# CHINESE ROAD TO RESPONSIBLE INNOVATION: CONSTRUCTING A GREEN PORT IN DALIAN

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ABSTRACT

This paper starts with two pieces of news from 2013 about Dalian Port, one was about its green port construction and the other was about the port's Arctic sea route development. What are in the two pieces of news brought us into focus on the term of responsible innovation, and this research especially shows that Dalian Port is developing its own version of responsible innovation, in response to its own needs and in line with the general conditions in China, rather than applying a western concept. With the exploration of the special pattern of responsible innovation of Dalian Port, this paper highlights two interesting technologies as case studies: the emergency pool project and the onshore electricity project. The first case shows that if we take the concept of responsible innovation as some kind of standard to evaluate the construction of Dalian Port, we could say that the port meets the requirements of being a responsible innovative port; the second case demonstrates that later on, with the development of the port, it has formed an internal approach of implementing the ideas of responsible innovation with its own way of communication and deliberation in the aims of green port construction. The conclusion of this research is that the Dalian Port development has gradually evolved from trajectories that might meet some of the requirements of (western) responsible innovation to the port inventing its own version of it, consisting of an environmental and government-oriented way of responsible innovation including deliberation with stakeholders.

*Keywords: responsible innovation, Dalian Port, emergency pool, onshore electricity.*

## 1 INTRODUCTION

In the summer 2013, we found two news about the port of Dalian especially interesting. The first one was released on 5th June 2013, with the title of "Dalian Port investing 1.2 billion RMB to promote 10 ecological green projects" [1]. The news told that Dalian Port decided to invest 1.2 billion to implement the ecologicalization of planning and construction as well as production and management of the port, in order to construct an eco-port or green port. The concrete planning included paying attention to green technology and green management, to advocate an environmentally-friendly logistics concept, and, in general, the ecologicalization of production and management. Specific characteristics include energy saving, low consumption, low $CO_2$ emissions, renewable energy, clean activities, clean transport, recycling economy, environmental protection and risk prevention system.

The second news was on 8th August 2013, entitled "Developing the Arctic sea-route: the first voyage from Dalian Port to Amsterdam Port" [2]. On that day, the China Ocean Shipping (Group) Company (COSCO) held a grand ceremony at Dalian Port to celebrate the "Yong Sheng" (long lasting victory) vessel's first voyage along the "Arctic Route". It was the first attempt by a Chinese merchant ship to reach Europe via the Arctic Route. The arctic route was about 2,936 nautical miles. It required crossing the Bering Strait to the west and crossing the Chukchi Sea and the German straits to the north point of Norway and eventually to arrive in different ports in Europe (see Fig. 1). From the perspective of maritime transport efficiency, the arctic route reduced 12–15 days of voyage compared with the traditional route, so the navigation world also called it "the golden waterway".

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Figure 1: The arctic shipping route [4].

From the first news, we learned Dalian was going to construct a green port, from the second news, we could understand that the purpose of taking the arctic route was mainly for reasons of economic benefit. If we take the two news together and look at them, we see that the development strategy of Dalian Port contained two aspects: one to pursue economic growth, the other to do that in a green, sustainable way.

This remind of the concept of responsible innovation, which aims to meet a diversity of values within one system, these values covering a range of needs and demands in relation to sustainable and social development. This paper aims to further investigate this, discussing the latest developments in Dalian Port from the perspective of responsible innovation. As such it complements and, to some extent, corrects an earlier article about the port [3]. This section especially shows that Dalian Port is developing its own version of responsible innovation, in response to its own needs and in line with the general conditions in China,

rather than applying a western concept. This might reflect a broader trend in the Chinese society, although further research would be needed to demonstrate this.

## 2 RESPONSIBLE INNOVATION IN THE WEST AND THE EAST

In recent years, "more and more port cities across the world seem to consider a reorientation and sustainable port development projects" [5], as in Dalian Port, where we can see that the sustainable port development effort is to construct a green port. Before we can answer the above question, whether a green port can be transformed into a responsible innovation port, we firstly have to figure out why should we take responsible innovation into port development?

