Networks in Shipbuilding Cluster in Western Part of Japan

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Abstract--**Lately, we are interested in networks of industrial clusters. Though these studies point out the importance of cluster networks, the network itself has not been analyzed. The Japanese shipbuilding industry is concentrated in western Japan, specifically in the Seto-Uchi and northern Kyushu areas, and makes the value chain in this cluster. It consists of two industries, ship manufacturing and marine equipment. The research objective is to derive solutions for some issues regarding future prospects of the Japanese shipbuilding industry cluster by targeting an analysis of the present situation in western Japan, including the Seto-Uchi and northern Kyusyu areas, based on a cluster or a network analysis. Our analysis perspectives are the following three points: (1) transaction status among the cluster, (2) the network structure, and (3) the network function. Our study shows that the multilateralization of Japanese ship industry has changed its cluster structure. The ship manufacturing industry developed out of the Meiji ere Navy yard and was successfully taken over by the private sector. The marine equipment manufacturing industry, on the other hand, was widely spread out across Japan. In other words, we understand that it becomes apparent that this cluster constitutes a specialization network in western Japan and it has a different structure in each industry.**

I. INTRODUCTION

The shipbuilding industry in Japan jumped to first place worldwide in the period after World War II. After the two oil crises of the 1970s, however, it was considered a "Structural recession business" until the 1980s. Its excessive production capacities were rationalized under national policy. Based on worldwide market analysis, the shipbuilding industry has begun to recover thanks to economic growth principally driven by China since the mid-1990s. With the expansion of shipbuilding demand, the market strategy and rapid capital investment of the Chinese and Korean shipbuilding manufacturing industries had a negative impact on the growth and the performance of the leading shipbuilding companies of Japan. However medium-sized Japanese shipbuilding companies, which proceed along an independent strategy, have grown.

In this context, we are interested in the advantage of industry clusters again. In prior research into industry clusters, there is agreement relating to the superiority of networks in industry clusters. However, these studies are intended to point out the importance of the network in the clusters, but we have not analyzed the networks in the clusters themselves. Furthermore, there has been little analysis of the network of an industrial cluster in the shipbuilding industry in the past. It may be possible to arrive at solutions for some issues, allowing the company to evolve in the future by strengthening the network in a cluster given the current international competition in the shipbuilding industry. In addition, it may be also possible to encourage the improvement of trade practices such as mergers and reorganization of the group companies in the industry.

In this study, we targeted the Japanese shipbuilding industry, which is concentrated in western Japan especially in the Seto-Uchi and northern Kyushu areas and makes a value chain in this cluster. In addition, we analyzed the shipbuilding industry in Japan, which had been supported by the demands of the Japanese Navy and the shipping industry. But because of the oil crises, the operating performance of Japanese shipbuilding companies has been declining since the 1970s. The research objective is to arrive at the solutions for some issues regarding the future prospects of the Japanese shipbuilding industry cluster through targeting an analysis of the present situation in western Japan, including the Seto-Uchi and northern Kyusyu areas based on a cluster or a network analysis.

This study consisted of the following: In Section 2, we describe a method for analyzing a network in the cluster and research methods. In Section 3, we present the result of analyzing the network in the cluster. We conclude with the result of this study based on our research for a framework.

II. RESEARCH OBJECTIVES AND METHODS

A. Research objectives

1) Definition of a shipbuilding cluster

In this study, we define a shipbuilding cluster as the group companies in the ship manufacturing industry and the marine equipment industry. The ship manufacturing industry companies purchase approximately 95% of marine equipment from the same shipbuilding cluster and provides approximately 75% of its finished goods to the Japanese domestic market ([2]pp.15-17).

2)The market size of shipbuilding cluster in Japan

Japanese shipbuilding companies risked serious fluctuations in operating performance from business cycles. From the time of the oil shock of the 1970s, the Japanese shipbuilding industry was recognized as a "Structural recession industry". Its excessive production capacities were rationalized under national policy. Although the world-wide demand for ships expanded, it can be seen that the Japanese market share has been decreasing. (Fig.1).

