The Product Innovation Process with the Use of Mediators for Collaboration: The Case of Japanese Traditional Local Industry

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ABSTRACT

Many Japanese traditional local industries with long history are declining due to factors such as price competition with overseas products, the emergence of cheap substitutes, and changes in consumer demand. In order to resolve this problem, many local associations in the production areas have sought to develop new products. However, in many cases, the development of new products, so-called product innovation, is not progressing due to possessing a structure that depends on the ready-made in a culture of preserving tradition. Therefore, unconventional incentives are required. As a new incentive, we consider product innovation through collaboration with intellectual actors, since new product development requires novel knowledge and information from others, and focus on the effectiveness of mediators in facilitating collaboration. In this paper, taking some production areas as examples, based on the hypothesis that product innovation in production areas is realized by forming a network by utilizing mediators, the process and the network of product innovation are visualized to identify mediators and elucidate its types and roles. Additionally, the process of product innovation by utilizing mediators according to the regional characteristics and the technological capabilities of the local company is proposed.

Keywords: Traditional Local Industry; Product Innovation; Mediator; Collaboration.

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1. INTRODUCTION

The recent declining birth rate and ageing of the population in Japan is having an impact on economic and social development, requiring each region in Japan to take advantage of local resources to proactively create a diverse community and revitalize the local economy. In this context, local industries contribute to local employment and have a ripple effect on industrial relations in primary to tertiary industries, thus playing a role as a leader of the local economy.

A local industry is one in which a group of small- and medium-sized enterprises with local capital conduct production and sales activities by utilizing the management resources (raw materials, technology, human resources, sales capabilities, etc.) of the region (Small and Medium Enterprise Agency, 1981).

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From the Meiji period (1868-1912) until the period of rapid economic growth, local industries have been expanding their production, especially exporting to overseas countries, but since the 1990s they have shown a declining trend in production value and other indicators. According to the Small and Medium Enterprise Agency (2006, 2016), the number of employees decreased from a high of 1,057,482 in 1981 to 123,953 in 2015, and the production value decreased from a high of 16,432.7 billion yen in 1991 to 1,575.0 billion yen in 2015. Factors that have been pointed out as contributing to this decline include the slump in exports due to the appreciation of the yen during the Plaza Accord in 1985, the long-term recession caused by the bursting of the bubble economy in the 1990s, and later the increase in imports due to globalization and intensified international competition in the 2000s, changes in consumer demand and shrinking market size, and the emergence of cheaper alternatives.

Historically there are two types of local production areas: the traditional type, which originated in the Edo period (1603-1868) or earlier, and the modern type, which was formed after the Meiji period (1868-1912). The traditional type produces traditional crafts and daily necessities using traditional raw materials and manufacturing methods, while the modern type mass-produces daily necessities by transferring technology from overseas (Yamazaki, 1977). Examples of traditional products include lacquerware, furniture, Japanese paper, ceramics, and cutlery, while examples of modern products include towels, umbrellas, brushes, toys, sewing machines, and matches.

Traditional production areas have traditional technologies that have been cultivated over the years, and if in response to the declining trend of local industries more companies use these traditional technologies to improve or develop products, so-called product innovation, to produce high value-added non-daily goods, and to expand their business globally, then the entire production area will become more diverse and better able to cope with the drastically changing environment and survive sustainably, thereby contributing to the promotion of industry. Regarding the effects of innovation, Ismanu and Kusmintarti (2019) shows that innovation can play a very important role in firm management and improve firm performance, using the case of Batik handmade SMEs in East Java region, Indonesia. In this study, product innovation is defined as a new or improved product, based on the OECD (2018) definition, that is considerably different from the previous product of the firm producing it and is made available to or used by the firm concerned for potential users.

However, according to the Small and Medium Enterprise Agency (2016), 73.8% of production areas reported no change in the percentage of companies developing new fields and businesses in areas other than traditional products compared to five years before, indicating that the development of new fields and businesses has not expanded much. Therefore, it is necessary to consider how to improve the situation.

The original definition of innovation was a new combination of resources for the development of new products, introduction of new production methods, development of new markets, acquisition of new sources of resources, and organizational reform through creative activities (Schumpeter, 1926). However, in the 2000s, open innovation theory (Chesbrough, 2003, 2006), which seeks to combine resources not only within a company but also outside the company, gained scholarly attention. Small and medium-sized enterprises (SMEs), which make up the majority of local industries, are forced to adopt a strategy of concentrating limited resources on their business due to their small size. They tend to seek management resources that are in short supply such as technology and know-how from external rather than internal sources, and are therefore more likely to be familiar with open innovation.

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Even for companies in traditional production areas, product innovation can be achieved through collaboration with other actors such as other companies, universities, and public research institutes. The definition of actors in this study is social units as actors (Kanamitsu, 2003). However, traditional production areas tend to be in a state of negative lock-in because they have a culture of preserving traditions unique to the production area and are dependent on existing products with a production structure of mass production of homogeneous, low value-added daily necessities based on local raw materials. Negative lock-in means that specialization in a particular industry becomes a barrier to change by promoting rigidity, homogenization of the way of looking at things, and the inability to find solutions to problems because they are solved within the region, leading to a failure to respond appropriately as a group to external changes (Grabher, 1993). As a result, collaboration with other actors is difficult, and new and different incentives are needed to realize product innovation. In this study, we consider the new incentive to be the use of mediators for collaboration with other actors, and focus on the type and role of the mediator in network formation. In this study, a mediator is defined as an actor who connects two or more parties for the purpose of knowledge and information propagation based on the view that product innovation requires the acquisition of new knowledge and information.