Let us begin with the understanding of the concept of responsible innovation in different perspectives. So far there have been at least two kinds of understanding within this concept.

The American scholars' understanding of responsible innovation lays particular emphasis on its real impact in the process of technology innovation, including the stakeholders' effective participation, choices, evaluation, supervision and management.

As to the European perspective, since 2011, there were several conferences and workshops focusing on responsible innovation sponsored by the European Commission, and corresponding annual reports on responsible innovation and responsible research and innovation been made [6]–[8], which gave different conceptions and prescriptions of it. Although the concept is still under development, three scholars' descriptions can be seen as representative among all of the notions. The scholars concerned are Rene von Schomberg, Richard Owen and Jeroen van den Hoven.

von Schomberg believes "Responsible research and innovation is a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society)" [9]. With his interpretation of the concept, Schomberg is mainly focusing on the philosophical aspect of responsible innovation, while Richard Owen is mostly focusing on the management aspect.

Owen thought "rather than representing a clear novel governance paradigm, we might instead see responsible innovation as a location for making sense of the move from the governance of risk to the governance of innovation itself" [10].

As the combination of the two aspects above, Van den Hoven gives the broadest definition, which seems to be one of the most used definitions so far. Van den Hoven writes "Responsible research and innovation (RRI) refers to the comprehensive approach of proceeding in research and innovation in ways that allow all stakeholders that are involved in the processes of research and innovation at an early stage, (a) to obtain relevant knowledge on the consequences of the outcomes of their actions and on the range of options open to them; (b) to effectively evaluate both outcomes and options in terms of societal needs and moral values; and (c) to use these considerations (under (a) and (b)) as functional requirements for design and development of new research, products and services. The RRI approach has to be a key part of the research and innovation process and should be established as a collective, inclusive and system-wide approach" [8].

The above scholars provide definitions from and applying to the European and western context, but in terms of culture and modern development China is different from both Europe and the United State of America. The differences and the limits they imposed on the concept were noted in the discussion about responsible innovation [11], [12].

The Chinese government was not satisfied by rapid economic growth but also pursued sustainable development. In 1994, the Chinese government compiled the White Paper on

Population, Resources, Environment and Development in the 21st Century in China, which was the first time, a sustainable development strategy was integrated into the long-term planning of China's economic and social development. In 1997, the 15th National Party Congress has declared sustainable development a national strategy. The 16th National Party Congress has made sustainable development one of the goals of the comprehensive well-off society construction in 2002 [13]. Ten years later, at the end of 2012, the 18th National Party Congress proposed the "innovation driven development strategy", which clearly pointed out that "scientific and technological innovation is the strategic support for enhancing social productivity and comprehensive national strength, and must be placed at the core place of national development" [14]. It also stressed the need to adhere to the path of independent innovation and implementation of innovation-driven development strategies.

Under the above strategies, for China's port development, sustainable development is the strategic goal, using innovation as driving force. As "responsible innovation is to connect the practice of … innovation in the present to the futures that is promises and helps bring about" [15], responsible innovative port development can be seen as a better way of constructing ports not only in China but also in the world. As people, planet and profit are mostly considered as the key aspects of sustainable development [5], this section uses these three elements in its responsible innovation analysis of the values articulated by Dalian Port in its construction and development.

## 3 RESPONSIBLE INNOVATION IN DALIAN PORT

Concerning the values of people, planet and profit, Dalian Port focuses on environmental protection and multiple corporate social responsibilities (CSR). The environmental protection is mainly reflected in the construction of a green port, which takes energy conservation and emissions reduction as their contents and which relies mainly on the use of green technology and the implementation of "ten major ecological green project":

1. Green Technology: during its planning and development, Dalian Port is committed to green technology and pays attention to the selection of reusable, recyclable, renewable, biodegradable and easy to process green materials and clean energy equipment as well as the implementation of the green supply chain management.
2. Ten Major Ecological Green Projects: in its planning, construction and production operations, Dalian Port has promoted "Ten Major Ecological Green Projects" since 2013, reflecting social responsibility in environmental protection and sustainable development from a macro perspective.