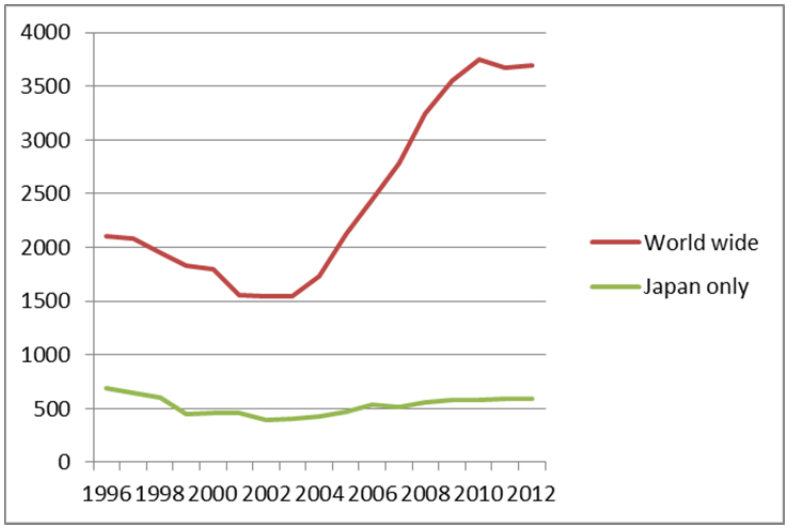

Fig.1 Numbers of ship completions 'Japan vs. world'
(MLIT,2014)

3) History and location in a shipbuilding cluster

Shipbuilding industry companies in Japan are concentrated mainly in western Japan. This is an outgrowth of the Meiji-era Navy yard (Table 1). In the past, there has been much research analyzing points such as corporate alliances and the history of the region. Murakami (1986) focuses on the development of the main shipyard in Japan through targeting the corporate alliances or grouping of enterprises and location patterns ([7] pp.42-58). The Japanese shipbuilding industry, which developed out of the effective use of the Navy yard in the World War II, experienced a golden age because of an increase in the size of ships, the energy evolution, and the export of high performance ships. However, Murakami insisted that the industry had many factories in western Japan, especially in the Seto-Uchi and northern Kyushu areas, because of the consolidation or the integration of shipyards in eastern Japan. ([3] pp.30-100)

TABLE 1. HISTORY OF JAPANESE SHIPBUILDING INDUSTRY

Years	Main events	Time Period
1886	Establishment of the Navy yard in Sasebo.	Before WWII
1889	Establishment of the Navy yard in Kure.	
1927	Hitachi-Zosen established shipyards in Mukojima.	
1942	Mitsubishi-Zosen established shipyards in Hiroshima.	
1947	National Ship Corporation was established.	Period of Reconstruction
1949-1954	Protection policy was started.	
1955-1959	Increase the number of the exported ship	
1960	Ishikawajima Heavy Industry and Harima Shipbuilding merged.	Period of Expansion
1962	Completion of the Third Nisshomaru.	
1964	Three Mitsubishi group companies merged.	
1966	Completion of Idemitsumaru	
1967	Mitsui-Zosen and Hujinagashima-Zosen merged.	Period of Building large shipyards
1968	Ishihari-Zosen and Kure-Zosen merged.	
1969	Establishment of Sumitomo Heavy Industry from a merger	
1970	Hitachi-Zosen and Maizuru-Zosen merged.	
1976	The recommendation of short-time working in the 40 leading shipbuilding companies was accepted.	Shipbuilding business downturn
1978	Reduction of excessive production equipment.	
1980	Completed the reduction of excessive production equipment.	Period of processing equipment restructuring
1986	Sasebo Heavy Industries Co., Ltd. became a subsidiary of Kurushima-Dokku.	
2000	Japanese new ship construction volume exceeded by Korea.	Period of world competition
2009	Japanese new ship construction volume exceeded by China.	

([2] pp.42-58)

B. Research method

1) The research method

Analysis of network structure is generally performed from the perspectives of independent relational dimensions and structural dimensions. Yasuda (1994) states that social network analysis is carried out as follows: (1) analyzing the social relations between the companies as a concept of a social structure, and then, (2) analyzing the effect on the respective companies of the relationship between the companies. ([8]pp.32-35)

In this study, we define the network as "a system which can advantageously use business management through markets and enterprises" from the reference of Imai and Kaneko(1988). ([4] pp.115-169)

2) Discussion points of network analysis

Lately, we've come tounderstand that the network in the cluster be "embedded"([5].pp.23-25) . In order to recognize "the embedded company group", we focused on the density, range and size of the network. And we also analyzed earlier literature concerning the strength of ties of the network.

3) Analysis of earlier literature

In this research, we analyzed networks in the shipbuilding cluster as considered in earlier literature by Uzzi(1996), Coleman(1990), Granovetter(1973), Burt(1992). Based on their research, we roughly classified networks into two types:

a) Bonding-type network

We redefined "the bonding-type network" from earlier literature written by Uzzi(1996) and Coleman(1990). Networks among companies closely and directly connected have a high density and repeat static and homogenous business activities ([6].pp243-277). That is to say, we define "the bonding-type network" as a company group connected closely with small range of entities and stronger ties between them.

b) Bridge-typed network

We redefined "the bridge–type network" from earlier literature written by Granovetter(1973) and Burt(1992). "Bridge-type" network implies ties between two companies or sub-groups through a "structure hall"([6] .pp243-277). That is to say, we define "the bridge-type network" as a company group which has a relationship with many industries with wide ranging but weaker ties between entities.