Since there are multiple types and roles of mediators, it is expected that the mediator to be utilized will differ depending on the situation of the company. In the case of a traditional local industry, the company may be in a situation where the producing area in which it is located is in a state of negative lock-in (hereinafter referred to as a

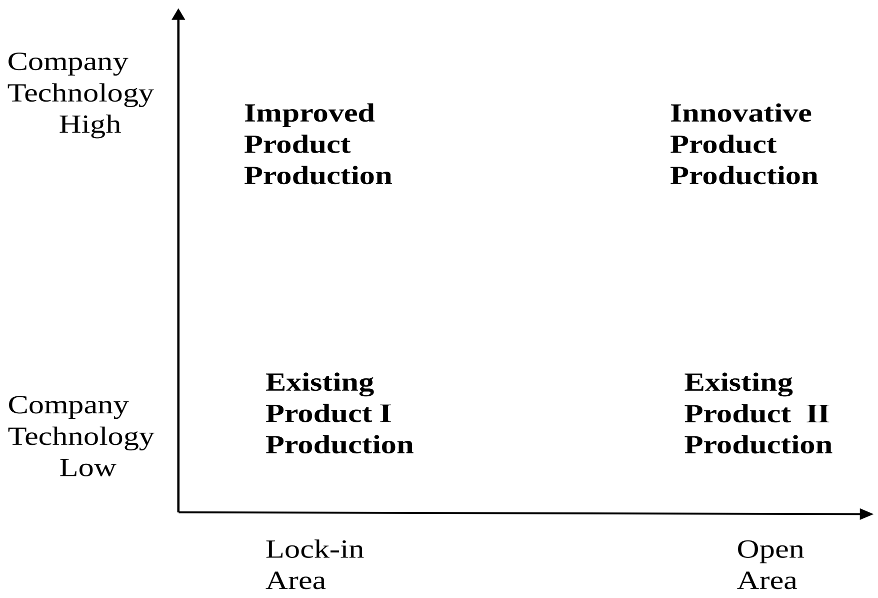

Figure 1. Production Status According to Regional Characteristics and Company Technological Capabilities

"lock-in area") or not (hereinafter referred to as an "open area"). In addition, there may be a situation in which the company itself is not technologically advanced enough to develop a new or improved product different from its existing products. It would be helpful to examine the process of developing product production using the appropriate mediators for such situations. As for the status of product production, we posit that the

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company produces existing products I when its technological capability is low in a lock-in area, existing products II when its technological capability is low in an open area, innovative products when its technological capability is high in an open area, and improved products when its technological capability is high in a lock-in area (Figure 1). It is assumed that existing products II is surrounded by more diverse existing products than existing products I.

A lock-in area is defined as a situation in which the ratio of specialization in a specific industry (existing products) is high. Therefore, in a lock-in area, the value of the specialization coefficient for the value of shipments of existing products in the prefecture (or ordinance-designated city) where the company is located in the year in which the product was developed is high, and an open area is defined as a situation in which the value is low. The specialization coefficient looks at the relative compositionalbias of an item by comparing its compositional ratio to the overall compositional ratio, and when this coefficient exceeds 1 (nationwide = 1), the item is considered to be specialized. Specifically, the specialization coefficient *LQij* (Location Quotient) of region *i* for industry *j* is defined by equation (1). *M* denotes the industrial volume (either number of jobs, production value, etc.), and variables without subscripts denote the respective total industrial volume of the nation.

$$\mathrm{L}Q\mathrm{ij} = \frac{\mathrm{M}ij/\mathrm{M}i}{\mathrm{M}j/\mathrm{M}} \tag{1}$$

Based on the hypothesis that product innovation in traditional local industries is realized by the formation of networks through the use of mediators, this study aims to visualize the networks in the process of product innovation through case studies and data, identify mediators, elucidate and verify their types and roles, and make recommendations for the realization of product innovation through the use of mediators that match the characteristics of the region and the technological capabilities of the companies.

2. LITERATURE REVIEW

Traditional local industries, where small and medium-sized enterprises in the same industry are concentrated in regional business clusters, can be regarded as industrial clusters. Looking at the propagation of knowledge and information from the perspective of industrial clusters, Maskell and Malmberg (1999) argue that the more tacit a piece of knowledge, the more face-to-face contact is required for knowledge exchange. Spatial proximity between actors is important, as proximity lowers the cost of learning, and also facilitates the transfer of tacit knowledge due to the cultivation of shared values and culture, or trust. On the other hand, Mizuno (2005, 2011) uses Nooteboom (1999)'s concept of "cognitive distance" to argue that in regions where the same industries are concentrated, cognitive proximity is extremely high due to the homogeneity of local institutions and practices, and therefore, in order to obtain novel knowledge, it is necessary to interact with cognitively distant counterparts, that is, counterparts located outside the region. Note that Nooteboom et al. (2007) define "cognition" as a broad mental activity that includes perception, value judgments, estimation, and emotions, and "cognitive distance" as the mental proximity of cognition. Regarding the mechanisms of local knowledge circulation and knowledge inflow from outside the local area, Bathelt, Malmberg and Maskell (2004) focused on the networks inside and outside the industrial

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cluster. Storper and Venables (2004) suggest that knowledge creation in a local area is promoted by buzz and pipelines (Owen-Smith and Powell, 2002, 2004), which refers to channels of knowledge propagation from outside the local area.

For a study on the product innovation process, Purbasari, Muttaqin and Sari (2020) analyzed the roles and interactions of the actors involved in the process using the A to F theory by Trias de Bes and Kotler. The results revealed that each actor has diverse role positioning and dynamic interactions. However, this study does not focus on the mediators that link the actors together.

