that the studies of predictions or forecasting about climate change and impacts are necessary and would be helpful for their operation and business activities.

5.2 Climate impacts on supply chains

Ports related business organizations and other nodes along the supply chains also are also influenced by climate change. Thus, the interview questions in this section are separated into two aspects (ports and supply chains). Also, answers are divided into two groups based

on the organizations that interviewees came from 1) ports and terminals; 2) other port stakeholders. By doing so, the answers can be analyzed through a broad aspect. First, all interviewees agree that the ports and terminals are essential nodes of global supply chains. In terms of shipping lines and supply chain, interviewees include both the operators from the ports or terminals and the organizations which relate to ports or terminals, so the questions were asked on how climate change impacts their business, while further questions were probed on whether there would be any implication for how cargoes would move along transportation system considering the potential impacts posed by climate change.

Among their responses, we found that flooding, storm surge, and server heat are common impacts. Interviewees from port and terminals point out that the roads and railways which connected to ports can be easily damaged because of storm surge. In addition, extreme heat and cold (e.g., snowstorms in China in 2008) can lead to the delay of the shipping of cargoes that can lead to significant economic loss and depreciation of the value of time-sensitive goods. Furthermore, the impacts on major roads and rail tracks can cause the loss of the connection with relevant partners, as many original routes would become impassable. Regarding freight shipping between ports and terminals, many interviewees raise their concern about the consequential congestion of vessels which can affect planned throughputs via their ports and terminals. The primary concerns for the interviewees which corporate with the port or terminals were fine for the congestion and delay of cargo shipping.

5.3 Impact posed by climate change on operation or business activities of port stakeholders

Interviewees were also asked to consider how climate change has already impacted or might impact on their ports and terminals or, for the organizations who have related business with ports and terminals, operation or other business activities. The general impacts posed by climate change on the ports or terminals based on the climate variables discussed above are damage to facilities, notably containers, cranes, and warehouse. Sometimes, they can lead to human casualties (due to accidents). Moreover, economic loss can be tremendous when the extreme impacts posed by climate change happen to these terminals and ports. Quoting one interviewee who was the vice-president of a private terminal company:

"Last year, we experienced an unexpected typhoon which is so strong that nearly no one can stand outside. The sky suddenly became dark without an omen. Many containers were damaged, and even some of the crane scrapped…millions of dollars of economic loss because of this unexpected typhoon. We are small business compared with other port stakeholders, so this economic loss resulted in a long time for us to recover."

Besides the damage caused by the extreme climate variables, more frequent and changes in the maintenance practices have been mentioned by several interviewees. Facilities in ports and terminals located in salt water zones where the wind and water contain corrosive elements are especially vulnerable. Also, interviewees point out that the need for additional maintenance routines, include anti-corrosive measures to protect the facilities in these ports and terminals, are required. Moreover, port stakeholders located in southern China report

that they are seasonally affected by typhoons. As mentioned earlier, delay in shipping, congestion of vessels in ports and terminals, and stoppage are anticipated as the major outcomes of increasing intensity and frequency of typhoons. The number of days that ports along the southern coastline need to close their ports and suspend operations due to typhoon is significantly greater than that in the past. Also, extreme heat impacts the daily operation of ports and terminals. In China, many port operations are supplemented by human labors - usually for 24 hours of three consecutive operations and cargo space displacement. Interviewees mention that this does not only increase the maintenance practices of the facilities but also the safety of dock workers. Extreme heat can cause workers getting heatstroke much easier. Other impacts are related to lower water levels caused by dry seasons that would affect ship's passage, thus increasing maintenance and operating cost of ports and waterway dramatically.

To understand the perception of the impact posed by climate change more comprehensively, interviewees were asked about how they forecast and prepare for extreme weather and climate. Most respond that they mainly rely on the notification and forecasting from the China Meteorological Administration. None of the port stakeholders dedicated group/department within the organizations for the same purpose. In addition, some interviewees mentioned that, hitherto, few studies had been done on impact assessments and adaptation of the port and other transport areas.

5.4 Climate change adaptation plans and perception

Based on the response from interviewees, without any doubt, they believe that climate change poses significant impacts on Chinese ports. Despite difference levels of influences, more or less, each port and terminal have applied at least some adaptation strategies, or at least have corporate plans with the aim to reduce the vulnerability of their ports or terminals to climate change impacts. *Chinese Policies and Actions for Addressing Climate Change* (2016) found that ports and terminals in China are actively involved in climate change issues, and some adaptive measures are proposed and implemented. In addition, related policies are highlighted in this report (National Development and Reform Commission, 2016). This illustrates social awareness on strategies coping with impacts posed by climate change and problems in accordance with climate change in the marine environment.

Indeed, all interviewees appear to be aware of potential climate change impacts on ports and terminals and their surrounding regions. However, we need to know whether such awareness has been transformed into real actions, as reflected by adaptation plans and strategies. Hence, the participants were asked by the author to evaluate whether the current adaptation strategies are sufficient and necessary. If they were agreed that adaptation is essential to the ports or terminals, the question was then probing further implement adaptation, including adopting more adaptation measures. Besides, for those who do not include adaptation in their strategic plan or port development plan, another question was asked- if needed to include. Each respondent noted the current adaptation measures are sufficient and necessary for ports and terminals to reduce their vulnerability to climate change impacts. However, when speaking of further plans about the adaptation, most of them do not have the intention to improve existing adaptation or implement new strategies.