Along with pursuing the strategy of technological innovation, Dalian Port takes its social responsibility seriously. Its plural CSR concerns multiple values and stakeholders, which can be specified in four domains:

1. Responsibility to economy and society.
2. Responsibility to customers and quality.
3. Responsibility to employee benefit.
4. Responsibility to public welfare.

Consequently, in Dalian Port, one system meets multiple values, fulfilling its environmental, economic and social responsibilities and thus benefitting multiple stakeholders.

Figure 2: Dalian Port [16].

## 4 CASE STUDIES [17]

### 4.1 Emergency pool project

The emergency pool is an oil collecting system. In case the oil flows out of the storage area, the emergency pool could collect the spilled oil, preventing it to pollute other places. It is a risk prevention and response system. Background of the case is that the emergency mechanism it replaced was unable to cope with the dangers and risks of spilling oil. After more than 40 years of development in Dalian Port, the old system did not meet the requirements anymore, as appeared from the devastating 2010 oil spill, which has been the direct reason or the plan. In 2013, Dalian Port invested and built a large cofferdam type of emergency pool [18]. Values concerned include land-saving, reuse of existing docks for a multi-purpose emergency system, environmental protection and protection of marine ecosystems.

As Horizon 2020 points out, the aim of responsible innovation is to guarantee the "collaborative work" among all stakeholders [19], "responsible innovation often resides in the initiatives and technologies mechanisms that help us to avoid to sacrifice one value in order to respect another" [20]. From this perspective, the emergency pool project in the port of Dalian is one of the typical cases of responsible innovation.

In the previous construction, the port of Dalian used some emergency facilities such as fire dikes to prevent the fire to affect other areas in the process of oil storage, or to avoid the negative impact to the environment by the spilled oil, according to "Code for Design of Oil Depot of P.R.C." [21]. However, with more than 40 years' development in the port of Dalian, there are many kinds of oil products and facilities in the oil storage area. The former emergency mechanism has been unable to cope with the dangers caused by the fire if it happened in the area. Under such circumstances, the port of Dalian organized one expert group, and further analyzed how to deal with the dangers in the large tank storage area home

and abroad in recent years. In 2011, the port of Dalian set up a special project to conduct research into the construction of emergency pool project.

In 2013, the port of Dalian invested almost 10 million Yuan to build a large cofferdam type of oil product emergency pool with completely independent intellectual property rights within one year. This emergency pool locates in the central area between the oil logistic zone and the sea (see Fig. 3), which provides an important instance for designing and constructing a large emergency pool in China's oil product area, and supplies a solid security defence line for developing oil product sector in the port of Dalian [22].

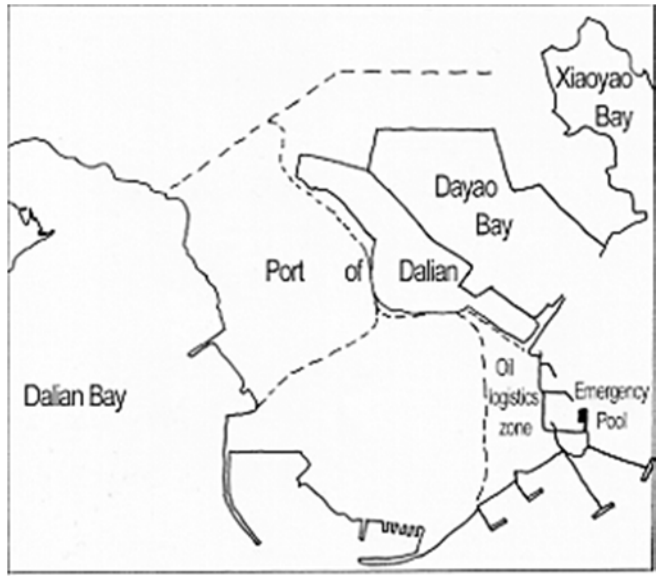


Figure 3: The position of emergency pool in the port of Dalian [23].