From the perspective of mediators in networks, the research has been conducted mainly in fields such as advanced industries. Sakata et al. (2006) refer to the mediator as the “connector hub” in the networks of business-to-business transactions, joint research among companies, universities, and industrial support organizations, and commissioned research in the medical industry in the Kinki region and the semiconductor industry in Northern Kyushu, and state that core companies and universities in the industrial field control the distribution of knowledge and information. Nakano (2007) also refers to the mediator as “hubs” in the network of business-to-business transactions among companies in Ota Ward, Tokyo, and states that some companies have relationships with many actors and form the core of the network. In the network of joint research among companies, universities, and public research institutes in the life science and nanotechnology fields of the “Consortium R & D Project for Regional Revitalization,” which aims to conduct research and development of products and services that will lead to commercialization by utilizing the technological seeds and knowledge of universities and other organizations, Yokura (2009) refers to the mediator as the “core” in the network, noting that public research institutes play a central role in the intra-regional circulation of knowledge and information, while universities and technical colleges play a central role in the intra-regional inflow of knowledge and information. Furthermore, Fuji (2013) refers to the mediator as “technology spillover hubs” in the network of joint patent applications among companies in the paint industry, and states that Kansai Paint Co., Ltd. and Nippon Paint Co., Ltd. play a central role in joint research among multiple companies. Apart from these, Manabe (2017) mentions companies that support the introduction of external technologies by general companies in open innovation, and refers to mediators as “intermediary companies,” stating that intermediary companies connect companies by matching knowledge and technologies. From the above, it can be seen that mediators have two roles: the hub, which acts as a mediator itself, and the intermediary role, which only connects multiple companies. While the studies discussed above were limited to identifying the mediators in the target field and clarifying their roles, the novelty of this study lies in the fact that it focuses on the use of mediators in traditional-type local industries according to the situation of the company and the region.

3. RESEARCH METHOD

As a method of research, we will focus on companies that have succeeded in product innovation in traditional-type production areas, analyzing the product innovation process of companies that have collaborated with actors on their own and companies that have participated in national cluster projects where a framework for collaboration has been created.

As case studies of individual companies, we will focus on ceramics and cutlery, which were the products of local industries that Japanese consumers purchased the most in the past two to three years, exclusive of food products, according to a nationwide

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survey conducted by JTB Tourism Research & Consulting Co. (2018). Specifically, we will focus on companies located in Seto City in Aichi Prefecture, which has the highest value of manufactured goods shipments of the manufacture of ceramic, stone, and clay products with four or more employees, and Seki City in Gifu Prefecture, which has the highest value of manufactured goods shipments of the manufacture of edge tools, artisans' tools, and hand tools, excepting files, saws, and knives for kitchen use, with four or more employees by the Census of Manufactures Report of 2019. As case studies of national cluster projects, we will target ceramic related companies in Tajimi City, Gifu Prefecture, and gold and silver thread-related companies in Kyoto City, an ordinance-designated city, which have implemented projects aimed at promoting traditional local industries.

In order to acquire data, we visit the target region and interview case companies, universities, and other collaborating actors who have succeeded in product innovation about the innovation process and other issues. Then, based on the results of the interviews and the patent data of the case companies related to the results, we visualize the network for knowledge acquisition in the process of product innovation, identify the existence of mediators in the network, and discuss their roles. Note that data from Oshima (2018) for the Seto and Seki case studies and Oshima and Toma (2017) for the Kyoto case study are cited and modified.

The visualization of the network is organized based on the Onion Model, which is used in stakeholder analysis in systems engineering. For example, Alexander (2005) considers the people involved in all processes of system planning, design, development, and operation as stakeholders in system development, and develops them on the Onion Model to analyze their relationships. The Onion Model is written in concentric circles, with the software/hardware product to be developed at the center. Moving outward from the center circle, the entire system to be built, other systems directly connected to it, and things that affect it as the environment (social system) are represented.

Figure 2 shows the spatial location of actors who propagated knowledge and mediators, with the case company at the center and the actors that are spatially farther away from the case company located outside. In addition to this, we added a new clockwise time element that visualizes the history of network change process. As for the strata, since the case study area is located in a metropolitan area (Seto, Seki, and Tajimi are located in the Chukyo area, and Kyoto is located in the Kansai area), it is divided into three strata: the production area, metropolitan area, and outside the metropolitan area. In addition, the time factor is assumed to be a yearly transition from left to right.

Based on the results of the interviews, the changes in the technological capabilities of the case study companies from existing products to improved or innovative products are captured, and the specialization coefficients are calculated based on the industrial statistics (Census of Manufactures) of the year in which the product innovation occurred to understand the regional situation. Then we use Figure 1 to position the mediator according to the technological capabilities of the company and the regional characteristics,

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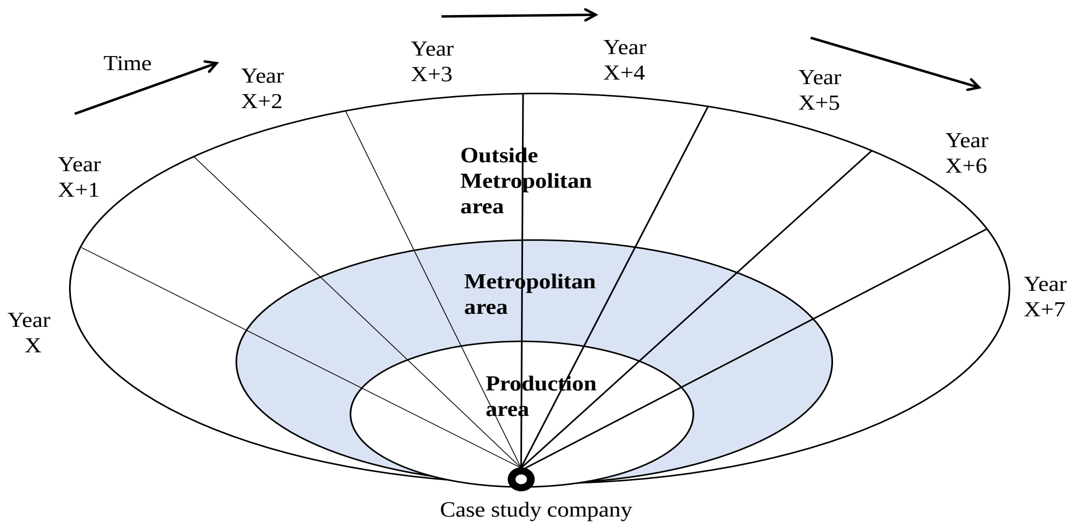

Figure 2. Onion Model with Additional Time Factor Clockwise to Express Product Innovation Network

and show the development from existing products to improved or innovative products when the companies utilize each mediator.