The answer for including adaptation in the strategic plan is alike. This suggests that the port stakeholders are not articulate climate change adaptation with regard to new routines codified as blueprints or port development plan.

Moser & Ekstrom (2010) proposed a framework to identify the obstacles of climate adaptation, including understanding, planning and managing phases. The unwillingness to make further steps about adaptation can be considered as an obstacle to adaptation implementation. The three stages correspond to the factors that affect the attitude of the port stakeholders we investigated. To better understand the reason behind this attitude of the respondents toward adaptation, the interview questions follow these three phases and try to find out the reasons behind their attitude toward adaptation measures.

As mentioned in the previous paragraph, the answer to the impacts is inevitable and considerable economic loss was generated by these impacts to the ports and terminals. Although they noticed the changes and impact that already happen, the government system and another social context, such as the publications faced to the port stakeholders, can affect how the port stakeholders interpret the impact. As revealed out by Tribbia and Moser (2008), indeed, the guidelines or governance from above and high-level leadership is indispensable for the managers in coastal areas, including port managers, to adjust the capacity and facilitate willingness to make adaptation decision. The answer for the respondents indicated that the lack of knowledge about adaptation and most of them do not understand or possess the knowledge to implement the adaptation strategies that have been used in other western countries (e.g., the best practice guidance proposed by the United

Nations Conference on Trade and Development introduced in 2012).

It was evident from the secondary data on each port or terminal in China that the proper response to the negative impact posed by climate change is essential and interviewees were asked by the author to consider how to improve the lack of knowledge related to adaptation. Education from the related department (such as port authorities) from the national government and government guidelines are the common answer to this question. In addition to this, the dominant strategies that are coping with climate change which are highlighted in most the social media, government policies and publications from some research groups are mitigation measures, educating or guiding the managers in the ports or terminals to develop green ports and reducing greenhouse gas emissions.

Other than lack of knowledge, the uncertainty of the adaptation strategies is another answer to the unwillingness for further adaptation strategies. The uncertainty includes a broad range of future climate conditions changeable, and the outcome of other adaptation strategies (the measures that are not adopted in these ports or terminals) is also ambiguous.

Despite such lack of knowledge and uncertainty of the adaptation strategies, still, most ports and terminals have implemented some adaptation strategies. With this premise, interviewees were asked about existing adaptation strategies.

Enhancing transportation infra- and superstructures were reported as being undertaken by the interviewees to respond to typhoon and flood inundation which caused by the cyclone

and sea-level rise. The elevation of the port's land is another strategy undertaken by the ports and terminals. In some ports and terminals in southern China, the first strategy is used to ensure that port and terminal facilities would withstand strong wind caused by the typhoons. Increasing the weight of cranes and reinforce the ability to withstand wind is included in this strategy. The second strategy is used to keep cargoes inside containers being dry all the time without drowning in the sea water when an inundation comes and ensure that the containers would be placed above the highest predicted tidal surge areas and thus cannot be washed to harbors or elsewhere. However, as the Chinese government has rather strict policies on the height of the port's land in certain regions, in most cases, the elevation of the port's land does not elevate the entire port. More specifically, parts of the land are higher than the rest, and the containers would stand on higher grounds. This process relocates containers that are carrying critical cargoes (e.g., the storage of dangerous goods) to zone above the tidal surge region. On the other hand, there are no absolute answers for the question on whether port and terminal infrastructures, such as wharves and cranes, should be built even higher so as to adjust floods in the future. In general, interviewees believe that they would not change existing land height unless related policies implemented by the Chinese government or official data prove that it is necessary to do so. Finally, some emergency response plans are adopted to prevent the vessels or containers losing their moorings and become adrift in the harbors due to the increase in storm intensity.

Answering the impact of increasing number and intensity of hot days, which would lead to the damage of facilities and road surface and health and safety issues, each port stakeholder has agreements with hot weather policies. More specifically, the government has related

policies about the hot weather and the ports or terminals behave based on these policies, and they also adopted their strategies to cope with the hot weather based on each port's situation. In addition, suspension or longer break time is included in the ports' policy to reduce the extent of the potential safety hazard. Quoting an interviewee:

"In summer, this year we give the workers a two- hour break or longer depend on the intensity of the heat at noon to prevent the workers from getting heatstroke."

The other approach adopted by some ports is using the air blower to increase the extent of cross-ventilation. These measures are existing adaptation strategies used by ports and terminals in China. However, more adaptation approaches are proposed by some marine organizations or ports in other countries. For example, ports in Australia use cyclone tidal surge and sea level rise flood inundation map to protect infrastructures from damage or washed by the high tidal surge (A. K. Y. Ng et al., 2013). As mentioned, the knowledge and education about climate adaptation strategies lack in China. Some respondents point out that improvements are needed because some ports and terminals are still in the process of remedial actions after the incidents. So, we further asked interviewees on the evaluation of existing adaptation strategies and whether more adaptation strategies are required in ports and terminals. Interviewees believe that existing adaptation strategies are necessary and useful, but more adaptation strategies would need more workforce and financial support. Moreover, their behaviors are regulated by Chinese government policies, and thus some strategies would be implemented only when required by government policy. They would implement only when there is substantial data to suggest that they must implement more adaptation strategies. Some specific reasons explain this situation. Quoting one

interviewee:

"We are under the supervision of the port's office and local government, nearly every action needs to be approved by these departments, especially the approach related to construction. In addition, whether the reduction of the economic loss due to the impact of climate change is more than the extra financial expenditure for additional adaptation strategies is unknown." Some of the interviewees also concern that the existing port facilities are restricted by the design standard and may not be adapted to the impact of sea level rise.