4)The analysis framework

In this paper, we can divide networks into two kinds: "Networks which have a high density and stronger ties" and "Networks which have weaker ties and structured holes". The former can be defined as a "bonding-type network", and the latter can be defined as "bridge-type network".

III. NETWORK ANALYSIS IN THE SHIPBUILDING CLUSTER

We analyzed the network in the shipbuilding cluster with information from the Japan Society of Naval Architects and Ocean Engineers ("JASNAOE") and the Japan Ship Machinery & Equipment Association ("JSMEA").

A. Networks in the ship manufacturing industry

1) Production process of the ship and business activities

This can be roughly divided into two steps; (1) a process for manufacturing the ship hull and (2) a process for attaching much ship equipment to the ship hull. The former process involves assembling several blocks of the ship hull, in what is called the "block method". The latter process is to attach various necessary marine equipment to the ship hull, in a process called "rigging".

Business activities vary by company size in the ship manufacturing industry. In general, major companies manufacture relatively large ocean-going vessels. Small companies manufacture the blocks of ship hulls, but don't become involved in activities such as the development or the manufacture of ships. In this study, we divided groups of companies by capital scale and production processes.

2) Location and classification of 26 ship manufacturing companies

We referred to the provisions of the Enforcement of the Companies Act of Japan as a way to classify the groups of these companies. As a result, the number of major companies is 12, the number of medium ones is 8, and the number of smaller companies is 6. Based on this classification, we looked into the location of 26 ship manufacturing companies.

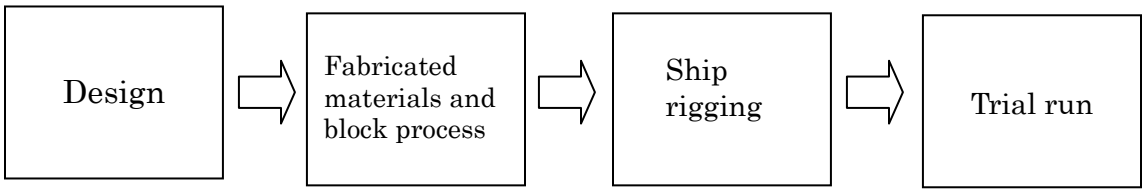

Fig. 2. Steps in ship production

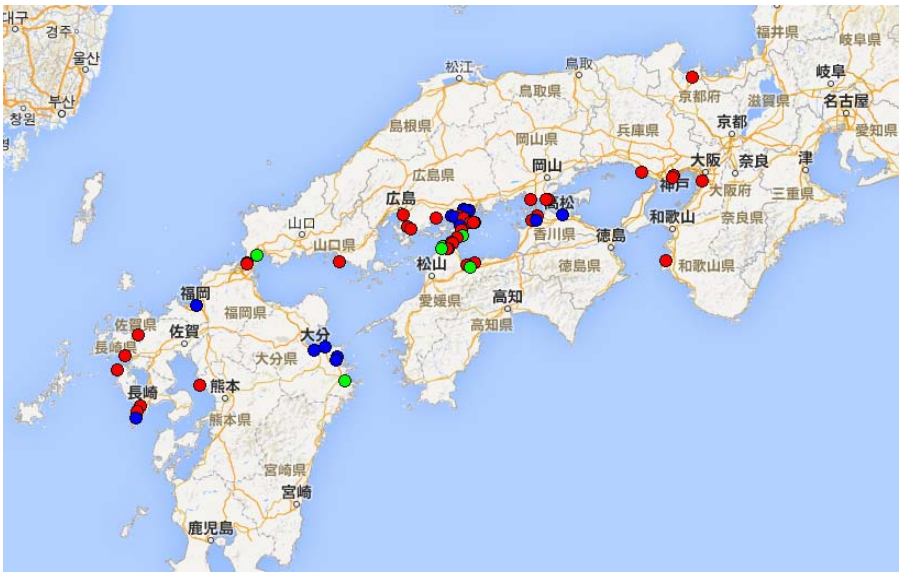

Fig. 3. Location of ship manufacturing industry in western Japan (JASNOE、2013)

3) Observations from the location relationships of the production base of ship manufacturers

The ship manufacturing industry in western Japan was developed from the Navy yard in the World War era. In other words, there are manufacturing bases both in the Sasebo Navy Yard and the Kure Navy Yard, on the site of private shipyards around the Innoshima. In addition, the large companies are located on the site of the old Navy yard. Small-scale companies are located close to the shipyards of large and medium-sized companies. In other words, there is a tendency of companies to divide the business activities in the ship manufacturing industry.