4. RESULTS AND DISCUSSION

4.1. The Case of Seto City

Seto City in Aichi Prefecture is a production center for ceramics. It is characterized by its long history and wide variety of products, as well as by the fact that it has one of the largest production volumes and the largest number of establishments in Japan. The history of Seto City began with the production of various containers such as Sue ware in the 700s; over time the number of production items increased, and by the late 1930s, a wide variety of ceramic products were being produced, including eating and drinking utensils, toys and figurines, tiles, washbasins, toilet bowls, medical instruments, insulators, switches, umbrella stands, vases, and ashtrays (Seto City History Compilation Committee, 2007, 2010).

In Seto City, according to the Census of Manufactures Report of 2019, the value of manufactured goods shipments of the manufacture of ceramic, stone and clay products with four or more employees was 46,196,470,000 yen, while the number of establishments was 156, the second largest in Japan.

As a case study, I would like to focus on Yamaju Ceramics Co., Ltd., a company that has shifted from ceramics to manufacturing fine ceramics products. The company currently manufactures a variety of oxide single crystals for the IT field, mainly for mobile communications, and has a 30% share of the world market for the manufacture of single crystals used as substrate materials for surface acoustic wave (SAW) filters.

The company was founded in 1925 as a ceramic exporter in Seto City. In 1935, the company built a new factory in Owari-Asahi City and established an integrated system of ceramic production, including raw materials, manufacturing, and painting processes, in order to expand exports to Southeast Asia. In 1958, the company began to manufacture semi-porcelain ceramic dinner sets (Western-style tableware) and shifted its main focus to sales to the United States, Canada, and Australia. However, due to the

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large number of employees in the factory, the president visited an advanced ceramics factory of an American company (YC1) in 1968 in order to learn how to streamline and expand the factory to increase production of ceramics. However, because of the poor working environment despite the advanced factory, he had doubts about the future of the factory and decided to stop the expansion of the ceramics factory in favor of streamlining production and developing a new business in place of ceramics. The following year, he proceeded with a complete rationalization of the ceramics production line, which led to an increase in the profit margin, and he sought to develop new businesses with the profits. An engineer who graduated from Waseda University (YC2) joined the company in 1969. In 1970, he visited the research institute in Tokyo (YC3) with a relative (M1)'s message to seek advice on new business. As a result, he found out that there were three areas in which new business could be directed: aluminum substrates for ICs, processed alumina products, and oxide single crystals. Of these, aluminum substrates and processed alumina products had already been developed by other companies in the same industry, but oxide single crystals were still in the research stage, so he decided to enter this field the following year. However, the ceramics produced in the past were polycrystals with different crystal axes depending on where they were cut, while the single crystals for which he decided to develop a new business have a constant crystal orientation no matter which part is taken out. After initially conducting research with Nagoya Institute of Technology (YC4), in 1972, under the guidance of Tohoku University (YC5), he proceeded with research on growing YAG (Yttrium Aluminum Garnet) single crystals for laser oscillation, but there was no demand for them. In the meantime, he learned from a relative (M2) that an American company (YC6) was conducting research on the use of single crystals as surface acoustic wave filters for TV sets. In 1974, the single crystal laboratory was moved to Seto City and started operation as the Seto Plant. He also invited two researchers who had been studying crystals at Nagoya University (YC7) and the research institute in Ibaraki (YC8), and received advice from a single crystal expert at the research institute in Tokyo (YC9) through a business partner (M3), leading to the mass production of single crystals of lithium niobate in 1976. The above is summarized in Figure 3.

Figure 3 shows that the company's network extends both inside and outside the metropolitan (Chukyo) area. As the ceramic and fine ceramics industries are concentrated in the Chukyo area, where there are universities (YC4, YC7) that specialize in this field of research, the company has formed a network with them to benefit from this concentration. However, when there is a lack of technical knowledge about a new business, development is carried out by connecting with research institutes (YC3, YC9) and companies (YC6) outside the sphere (far away) through a familiar relative (M1, M2) and familiar business partner (M3) in order to obtain novel knowledge. In 1976, when the developed product was completed, the specialization coefficient of the production area (Aichi Prefecture) in terms of the value of manufactured goods shipments of the manufacture of tableware pottery, an existing product, was 2.7.