This indicated that the national government plays a crucial part in the port planning phase. The policy shaped the development and implementation of adaptation strategies in the ports or terminals. The interviewees drew attention to that the implementation of the adaptation strategies must be legal and feasible within existing policies, laws, rules, regulations, programs, and mandates.

As for the managing phase of adaptation strategies, this part includes three aspects – the financial support, technology support and evaluation measures. Questions were asked to probe these three directions. Financial support from the national government plays a crucial role for the ports to implement adaptation strategies, especially for the ports that are owned by the state. The adaptation researches and reports and other technical support from the research organizations are necessary to facilitate the process of implementation of adaptation strategies. The respondents reported the research in China is still limited. The primary focus for their technology consultants or other research organizations is mitigation and reducing the emission of greenhouse gas emission. It was evident from each

interviewee that the outcome of the further implementation of adaptation strategies is difficult to evaluate due to the uncertainty of the climate change impact in the future.

Other port stakeholders (find in one of the theses about HIT) that have a business or other connection related to ports and terminals agree that the benefits that they can gain from the implementation of the adaptation strategies will be a priority when they consider whether they are going to implement adaptation strategies or not. In an overall, it appears that while all the studied port stakeholders consider climate change impacts, only some of the adaptation strategies are being implemented. Here one should note that, in some cases, adaptation plans and strategies (e.g., emergency plans), and their implementation, are not formulated explicitly in their corporate development or strategic planning. However, more knowledge creation and education are required for port stakeholders to understand climate change impacts and adaptation strategies better. The pursuit of co-benefits is an important driving factor for the adoption of climate change adaptation policies among Chinese ports and terminals.

5.5 Comparing the attitude towards mitigation and adaptation measures and strategies

In addition to adaptation, mitigation strategies are also adopted by port stakeholders to reduce the global warming and GHG emissions. It is evident from interviewees that mitigation strategies and corporate policies (for instance, Regulations of the People's Republic of China on the prevention and control of Marine environmental pollution by the ships of the People’s Republic of China and their related activities and Law on the

prevention and control of air pollution in the People's Republic of China) dedicated to reduce the emissions of greenhouse gas have been considered in port and terminal planning. In this study, the interview questions only probed with the attitude towards mitigation strategies and the comparison between mitigation and adaptation strategies.

First, all the interviewees were asked about the overview of mitigation strategies. All of them agree that mitigation strategies are critical to protect the environment and alleviate global warming. Also, they cite the desire to reduce energy costs and improve environmental conditions. They indicate that the notion of GHG emission reduction is considered as responsibility. In fact, government policies and international environmental organizations require port stakeholders to implement mitigation strategies, or otherwise, the government would impose punitive actions against them. Quoting one interviewee:
"Energy conservation and emission reduction are the measures that China encourages to take. There are also mandatory requirements for the implementation of energy conservation and emission reduction measures in the construction and approval of construction projects".

A follow-up question was asked about the effectiveness of the mitigation strategies. Both the interviewees from ports and terminals and other port stakeholders say that the outcome of mitigation strategies is difficult to evaluate because they are mostly long-term strategies. Besides, they indicate that mitigation strategies would be useless if there are only a few organizations that are committed to implementing such strategies. Despite the unpredictable results, most interviewees argue that every individual must reduce the greenhouse gas emission so as to protect the environment.

When asked about the comparison between mitigation and adaptation strategies, most interviewees argue that they are of similar importance and do not necessarily conflict with each other. Some port stakeholders point out that mitigation strategies can help them to gain a better reputation that can result in expanded market share and more financial gains. At the same time, they believe that adaptation strategies can help port stakeholders to minimize the economic loss in the future. Regarding financial concern, questions were asked about the balance of the financial expenditure for these two strategies. In this case, interviewees answer that most adaptation or mitigation strategies are implemented because 1) they believe that it is necessary to do so, and 2) requirements from government policies. They also point out that the implementation of these two strategies would not affect each other.

Also, interviewees highlight government regulations in their responses. Interviewees mentioned that the management and governance of most Chinese ports are centrally managed. More specifically, local authorities are mostly responsible for the management of leading cadres within the ports (Gao and Sun, 2002) and other areas are managed mainly by the Chinese government (Gao and Sun, 2002). Understanding such circumstance, it is not surprising for local authorities to remain enthusiastic in managing ports (Gao and Sun, 2002). However, many ports in other nations are decentralized or under district management. The policies that formulated by the Chinese national government have primarily influenced the implementation of mitigation and adaptation strategies. For example, it has set the height of the port's land, protecting the ports from flooding. Local

ports or terminals follow the standard height, and they would not have the motive to consider the height of the Portland further. Quoting one interviewee:

"At present, we mainly organize the port design construction according to the national standard. We will keep track of relevant national policies and regulations."

Many interviewees point out that the current implementation of adaptation and mitigation strategies still lack adequate support from policies, norms, and financial support. Indeed, most of the ports' development planning is restricted by the national standards and government policy. Some of the respondents mentioned that some further climate change impact might cause the economic loss because of the lag between the national standard and the reality. For example, the operation manager of the Port of Ningbo-Zhoushan put forward the concerns that the existing port facilities in China may not adapt to the impact of sea level rise due to design standards and other problems. Also, sea level rise will affect the seaworthiness of the port. Rising sea levels, for example, could limit the access of large ships to Bridges in and out of ports. This situation remains a concern for the adaptation implementation for most state-owned ports in China.