B. Network in the marine equipment manufacturing industry

1) Classification and profiles in the marine equipment manufacturing industry

There are many kinds of marine equipment and business activities include the manufacture of other equipment for plants in marine equipment manufacturing industry companies. We explain how to classify marine equipment manufacturing companies based on the statistical tables issued by the Ministry of Land, Infrastructure and Transport.

2) The statistical tables issued by the Ministry of Land, Infrastructure and Transport

The statistical tables of the Ministry of Land, Infrastructure and Transport show how to classify marine equipment in a shipbuilding statistical survey. It is a survey that has been carried out since 1896 in order to analyze the current status of engineers and shipbuilders. This statistical table is divided into six types: (1) marine turbines, or engines, (2) marine boilers, (3) marine auxiliary parts, (4) shafting, (5) fittings, and (6) others. However, as we think it is better to classify marine equipment manufactures by product use, we classify them again in Table 2 below. We divided 118 companies into: (1) as 44 companies, (2) as 19companies, (3) as 58 companies, (4) as 46 companies, and (5) as 76 companies.

In this study, we select 3 types such: (1) marine power equipment, (4) shafting, and (5) fittings, for a detailed analysis.

TABLE 2. COMPARISON OF CLASSIFICATIONS

Statistical Table	This study
① Marine turbine, engine	① Marine power equipment
② Marine boilers	
③ Marine auxiliary parts	② Marine auxiliary parts
④ Shafting	③ Shafting
⑤ Fittings	④ Fittings
⑥ Others	⑤ Others

3) Location of marine equipment manufacturing industries

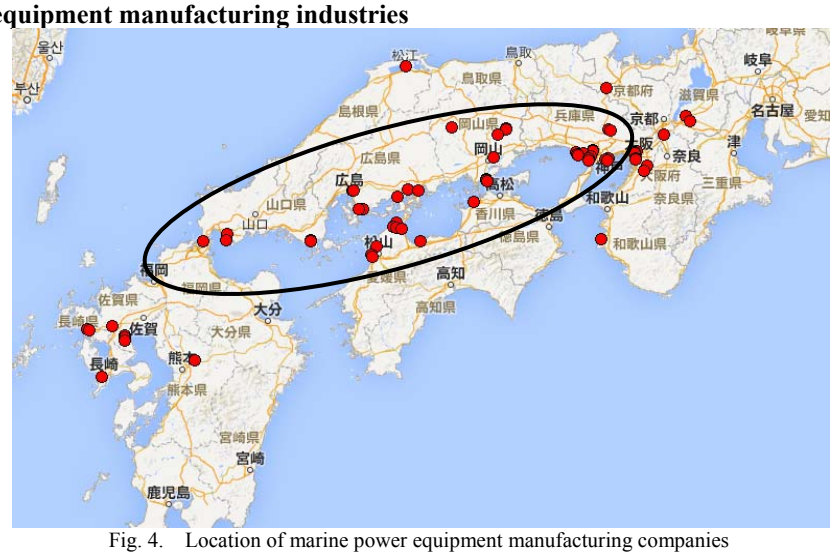

Fig. 4. Location of marine power equipment manufacturing companies
(JAMEA, 2013)

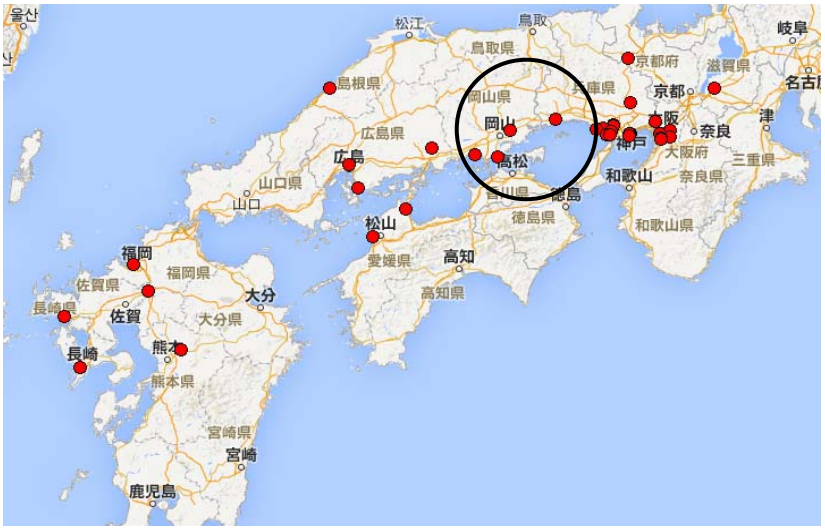

Fig. 5. Location of shafting manufacturing companies
(JAMEA, 2013)