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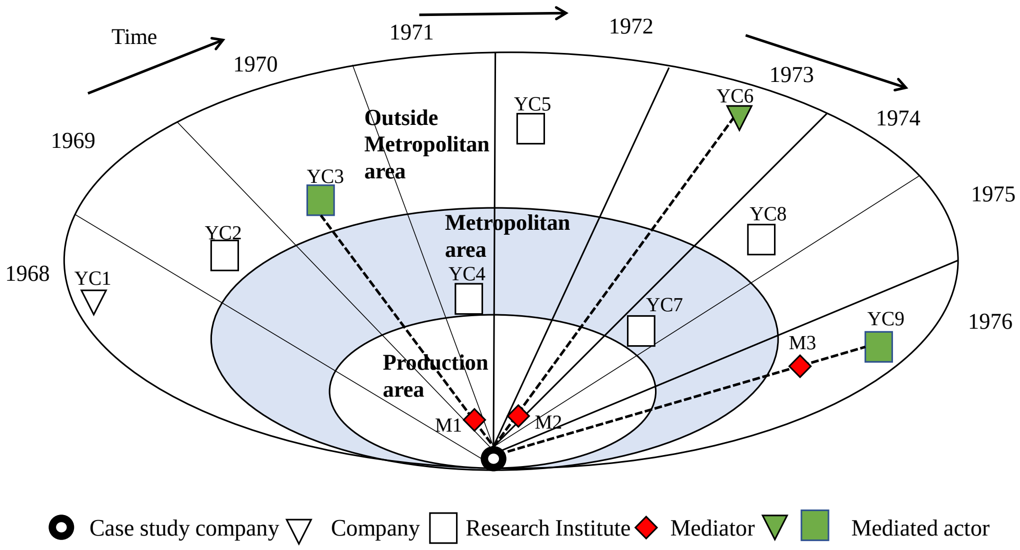

Figure 3. Onion Model of the Network of Product Innovation (Seto)

4.2. The Case of Seki City

Seki City in Gifu Prefecture is a production center for cutlery. It is characterized by its long history, high name recognition, and one of the largest production volumes and number of business establishments in Japan. In terms of history, sword smithing began in the 1200s, and the production of swords was followed by a shift to knives, scissors, knives, razors, and other daily-use cutlery. (Seki City Board of Education, 1999). Seki knives have become world famous along with Solingen in Germany and Sheffield in England for their sharpness, strong core, and resistance to spilling.

In Seki City, according to the Census of Manufactures Report of 2019, the value of manufactured goods shipments of the manufacture of fabricated metal products with four or more employees was 107,959,460,000 yen, and the number of establishments was 166.

As a case study, we will focus on Miyakawa Industry Co., Ltd., which has shifted from manufacturing knives to manufacturing drilling machinery and equipment. The company currently produces the world’s first multi-axis attachment that can drill multiple holes at once, and is known in the industry as the “multi-axis Miyakawa.” The company holds patents in eight countries and has a large share of the market in Southeast Asia, and is also expanding into India.

The company was founded in Seki City in 1935 as a sword processing wholesaler. During the war, the company made military swords, but after the war, it started making kitchen knives with bamboo handles. In the process of making kitchen knives, there is a process of drilling two holes by hand one at a time to fix the handle, but one day, a predecessor injured one of his arms and wondered if it was possible to drill two holes at the same time. Thus, in 1953, the predecessor, who had an advanced perspective at the time and was already aware of the situation overseas, planned and designed his own machine using a German company’s (MK1) machine as a model, and collected parts from nearby areas to develop a two-axis attachment for drilling machines. As a result,

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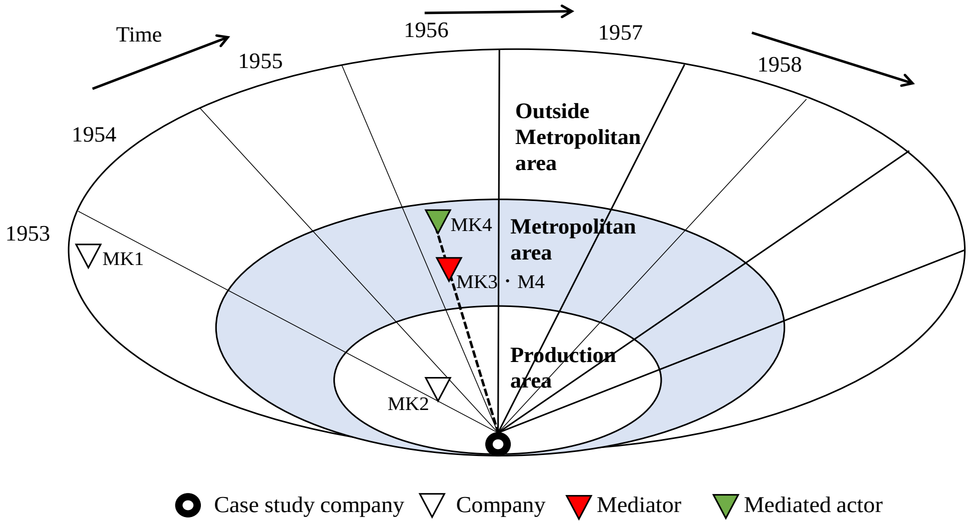

Figure 4. Onion Model of the Network of Product Innovation (Seki)

work efficiency was improved and production was accelerated. When he introduced the attachment to industry peers in the producing area (MK2), they asked him to sell it to them, so he made arrangements with parts suppliers around the production area (MK3), and in 1958 he started production and sales of multi-axis attachments for drilling machines with adjustable shaft spacing. The above is summarized in the Figure 4.

Figure 4 shows that the company's network is almost entirely within the metropolitan (Chukyo) area. In addition, the company developed attachments in the early stage, and when the technology improved, it developed further attachments through the intermediary of parts companies in Chukyo area. This is due to the fact that Chukyo area has a large concentration of major machinery manufacturers such as Toyota Motor Corporation and machinery parts companies. Parts companies are exposed to competition for orders from major manufacturers and receive high-level orders. In order to meet these orders, parts companies are required to improve their technologies. By continuing to respond to these orders, the parts companies will accumulate the advanced technologies of the major manufacturers. In the development of the company's products, such parts companies (MK3, M4) act as mediators to spread the advanced technologies of the major manufacturing companies (MK4). In 1958, when the developed product was completed, the specialization coefficient of the production area (Gifu Prefecture) in terms of the value of manufactured goods shipments of the manufacture of knives for kitchen use and hairdressing, an existing product, was 11.9.