In general, it appears that all the studied port stakeholders consider both mitigation and adaptation strategies. Furthermore, these two strategies are considered as equally important and necessary for ports or terminals to implement.

Chapter 6: Discussion and Conclusion

6.1 General Discussion

This study investigates climate adaptation and mitigation strategies and their implementation. The survey and cases in China provide an insight on how port stakeholders consider the adaptation and mitigation measures. The findings indicate that port stakeholders are aware of the impacts posed by climate change and most have developed, at least, some adaptation plans and strategies. Although most port stakeholders are aware of the issue and some actions have been undertaken, they do not possess adequate knowledge and education in climate adaptation planning and the development of accompanied strategies. None of the studied port stakeholders have established a dedicated department, team, or employee to deal with climate change-related issues. However, most of them have included adaptation strategies in their development plan and daily operating schedules. Hence, while inadequate knowledge on climate change adaptation might be an issue, their positive attitude and perception towards adaptation to climate change impacts are not in any serious doubt.

The participants in this study disclose similar cognition about climate variables and concerns and prediction about extreme weather events. In this case, interviewees from different ports have slightly different views on climate variables. For example, ports and terminals in Shanghai have experienced the impacts of haze, of which ports and terminals in southern China do not experience it (e.g., those along the Pearl River Delta). As for mitigation strategies, the results contrast with Becker et al. (2012). In Chinese ports,

mitigation strategies are being considered and taken actions so as to address the global warming, but yet taken the implications of climate change on port facilities and continuing operations. However, they share the view that climate mitigation and adaptation are equally important. In addition, they believe that no conflicts are existing between them. This aspect is consistent with the view from the literature review that both mitigation and adaptation strategies are needed for port stakeholders to deal with the climate change. Thus, further research would undoubtedly benefit port planning and development. One of the barriers for port stakeholders is the lack of reliable prediction about the climate change and the evaluation of adaptation strategies. All studied port stakeholders consider budgetary constraints when making development or daily plans. In addition, each port stakeholders can only make plans for the foreseeable future.

A significant characteristic among Chinese port management is that most of its ports are centrally managed, whereas many ports in other nations are decentralized or under district management (Gao and Sun, 2002; Zhang, 2000). Most large ports in China are solely state-owned or Sino-foreign joint venture, and Sino-foreign joint venture only occupied a small amount. For example, the Port of Shanghai is operated by 11 solely state-owned companies and 3 Sino-foreign joint venture companies. This also means that the policies and guidelines from the national government play a crucial role in the ports' operation. To be more specific, every port stakeholder's strategic plan or development plan is designed based on the policy enacted by the government. Most interviewees put forward the notion that regulations and policies implemented by the Chinese government are considered as guidelines when they design their strategies and development plans. Hence, the Chinese

government plays a pivotal role in developing adaptation strategies in ports and can be considered as a critical criterion when analyzing the attitude and perception of port stakeholders toward adaptation strategies.

Smith, Vogel, and Cromwell III (2009) highlighted the neglect of previous literature that mainly focuses on the identification of climate change impact, vulnerabilities moderate and evaluation, and assessment of adaptation strategies and only few research pay attention to the impact of adaptation policy formulated by the government, which address problems related to the supporting policy to facilitate the implementation of adaptation strategies and education to encourage the managers to learn more about these strategies. The results from this study confirm the importance of the role that the government plays in adaptation decision making, planning, and implementation. Especially in China, where the most significant ports or terminals are owned by states and operated by the national government.

A brief comparison between Hongkong International Terminal and port of Zhuhai help to better understand the difference between a representative of large ports in mainland China and a representative of other private owned ports. Port of Zhuhai is operated by Zhuhai Port Holdings which is a wholly state-owned enterprise, whereas HIT is operated by Hutchison Port Holdings, a private holding company incorporated in the British Virgin Islands. *Port Law of The People's Republic of China* is considered as a guideline for the port of Zhuhai when the operation managers formulate the developing plan. In this policy, it is clarified that the department of transportation under the state council is in charge of the management of ports throughout the country. In addition to this, the local governments

shall, in accordance with the provisions of the state council on the port administration system, determine the management of the ports in the administrative region. All the management decisions and construction should be consistent with standards in the policy, and any changes need be reported to the related department in the upper-level government to get a permit. The operation managers in the port of Zhuhai explained as follows:

"Any construction changes and major strategies plan modifications of the port's operation or developing plan need to report to the related government department or port authorities to get approved. Financial support from the government is also necessary for us to adapt the impact posed by climate change."

The government policy and guidelines can help to encourage the stakeholders to learn more about the climate change adaptation. In addition to this, the uncertainty of the adaptation to the ports or terminals could also be reduced by the decision-making techniques provided by the policymakers that help the managers to identify appropriate choices in the face of uncertainties. In this case, we argue that regulations and policies should encourage knowledge creation and better education on climate change impacts. Also, they should effectively help port stakeholders to balance resources and efforts between mitigation and adaptation plans and strategies. Further incentives should be created to facilitate the development of adaptation strategies in port regions. As stated earlier, the implementation of adaptation strategies is still at its embryonic stage. The scarcity of policies as guidelines and adequate incentives, lack of education about adaptation, and related research studies are the main barriers for port stakeholders. Support from both the government and related

organizations are necessary for the development of effective adaptation strategies.