Fig. 6. Location of fittings manufacturing companies
(JAMEA,2013)

4) Observations from the location analysis of each marine equipment manufacturing company

We found that the locations vary for each of the industry clusters depending upon business categories. First, marine power equipment manufacturing companies are widely spread out across western Japan. However, shafting manufacturing companies are more localized in the Hanshin and Osaka areas. Fittings manufacturing companies are located principally near marine power equipment manufacturing companies.

IV. DISCUSSION

A. Structure and features of the network in the ship manufacturing industry

Based on the analysis above, we found that there is a divisional network structure close to the region located in the ship manufacturing industry. During the shipbuilding recession of the 1980s, many shipyards closed. However, there are many manufacturing shipyards in the area near Innoshima, an old Navy yard site, because of the improvement of supply efficiency of marine equipment due to the opening of the Honshu-Shikoku Bridge between Imabari and Sakaide. As explained above, there are 'bonding-typed network" in the ship manufacturing industry because the different sizes of shipbuilding companies enter into transactions by dividing the actual business activities among nearby companies.

B. Structure and features of the network in the marine equipment manufacturing industry

There are several kinds of networks of marine equipment manufacturing industry members in the western part of Japan. The marine power equipment industry has a "bridge-typed network". Boilers, engines and turbines are also used by shipbuilders but also in other industries, such as automobile and aircraft manufacturers. Thus, because they sell to other industries as well as ship manufacturing, there is a tendency for manufacturers of marine power equipment to form a geographically vast network.

Secondly, shafting manufacturing companies also have a "bridge-typed network". There is a small number of specialized companies that manufactures fittings. These companies have dealt with many ship manufacturers especially in the Hanshin area despite having no significant geographical relationship.

However, fittings manufacturing companies have a "bonding-typed network". Relatively small- and medium-sized specialized companies manufacture many varieties and a high volume of marine equipment, such as instruments, paints, and electrical equipment. Therefore, we noted that these fittings manufacturing companies may locate in nearby shipyards in order to build a vertical relationship with nearby shipbuilders.

From the analysis above, marine equipment manufacturing companies have two types of network: (i) bonding-typed network and (ii) bridge-typed network, based upon the different types of marine equipment which they manufacture.

V. CONCLUSION

The object of this research is to derive solutions for some issues regarding the future prospects of the Japanese shipbuilding industry cluster of western Japan in order to maximize its competitive power through analyses of cluster structures and social networks. We analyze the networks in the western Japan shipbuilding cluster, such as ship manufacturing companies and marine equipment manufacturing companies. From these analyses, we find that the shipbuilding industry has two types of network; (i) bonding-type network and (ii) bridge-type network, based upon the different structures by categories of business.

1) The shipbuilding industry companies in Japan are concentrated mainly in western Japan, arising from the Meiji-era Navy yard; There is a divisional network structure with a closer connection. That is, companies with a different sizes make a vertical specialization network in a small range of areas. As a result, we concluded that the shipbuilding industry is bonding-type network.

2) It is found that the marine equipment manufacturing industry has both types of network (bonding-type network and bridge-type network). The companies, which produce equipment for other industries or make a small volume of equipment, form a wide range of networks, such as bridge-type network. However, the marine equipment manufacturing companies which make a large volume of equipment are located near the shipbuilding industry, and tend to participate in bonding-type networks.

3) From this analysis, it is considered that a marine equipment manufacturing company which participates in a bridge-type network does not have to locate near shipbuilding companies. However, marine equipment manufacturing companies which participate in bonding-type networks have to be located near shipbuilding companies. This means that, for example, when a shipbuilding company in Japan expands its business to the overseas market, a related marine equipment manufacturing industry with a bonding-type network should follow it.

VI. FUTURE RESEARCH DIRECTIONS

In this study, we analyzed the shipbuilding cluster. There are still many remaining issues. From the analysis above, we recognize that it is necessary to do further research into the development of clusters through a further detailed analysis of such factors as the functions of national and local governments, special regional business culture, and historica background. Further analysis of the shipbuilding cluster with consideration of these factors may give us new ideas for the establishment and development of networks between companies.

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