4.3. The Case of Tajimi City

Tajimi City in Gifu Prefecture, together with the neighboring Toki City and Mizunami City, is known as the western Tono area, and is a production center of ceramics. In the 900s, ash-glazed pottery was produced and spread throughout the country. Later, unglazed pottery was also produced. In the 1500s, large kilns appeared and mass production began, while tea ware such as Kiseto, Setoguro, Shino, and Oribe came to be produced. Later, the production of sake bottles, earthenware teapots, porcelain, western

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tableware, and tiles developed in each area, and mass production was developed by modernizing firing kilns and introducing machinery equipment. According to the Census of Manufactures Report of 2019, the value of manufactured goods shipments of the manufacture of ceramic, stone and clay products with four or more employees was 65,395,730,000 yen, while the number of establishments was 144, the third largest in Japan.

From 2005 to 2007, the western Tono area was selected for the national cluster project, “City Area Program (General Type)” and Gifu Research and Development Foundation served as the core organization for the development of next-generation manufacturing technology for ceramics. The core research organizations were Nagoya Institute of Technology and Gifu Prefectural Ceramics Research Institute, both located in Tajimi City. The number of participating institutions was 28 (industry), 1 (academia), and 4 (government). One of the companies participating in the project was Yamase Co., Ltd., which was located in Tajimi City and manufactures raw materials for ceramic tiles and tableware.

The company was founded in Kasahara Town (Tajimi City) in 1918, and was engaged in the manufacture of raw materials for tableware, but in 1954 it also began to manufacture raw materials for tiles. In 1995, when the chairman of the company was serving as the chairman of the industrial promotion committee of the Kasahara Chamber of Commerce and Industry, a group of tile-related companies, he saw the decline of the tile industry up close and felt that it was necessary to pass on the original charm of tiles to future generations. He then started an effort to collect old tiles with about 100 companies, and proposed the establishment of a tile museum, which he helped to open. This led to the opening of the Mosaic Tile Museum in 2016, which is centered on a tile collection and disseminates information and techniques about tiles that have been cultivated in this area, and the chairman became the director of the museum. The company also has a laboratory where it continues to research raw material formulations and utilize new materials. In 2001, the company filed a joint application with a company in the western Tono area (Y1) for a method to manufacture porous materials, and in 2005, through the Gifu Research and Development Foundation (M5), the company developed and patented a heat island mitigation building material based on the company’s raw material manufacturing technology, Nagoya Institute of Technology’s (Y2) porous ceramics technology, and Y1’s manufacturing technology through a national cluster project. This is a new building material tile made of porous ceramics, which is light, soft, and has water retention properties due to the numerous small holes. A single tile (30cm×30cm×2cm) can hold 1 liter of water, and in summer, when the water evaporates, it has an average cooling effect of 5 degrees. The above is summarized in Figure 5.

Figure 5 shows that the company’s network is limited to the production area (Gifu Prefecture). In addition, while the company was still manufacturing existing products, it was able to link up with Y1 and Y2 through the cluster project mediated by M5, and succeeded in improving the functionality of tiles, a product of the production area. In addition to the relationship with Y1 as a business partner, Y1 is also involved in the mosaic tile museum project, and the connection with Y1 can be seen through the community-wide networking activities for the establishment of the mosaic tile museum by the Kasahara Chamber of Commerce and Industry (M6), an industry group. In 2005, when the developed product was completed, the specialization coefficient of the

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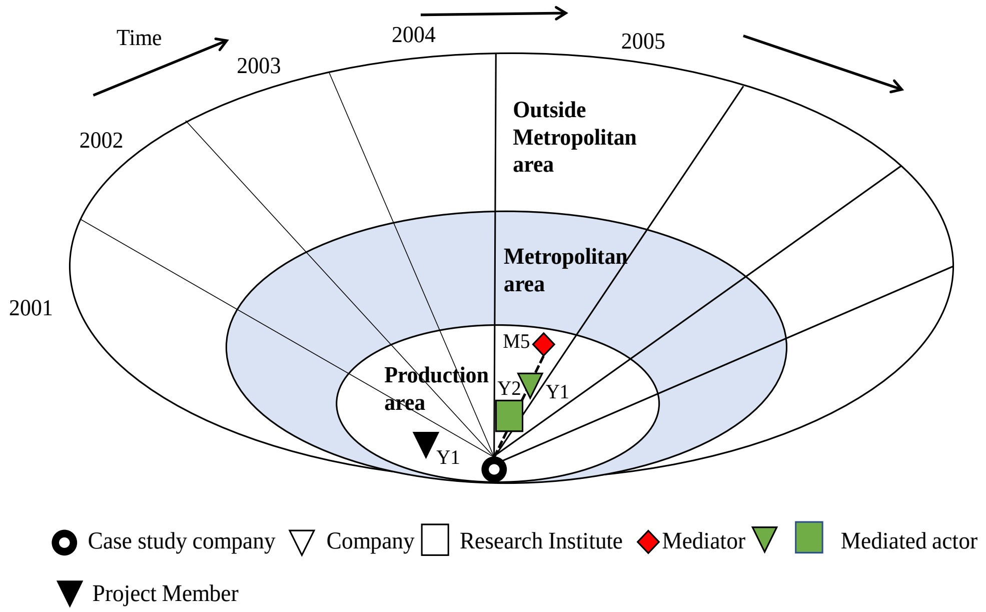

Figure 5. Onion Model of the Network of Product Innovation (Tajimi)

production area (Gifu Prefecture) in the value of manufactured goods shipments of the manufacture of tile and mosaic except quarry tile, an existing product, was 33.0.