Based on previous findings, the role of government can be considered as a dominant factor of port adaptation planning. Becker (2015) put forward a collaborative approach which would benefit the adaptation development on ports. They highlighted the importance to take all the stakeholders' perspective into consideration throughout the whole adaptation process. These stakeholders include every organization from specific ports management companies to nations. They also emphasized that the engagement from every organization including both internal and external stakeholders is necessary for the adaptation strategies to ensure success because adaptation is affected by various factors, including policies, communications with organizations from different sectors and countries and public engagement (Becker, 2015). Based on the result of the survey and interview, Indeed, adaptation requires support from the researches from the academic organizations, the policymakers, industrial practitioners, interest groups, and other port stakeholders. In the collaborative approach perspective, this concept highlighted the partnership and mutual trust between different stakeholders at a global level from different sectors, countries, and regions to benefit the knowledge transfer and communication within the network.

However, is this collaborative approach also applying to the situation of the adaptation in the ports in China? The answer is worth to be discussed. The short cases comparison between the Hong Kong International Terminals and the port of Zhuhai indicated the crucial role of national government plays in the port of Zhuhai, which is entirely different from the circumstance in HIT. In HIT, the government role is the same as or less important

as the other port stakeholders, while in Port of Zhuhai, the government is the dominant factor affecting the port operation and developing the plan. The ports operated by privately held company (e.g., Hongkong International terminal) have more autonomous right than those held by the national government. However, in China, the administrative authority of the ports investment management is divided according to subordinate relations and investment volume (Zhang, 2000). The central government directly manages the construction projects and operation under the direct and dual leadership ports, and those of local ports and cargo terminals are managed according to the different scale of construction (Zhang, 2000). In addition to this, port investment structure and investment subject are single under the port management policy in China (Zhang, 2000). The amount of the funding needed for port construction and operation is a lot. Even though the Chinese government encourages various sources of investment, the fact is that the investment is government monopoly and the operation of ports is port authority monopoly because of strict planning management and conditions (Zhang, 2000; Zhang, 2012). To be more specific, the part of the investment and operation of other private organizations or companies is still limited (Zhang, 2000; Zhang, 2012). As we can see, because of the different governance, when applying the collaborative approach to the Chinese ports, the government intervention and policy regulation should be the considered as the priority to facilitate adaptation implementation. Besides the regulation of the government, nearly all the large ports or terminals in China only have sustainable reports. Few information can be found that are related to adaptation strategies, which means that even though in the interview results the participants agree that both mitigation and adaptation are equally important, the strategic plan still need improvement. Based on Maslow's Hierarchy needs,

the ports stakeholders in China still mainly focus on the profit making and normal operation management. From the results, most of them do not have initiative to improve their current measures and believe the improvement plans should be done under the policy instructions and technology support from other organizations. Comparing with HIT, the managers in HIT are more willing to do some improvements and initiative plans. We can conclude that the port stakeholders in China are still mainly focus on the basic needs for their ports or terminals. The adaptation strategies are higher level of needs for them and will not be considered until they believe the implementation of adaptation strategies can provide them substantial benefits and won't harm the basic needs which are profit making and normal operation. To be more specific, the port stakeholders do not have initiative to implement adaptation strategies or improve their current measures, because the cost and benefit balance is their priority concern.

6.2 Contribution, limitation and implementation

The thesis provides an overview of the attitude of port stakeholders towards climate change and analyzed some possible explanations. At the same time, recognition of impacts posed by climate change calls for port stakeholders to pay attention to the knowledge and assessment of the impacts. Based on the research findings, we believe that all the factors included in this study can partly impact the attitudes of port stakeholders. Some improvements to call port stakeholders to highlight the impacts posed by climate change can be based on these factors. For example, policymakers can formulate climate change-related policy to inform port stakeholders on the importance of responding to impact posed

by climate change. The results that port stakeholders do not believe that adaptation strategies are effectiveness indicate that more efforts are required to encourage port stakeholders to implement climate adaptation strategies. In addition, transforming current management and planning need to be highlighted in response to climate change. Practical suggestions are provided in the thesis that can be considered as reference for the decision-makers in port stakeholders and related organizations when they analyzed the climate change impact. This study applies two theories – ambiguity effect and hyperbolic discounting, and these two theories are partially confirmed. Indeed, based on what we know, this study is a pioneer in using these two theories to explain the attitude of port organizations.

Based on this study, further research study can apply these theories more frequently in analyzing organizations' attitude towards climate change or strategies in the context of climate change. In addition, this study investigates the general attitude of port stakeholders towards climate change, and some possible impact factors are verified. Further study can consider this thesis as a platform to further investigate the reasons that the port stakeholders hold this attitude.

This study can also be considered as an attempt to systematically study the attitude and perception of stakeholders on climate change adaptation. It highlights the importance of government policies towards the development of adaptation strategies on ports in the Chinese context. One should remind policymakers and managers in port stakeholders the necessity of implementing adaptation strategies and the risk posed by climate change that

they may face in the future. The limitations of this study include the small sample size and that some investigations are undertaken at a relatively preliminary stage. Larger sample size should be conducted in future research. Moreover, more detailed comparisons between mitigation and adaptation strategies should be undertaken. Having said so, we believe that this thesis offers a decent platform for further research on this topic.

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Appendix 1 – Survey

First part – Short answer：

1. Have you ever heard or involved the response to the disaster that climate change impact?

a. Yes b. No

2. Emergency measures are critical to port safety and can respond quickly and effectively once a catastrophic accident happen.