There is no similar project in China. The port of Dalian develops its own way of innovation and sets up a group of experts in conjunction with safety department of oil companies and other relevant units and departments to carry out some research into designing and constructing the project. After almost one year's exploring and practicing, the expert group finished the report of "research on the design and construction project of emergency pond in the port of Dalian", and passed the experts evaluation organized by the local authorities in July 2012 [22].

Traditional emergency pool occupied land resources in oil product storage area, which was often constrained by the area size. The port of Dalian innovatively designs the emergency pool in the sea, saving a large amount of precious land resources. Only a few changes to the network of pipes, could make all the accident water flow into the emergency pool through the existing network of drainage channels, save a lot of work of reconstruction, and will not affect the normal work of oil product storage area [22].

Emergency pool in the port of Dalian fully combined with the terrain characteristics of the new port area, deliberately utilizing the existing facilities and collecting/accumulating all accident water together into an organic system. By doing this, not only does the port of Dalian not only minimum the cost but also it achieves the goal of "full cover, no omission" of collecting accident water if there's accident [22].

Emergency pool is with the shape of square, and it makes the use of existing docks in the east, south and west, and just to build a new cofferdam in the north. Together with the existing docks, the emergency pool has the capacity of 100,000 cubic meters [23].

Relying on the emergency pool, the port of Dalian has set up a "three vertical layers" and "three lateral layers" water accident emergency system, which greatly prevent accident water flow into the sea. Specifically, three vertical layers take the advantage of the three main drainage systems within the area, and divide all the oil storage area into three layers against the accident water. By virtue of the reconstruction above, the new port area has formed/turned into three major accident water collection zones. The first zone contains fire dike, rainwater pipeline, sewage pipeline, collection pool, pump pool and flood discharge trench. The second zone is from the first zone till the inlets gate of the sea. The third zone is from the inlets gate of the sea to the emergency pool. Therefore, from upstream to downstream, the three zones form a vertical chain to prevent and collect the accident water [23].

Three lateral layers follow the principle of tertiary prevention and control more than three layers to stop the accident water, so the sea could be protected from pollution maximally. The first line of defence means every oil tank base in the oil storage area has the fire dike to prevent the spread of accident water. The second line of defence is from the fire dikes to the inlets gate of the sea, and the third line of defence is from the inlets gate of the sea to the coastal retaining walls. All the three lines are made to prevent the accident water from flowing into the sea [23].

The construction of emergency pool of the port of Dalian takes the characteristic of the landscape into account and ingeniously uses the existing facilities to line up all the collecting facilities of accident water into an organic system, which not only makes the investment down to the minimum, but also achieve the aim of full cover, no omission. In other words, the construction of emergency pool fully reflects and implements the idea of responsible innovation/RI that takes economic values, environmental values and social values into account at same time in the port of Dalian. Therefore, it can serve as a typical case of responsible innovation in the port.

### 4.2 Onshore electricity project

The onshore electricity project in Dalian Port aims to change the onshore energy of the factors of production from "oil" to "electricity". During the process of the implementation of the onshore electricity project, Dalian Port applies an effective deliberation mechanism under the guidance of the government, in order to take the interests of the stakeholders into account. In this way the energy transition in the port is part of a broader transformation aimed at making the port an environmentally-friendly and responsible innovation centre. Dalian Port organized an investment of more than 17 million RMB to start the "Marine Onshore Electricity" project in March 2015 [17]. The onshore electricity at sea consists of container electricity connected to onshore electricity via a cable, whereby the electricity supply of the container is used for cargo handling during its onshore periods.