4.4. The Case of Kyoto City

Kyoto City has traditional industries that have been closely linked to daily life for a long time, such as Nishijin textiles, Kyoto Yuzen dyeing and weaving, Kyoto Buddhist altars, Kyoto fans, Kiyomizu-yaki pottery, and Kyoto dolls. According to a 2005 survey by the Association for the Promotion of Traditional Craft Industries, the total number of traditional craft items designated by the Ministry of Economy, Trade and Industry and those not in Kyoto City was 72, ranking first in Japan, accounting for 5.6% of the total number of 1,275 items nationwide. A wide variety of products exist. In addition to traditional industries, Kyoto City also has a thriving manufacturing industry, which is characterized by nanotechnology-based precision instruments and machinery manufacturing. According to Kyoto City (2004), at 2002, the specialization coefficients for the value of manufactured goods shipments of the manufacture with four or more employees are, in descending order by 2-digit industrial classification, precision instruments and machinery (7.1), textile mill products (except apparel and other finished products made from fabrics and similar materials) (6.2), and beverage, tobacco, and feed (4.2).

In Kyoto City, the “Kyoto Nanotech Cluster” project was adopted as a national cluster project, “Knowledge Cluster Initiative,” from 2002 to 2007, and was implemented based on six research and development themes with the Advanced Software Technology and Mechatronics Research Institute of Kyoto (ASTEM) as the core organization. The core research organization was Kyoto University, and the total number of participating institutions was 200 (industry), 34 (academia), and 13 (government) each year during the project period. One of the research and development themes was to use nanotechnology to revitalize Kyoto’s manufacturing industry, which has been nurtured in the field of traditional industries, and one of the companies participating in the project was Oike & Co., Ltd..

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According to Kyoto Gold and Silver Thread Industry Cooperative Association (2009), domestic gold and silver threads were probably used together with imported ones for Nishijin brocade sashes and gold gauze in the late Muromachi period (1336-1573). The first example of the name "gold thread shop" was said to be from the Edo period (1603-1868), and in the Meiji period (1868-1912), the new government allowed liberalization of the business, which led to the emergence of the businesses that continue today.

The company began manufacturing and selling gold and silver thread for Nishijin textiles in Kyoto in 1876. The process involved manually attaching gold and silver foil to washi paper and cutting it, but the company later developed a device for attaching foil to washi paper. Then, in 1955, when the Kyoto City Craft Guidance Center opened the vacuum deposition method to the public, they tried to commercialize it and started manufacturing gold and silver thread using the first vacuum deposition machine in Japan in 1956. Starting with the vacuum deposition machine, product innovation was seen from attaching to Japanese paper to attaching to plastic film. Subsequently, through the development of metallic transfer foils and soft packaging (aluminum vapor deposition) in the 1960s, and sputtering technology in the 1970s, the company began to manufacture transparent conductive film for touch panels, optical film, materials for circuit boards, functional transfer film, and vapor deposited film for molding (for automobile parts), in addition to gold and silver thread. During the period of the Kyoto Nanotech Cluster Project, based on the data of the joint patents of the company in the field of developed products (International Patent Classification B32 (laminates) and H01 (conductive materials)), the company applied for patents on transfer materials with a company in Okayama (O1) and a company in Osaka (O2), and on gold and silver threads with a research institute in Gunma (O3). In 2006, the company conducted joint research with Kyoto University (O4) through ASTEM (M7) to establish a low-resistance transparent ferromagnetic material and its production method. The idea is that by using indium tin oxide doped with manganese as a starting material and depositing a thin film on a substrate by the sputtering method, room temperature ferromagnetism can be imparted without degrading conductivity or transparency. After the cluster project, the company applied for a patent on the manufacturing method of laminate with a company in Tokyo (O5), and a patent on transfer material with a company in Okayama (O1) and a company in Osaka (O2) in 2008. Then, in another project, the company became the principal investigator and ASTEM (M7) as the administrator, together with Kyoto University (O4) and a company in Tokyo (O6), deposited a large area of zinc oxide on plastic film by sputtering method in 2009, producing the world's first touch panel using zinc oxide film. The company has obtained a patent on its own. The above is summarized in Figure 6.

Figure 6 shows that the company's network extends inside and outside the metropolitan (kansai) area. In addition, when the company possessed a relatively high level of technology, it developed a cluster project with O4 through the medium of M7. After the cluster project, the company, which possesses high technology, took the initiative in implementing other projects, and added O6, which has applied for a joint patent with the National Institute of Advanced Industrial Science and Technology (O7) in the field of H01, to the network formed by the cluster project, so that the knowledge

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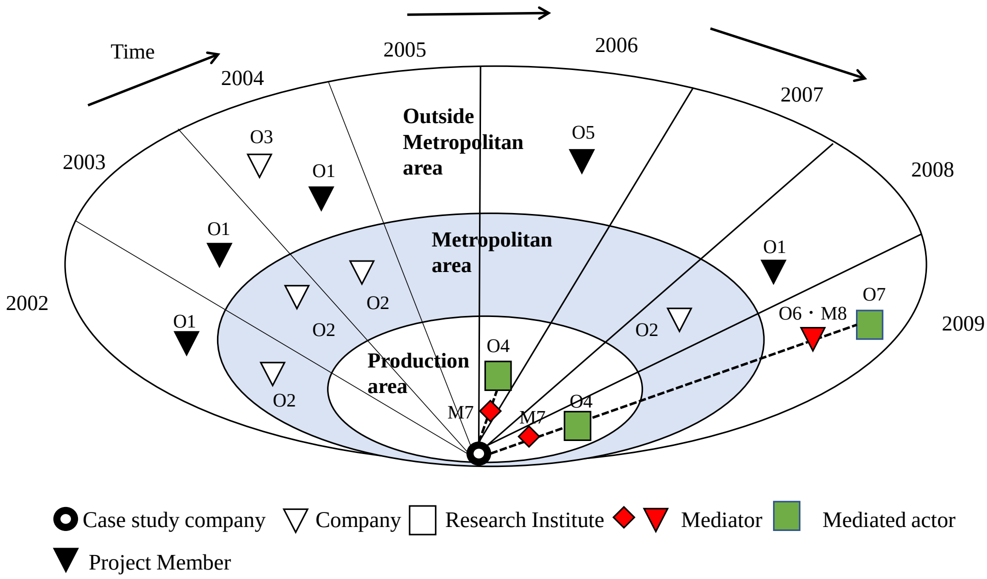