(a) Does your company / department have a port contingency plan?

a. Yes b. No

i. if yes, have you ever read it?

c. Yes d. No

(b) Are there any routine horizontal plane and flood monitoring?

horizontal plane： a. Yes b No c. Don't know

Flood：a. Yes b. No c. Don't know

(c) Does your port have a special emergency department?

(d) How often for a flood emergency exercise? (probably)?

(e) How often for a typhoon emergency exercise? (probably)

3. Mitigation vs. Adaptation to Climate Change

You think, 1) Implementing energy-saving emission reduction and green low-carbon actions in the port

2) Implementing adaptation strategies to address climate change in the port to enhance protection and emergency response

i. Which one is more important?

a. mitigation b. adaptation

ii. Which is easier to implement?

1. Why? (Multiple choice)

a. Policy support

b. Related technology is more complete, more choices

c. Cost problem

d. The investment return period is too long

e. Other, please elaborate

4. For port construction and planning: Are there any authoritative support and technical

guidance outside of your company's employees? (Eg, cooperation and help from a local university, a nonprofit organization, a team of scientists)

a. Yes b. No

i. if yes, please elaborate:

5. August 23, 2015 around 23:30, located in Tianjin Binhai New Area Tanggu Development Zone, the dangerous goods warehouse belongs to Ruihai International Logistics Co., Ltd. in Tianjin Dongjiang Bonded Port Area experienced an explosion, resulting in more than 100 people died, including firefighters more than 20 people as an alarm for the port security. Has your company / department made the appropriate precautions and intensified actions after the bombing in Tianjin? In what areas to make what extent changes, please elaborate.

Second part

(Please refer to the following description for the scoring criteria for the five grades in the form below 1, 2, 3, 4, 5)

Description of Variables

Timeframe (for when you expect to first see this impact)

1. Very long - more than 20 years

2. long - about 15 years

Moderate to about 10 years

4. Short - about 5 years

5. very short - less than 1 year

Severity of consequences

1. Catastrophic- very serious economic losses and / or disruption on the facilities / systems / services requiring a very long period and very high cost of recovery

2. Critical - severe economic losses and / or disruption on the facilities / systems / services requiring a long period and high cost of recovery

3. Major - significant economic losses and / or disruption on the facilities / systems / services requiring a certain amount of time and cost of recovery

4. Minor - some economic losses and / or destruction of facilities / systems / services requiring some time and cost of recovery

5. Negligible – a bit of disruption on the facilities / systems / services, but with not real impacts on the continuance of services, nor does it requires significant time and cost of recovery

Likelihood that the event will occur

1. Very high – It is very highly likely that the stated effect will occur, with a probability of around 90% of at least one such incident within the indicated timeframe

2. High - t It is highly likely that the stated effect will occur, with a probability of around 70% of at least one such incident within the indicated timeframe

3. Average - It is likely that the stated effect will occur, with a probability of around 50% of at least one such incident within the indicated timeframe

4. Low - It is unlikely that the stated effect will occur, with a probability of around 30% of at least one such incident within the indicated timeframe

5. Very low - It is very unlikely that the stated effect will occur, with a probability of around 10% of at least one such incident within the indicated timeframe

What do you think is the risk and impact of climate change on your port / wharf?

1	<u>The following is the danger from sea level rise</u> (Assuming the intensity and frequency of the storm did not change)	The seriousness of the consequences (Please fill 1 ~ 5, Note: 1 is the most serious)
(a)	High waves (due to sea level rise) will damage the port / terminal facilities, as well as the vessel's berthing	

(b)	Traffic infrastructure and superstructures (such as cranes and warehouses) and port / wharf facilities will be flooded or subjected to higher tidal damage	
(c)	Coastal erosion occurs at or near the harbor	
(d)	Sediment sedimentation in the waterway berth	
(e)	Due to floods, land access (roads, railways) arriving at ports / terminals will be restricted	
2	The following is from the strong winds and storms become more frequent / stronger damage	The seriousness of the consequences (1 to 5)
(a)	High waves (due to storms) will damage the port / terminal facilities, as well as the berth of the vessel	
(b)	Traffic infrastructure and superstructures (such as cranes and warehouses) and port / wharf facilities will be flooded or damaged by high intensity, high frequency storms	
(c)	Downtime for port / terminal operations will increase due to strong winds and storms	
(d)	Strong winds from higher intensity / frequency	

	storms will damage port facilities (such as cranes and warehouses)	
(e)	Due to the stronger / frequent storms, land access (roads, railways) arriving at the port / pier will be restricted	

The risks and impacts of climate change over the past decade

(a)	Please explain and describe whether your port / terminal has been affected by one of the risks over the past decade:
(b)	If your port / pier has been hit in the past decade, this shock has brought about any economic loss (optional):
(c)	What are the other major consequences of a few weeks, months, years after the incident? (Optional):

3. How does your port respond to current climate change?

(a)	How do you deal with the risks and impacts of climate change on your port / wharf? Please select all items currently applied to your port / wharf:

	☐ To include climate change in the strategic plan ☐ Climate change is not yet emphasized	☐ Climate change is highlighted in specific planning documents ☐ Climate change has changed part of the design program and standards ☐ Climate change is covered and kept in your budget ☐ Climate change is particularly emphasized in your insurance ☐ I am not sure
	Other, please elaborate:	