According to the definition of technology innovation from Joseph Schumpeter, innovation is to "establish a new production function", which means "the combination of factors of production" [24]. The "onshore electricity project" in the port of Dalian aims to change the onshore energy from oil into electricity. Meanwhile, in the process of implementing onshore electricity project, the port of Dalian carries out an effective deliberation mechanism led by the government with the focus on the port. It takes the benefits of related stakeholders into account in order to achieve the transformation from the way of

energy supplement into making the port an environmentally-friendly and responsibly-innovated center.

As the most important comprehensive foreign trade port and an international port, the port of Dalian owns 75 lanes of international containers at present. The traditional power utilization of cranes and containers mostly generated from/by diesel had high cost, big noise and environmental pollution [25]. For solving the problems above, and in order to respond to the "Twelfth Five-Year Plan on Transportation" [26] and the advocacy of promoting the usage of onshore electricity in ports promoted by the Ministry of Transportation [27], meanwhile for constructing the green port of energy-saving and environmental protection, the port of Dalian got the investment of more than 17 million RMB and started the onshore electricity project since in March, 2015. Marine onshore electricity is to connect the container electricity and onshore electricity with cable, using the land electricity supply for cargo handling during the container's onshore period. The project is expected to reduce oil consumption of diesel generators up to 600 tons each year. While reducing carbon dioxide emissions by 66%, the project aims to reduce sulfur dioxide emissions (17.3 tons) and $NO_X$ emissions (10.02 tons) each year. Simultaneously, the noise pollution can also be effectively controlled [28].

The construction of the project of onshore electricity is supported by Dalian government, the department of transportation and port in Dalian and China's State Grid and other ports in China [29]. In order to promote the green port construction, the State Grid supplies great support to the port of Dalian, and makes the port as a pilot for accumulating related experiences that sets up a good example for other coastal cities in China [30]. However, the marine onshore electricity project also met some obstacles in the construction process. The main obstacle was from shipping companies which did not didn't all support and refused to cooperate with the project since in recent years, oil price has been continually falling, while electricity price was relatively high, and the implementation of the marine onshore electricity project required the change of power supplying from oil into electricity, which possibly affected shipping companies' profits. Under such a circumstance, the port of Dalian actively communicated with all stakeholders, trying to balance different pursuit of values at the same time. On the 6th May 2015, with the host of Port and Port-Of-Entry Authority, Dalian government organized the stakeholders to attend a conference with the theme of how to promote the application of marine onshore electricity in Dalian. The conference concentrated on the plan and construction scheme of onshore electricity, discussing how to propel/advocate the technology of onshore electricity and its application and proposing concrete requirements to project construction from the perspective of local government [31]. Under the leading role of government, the conference improved the knowledge and understanding of the project for shipping companies, and promoted the implementation of onshore electricity project based on full communication and deliberation.

From the two cases above, it can be seen that the development of responsible innovation in China in the last past years, especially in aspect of the port construction, has changed from to examine whether the port meets the requirements of RI into a government-oriented responsible innovation mode with autonomy based on communication and deliberation. Although there still exists many problems that need further solving, but the concept of responsible innovation is playing an influential and leading role in planning, constructing and developing China's ports. The construction of emergency pool project and the start of marine onshore electricity project to a large extent have reflected such developing directions and trends.

## 5 CONCLUSION

Dalian Port development has gradually evolved from trajectories that might meet some of the requirements of (western) responsible innovation to the port inventing its own version of it, consisting of an environmental and government-oriented way of responsible innovation including deliberation with stakeholders. This Chinese context, in which this development takes place, differs from conditions in Europe and the United States. In addition, China, the EU and America are confronted with similar but not completely overlapping environmental and social challenges. All of this results in different pathways and versions of responsible innovation. In Dalian that materializes in the construction of a green port, in which both the government and other stakeholders play a part. Although there could be many problems with this mode of responsible innovation, especially if reviewed with Western concepts and requirements, it is obvious that the notions promoted by responsible innovation have become most influential in the port and even could become one of the major driving powers in its further planning, construction and development. The cases of the emergency pool and the onshore electricity clearly reflect this development direction of the port.

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