<table>
<tr><td></td><td colspan="2"></td></tr>
<tr><td rowspan="3">(b)</td><td colspan="2">Please select the following protective measures for your current port / wharf:</td></tr>
<tr><td>☐ Flood insurance
☐ Storm insurance
☐ Storm Barriers
☐ Breakwater
☐ Replace the existing structure
☐ Reinforcement of existing structures</td><td>☐ Embankment
☐ Storm response plan
☐ Drain pump
☐ Seawall
☐ Construction of new storm protection measures (new dam or breakwater)
☐ Improving the elevation of port land</td></tr>
<tr><td colspan="2">Other, please elaborate:</td></tr>
</table>

If your port / wharf does not take any response, do you think the following hazards will occur in the next few years? What is the severity of the consequences? What is the

likelihood of occurrence? (For example, if the items in the following table are filled with 2,5,1 respectively, then, according to the level of the first page description, the time line 2 represents - such a high wave of damage to the port after 15 years. Severity 5 represents - if the high waves really damage the port facilities, the impact will be very light. Possibility 1 represents - the possibility of high waves causing damage to the port is very high.)

1	From the sea level rise (Assuming the intensity and frequency of the storm did not change)	Timeframe (Please fill in 1 ~ 5; 1 is the longest time)	The severity of the consequences (please fill 1 ~ 5, Note: 1 is the most serious)	The likelihood of this hazard (1 ~ 5, 1 is the most likely)
(a)	High waves (due to sea level rise) can damage port / terminal facilities, as well as vessel berthing			
(b)	Traffic infrastructure and superstructures (such as cranes and warehouses) and port / wharf facilities will be flooded or damaged by higher tides			

(c)	Coastal erosion occurs at or near the harbor			
(d)	Sediment sedimentation in the waterway berth			
(e)	Land access (roads, railways) arriving at ports / terminals will be restricted due to floods			
2	From strong winds and heavy rains become more frequent / more dangerous	Timeframe	Severity of consequence	Likelihood
(a)	High waves (due to storms) will damage the port / terminal facilities, as well as the side by side of the vessel			

(b)	Traffic infrastructure and superstructures (such as cranes and warehouses) and port / wharf facilities will be flooded or damaged by high-intensity, high-frequency storms			
(c)	Downtime for port / port' operations will increase due to strong winds and storms,			
(d)	Strong winds from higher intensity / frequency storms will damage port facilities (such as cranes and warehouses)			
(e)	Land access (roads, railways) arriving at the port / pier will be			

	restricted due to the stronger /frequent storms			

5. Assuming that your port / wharf has implemented a corresponding response within the next decade, what changes will you expect to see? Please re-evaluate.

1	Sea level rise	Adaptation strategies	Timeframe	Severity of consequence	Likelihood
(a)	High waves (due to sea level rise) will damage the port / terminal facilities, and ships berthed alongside	Create new breakwater and / or increase their dimensions			
(b)	Traffic infrastructure and superstructures (such as cranes and	Enhance transport infra- and superstructures resilience to flooding			

	warehouses) and port / wharf facilities will be flooded or subjected to higher tidal damage				
		Elevation of port land			
(c)	Coastal erosion occurs at or near the harbor	Protect the coastline and increase the beach nourishment programs			
(d)	Sediment sedimentation in the waterway berth	Increase and / or expand dredging			
(e)	Land access (roads, railways)	Improve the quality of land			

	arriving at ports / terminals will be restricted due to floods	connections to port/terminal			
		Diversify land connections to port/terminal			
2	Strong winds and heavy rains become more frequent / stronger	Adaptation measures	Timeframe	Severity of consequence	Likelihood
(a)	High waves (due to sea level rise) will damage the port / terminal's facilities and ships berthed alongside	Create new breakwater and / or increase their dimensions			

(b)	Traffic infra- and superstructures (such as cranes and warehouses) and port / wharf facilities will get flooded or damaged in higher tidal damage Coastal erosion will occur or occur at neighboring ports	Enhance transport infrastructure and superstructure to withstand floods			
		Elevation of port land			
(c)	Sludge and sediment will occur in the port / wharf channel	Improve the management of prevention effects			

(d)	Land access (roads, railways) arriving at ports / terminals will be restricted due to floods	Improve the future port construction standards			
(e)	High waves (due to sea level rise) will damage the port / terminal's facilities and ships berthed alongside	Improve the quality of land connections to port/terminal			
		Diversify land connections to port/terminal			

Appendix 2 – Significant results

General attitude of port stakeholders towards with and without climate adaptation strategies in the future

Sign Test

Frequencies

		N
V1cC - F1cC	Negative Differences[a,d,g]	2
	Positive Differences[b,e,h]	11
	Ties[c,f,i]	7
	Total	20
V2dC - F2dC	Negative Differences[a,d,g]	2
	Positive Differences[b,e,h]	10
	Ties[c,f,i]	8
	Total	20
V2dP - F2dP	Negative Differences[a,d,g]	1
	Positive Differences[b,e,h]	8
	Ties[c,f,i]	11
	Total	20

a. V1cC < F1cC
b. V1cC > F1cC
c. V1cC = F1cC
d. V2dC < F2dC
e. V2dC > F2dC
f. V2dC = F2dC
g. V2dP < F2dP
h. V2dP > F2dP
i. V2dP = F2dP

Test Statistics[a]

	V1cC - F1cC	V2dC - F2dC	V2dP - F2dP
Exact Sig. (2-tailed)	.022[b]	.039[b]	.039[b]

a. Sign Test

b. Binomial distribution used.

P.s. Capital letter "C" refers to severity of consequence. "1" and "2" refer to different kinds of climate change impact. "F" refers to without climate adaptation strategy and "V" refers to with climate adaptation strategy. "P" refers to the likelihood of occurrence.

Without organizations' support as an impact factors

Sign Test

Frequencies

		N
V2dP - F2dP	Negative Differences[a]	0
	Positive Differences[b]	6
	Ties[c]	5
	Total	11

a. V2dP < F2dP

b. V2dP > F2dP

c. V2dP = F2dP

Test Statistics[a]

	V2dP - F2dP
Exact Sig. (2-tailed)	.031[b]

a. Sign Test

b. Binomial distribution used.

Policy as an impact factor

Sign Test

Frequencies

		N
V1cC - F1cC	Negative Differences[a,d]	0
	Positive Differences[b,e]	6
	Ties[c,f]	1
	Total	7
V2cP - F2cP	Negative Differences[a,d]	0
	Positive Differences[b,e]	7
	Ties[c,f]	0
	Total	7

a. V1cC < F1cC

b. V1cC > F1cC

c. V1cC = F1cC

d. V2cP < F2cP

e. V2cP > F2cP

f. V2cP = F2cP

Test Statistics[a]

	V1cC - F1cC	V2cP - F2cP
Exact Sig. (2-tailed)	.031[b]	.016[b]

a. Sign Test

b. Binomial distribution used.

Technology as an impact factor

Sign Test

Frequencies

		N
V1cC - F1cC	Negative Differences[a,d]	0
	Positive Differences[b,e]	7
	Ties[c,f]	0
	Total	7
V2cP - F2cP	Negative Differences[a,d]	0
	Positive Differences[b,e]	6
	Ties[c,f]	1
	Total	7

a. V1cC < F1cC
b. V1cC > F1cC
c. V1cC = F1cC
d. V2cP < F2cP
e. V2cP > F2cP
f. V2cP = F2cP

Test Statistics[a]

	V1cC - F1cC	V2cP - F2cP
Exact Sig. (2-tailed)	.016[b]	.031[b]

a. Sign Test
b. Binomial distribution used.

Cost as an impact factors

Sign Test

Frequencies

		N
V1cC - F1cC	Negative Differences[a,d,g]	0
	Positive Differences[b,e,h]	6
	Ties[c,f,i]	1
	Total	7
V2cP - F2cP	Negative Differences[a,d,g]	0
	Positive Differences[b,e,h]	7
	Ties[c,f,i]	0
	Total	7
V2dT - F2dT	Negative Differences[a,d,g]	0
	Positive Differences[b,e,h]	7
	Ties[c,f,i]	0
	Total	7

a. V1cC < F1cC
b. V1cC > F1cC
c. V1cC = F1cC
d. V2cP < F2cP
e. V2cP > F2cP
f. V2cP = F2cP
g. V2dT < F2dT
h. V2dT > F2dT
i. V2dT = F2dT

Test Statistics[a]

	V1cC - F1cC	V2cP - F2cP	V2dT - F2dT
Exact Sig. (2-tailed)	.031[b]	.016[b]	.016[b]

a. Sign Test

b. Binomial distribution used.

Investment Return as an impact factors

Sign Test

Frequencies

		N
V1cC - F1cC	Negative Differences[a,d,g]	0
	Positive Differences[b,e,h]	6
	Ties[c,f,i]	1
	Total	7
V2cP - F2cP	Negative Differences[a,d,g]	0
	Positive Differences[b,e,h]	7
	Ties[c,f,i]	0
	Total	7
V2dP - F2dP	Negative Differences[a,d,g]	0
	Positive Differences[b,e,h]	5
	Ties[c,f,i]	2
	Total	7

a. V1cC < F1cC

b. V1cC > F1cC

c. V1cC = F1cC

d. V2cP < F2cP

e. V2cP > F2cP

f. V2cP = F2cP

g. V2dP < F2dP

h. V2dP > F2dP

i. V2dP = F2dP

Test Statistics[a]

	V1cC - F1cC	V2cP - F2cP	V2dP - F2dP
Exact Sig. (2-tailed)	.031[b]	.016[b]	.063[b]

a. Sign Test

b. Binomial distribution used.

Appendix 3 – Case study

QUESTIONS FOR INTERVIEW

Part A: The overview of impact posed by climate change

A1 Do you know about the impact of climate change on ports? Such as the impacts of sea level rise and storm surge.

A2 What do you think are the main climate change risks faced by the ports or terminals in China (Or your ports)? Past and Future.

A3 How do you identify or evaluate these impacts posed by climate change?

A4 Do you think the climate change will impact your terminal or ports?

A5 What do you think are the possible reasons behind the result of Q3

A6 Do you know about the strategies that other ports adopted on ports or terminals in response to the impact posed by climate change in other countries? Comparing with the situation in China?

Part B: Mitigation and Adaptation

B1 Do you know about the mitigation and adaptation strategies? (Some examples will be listed)

B2 Does your port have any adaptation strategies or plan to implement any adaptation strategies? What do you think of them?

B3 Do you think climate adaptation strategies will help to reduce the vulnerability of the ports or terminals?

B4 What do you think is the most difficult part of the plan to implement an adaptation strategy? Or what other factors do you think will affect the attitude of port stakeholders?

Part C: Extra questions for organizations that are not directly related to port or terminals

C1 If your organizations only related to ports or terminals, what do you think climate change will impact the activities in your organizations through the influence of the ports or terminals?

C2 How do you think about the climate adaptation strategies? Do you think it is necessary for ports or terminals to implement? Why?

C3 What are the reasons that you think the port stakeholders implement or not the adaptation strategies?