Figure 6. Onion Model of the Network of Product Innovation (Kyoto)

of O7 and others is propagated to the company through O6. Furthermore, for O1 and O5, there is a connection between this company and both companies belonging to the industry group "Functional Film Research Association" (M9). This group was established in 2000 with the aim of creating film products with new functions and values by combining the technologies of companies with unique technologies related to converting. The activities include workshops to understand the technologies and strategies of member companies and to create opportunities for joint development and new product creation, as well as social gatherings held five or six times a year to provide opportunities for personal interaction. In 2005, the company and O1 reported on their membership, and connections have been strengthened through the group. These factors have led to the successful development of the technology to rank first in the world through the collaboration of project frames, intermediary companies, and industry groups. In 2009, when the developed product was completed, the specialization coefficient of Kyoto City in terms of the value of manufactured goods shipments of the manufacture of twisting yarns (including gold and silver twisting yarn), an existing product, was 2.8.

4.5. DISCUSSION

From the case studies so far, there are four types of mediators that link companies together in the background of network formation. Mediator A includes relatives and business partners (M1, M2, M3) with high cognitive proximity, who only connect actors upon request and do not appear as collaborators. Mediator B is a company that appears as a collaborator and propagates the knowledge of the company or research institution (knowledge propagation company; M4, M8). Mediator C is a public institution (project manager; M5, M7) that represents the project and manages the project to form a vertical link. Mediator D is an industry group (M6, M9) that does not appear in the project but provides a place to promote connections (horizontal connections) among actors. In

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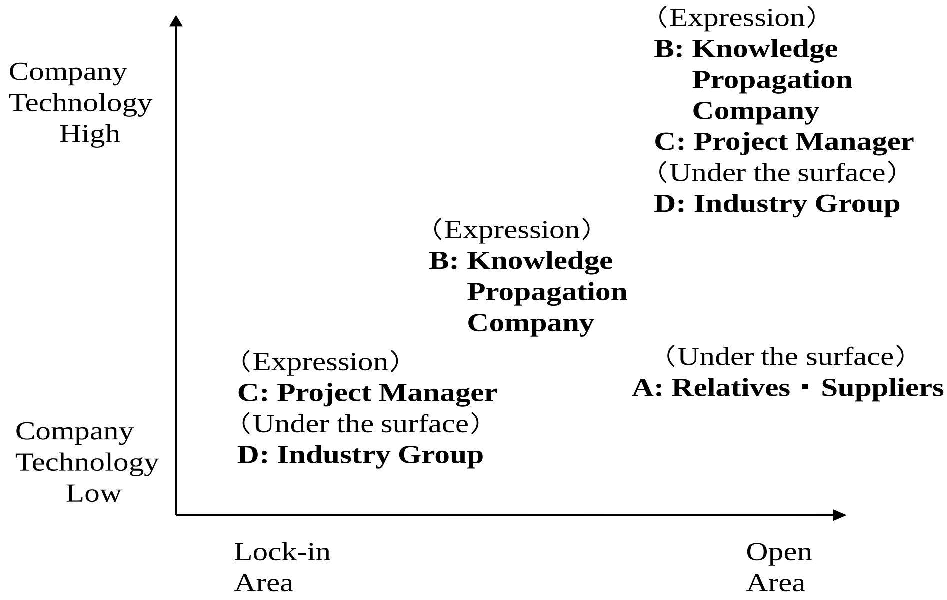

Figure 7. Mediator Model According to Regional Characteristics and Technological Capabilities of the Company

addition, a strong network was formed by the addition of Mediator C, Mediator D, and Mediator B. Based on the above, the following figure shows the types of mediators that are suitable for realizing product innovation, depending on the characteristics of the area and the technological capabilities of the company (Figure 7).

If the area is in a lock-in situation, as in Case Tajimi, and the company's own technological capabilities are low, the entire area should consider working together to promote product innovation, and use mediators such as a project manager (Mediator C) to leverage the project and an industry group (Mediator D) to form underwater connections. As shown in Case Seki, if the company's own technological capabilities are high, it has the ability to directly collaborate with other companies. Therefore, the company may collaborate with companies (partners) and also acquire the technologies of the actors that exist in the background of the partner, viewing the partner as a mediator (Mediator B). On the other hand, if, as in Case Seto, the area is in an open situation, that is, other companies are expanding production in other industries through product innovation, and the company's own technological capabilities are low, it is difficult to know where to start because there is a large difference between the company's own technology and that of other companies, making it difficult to connect directly with other companies. Therefore, a method of consulting relatives or business partners with high cognitive proximity (Mediator A) to introduce collaboration partners is frequently adopted. On the other hand, if the company's own technological capabilities are high, as in Case Kyoto, along with the use of a knowledge transmission company (Mediator B), a business manager (Mediator C) can be used to implement the project and an industry group (Mediator D) can be used to form an extensive network in order to achieve product innovation that can be used throughout the region up to the international market.

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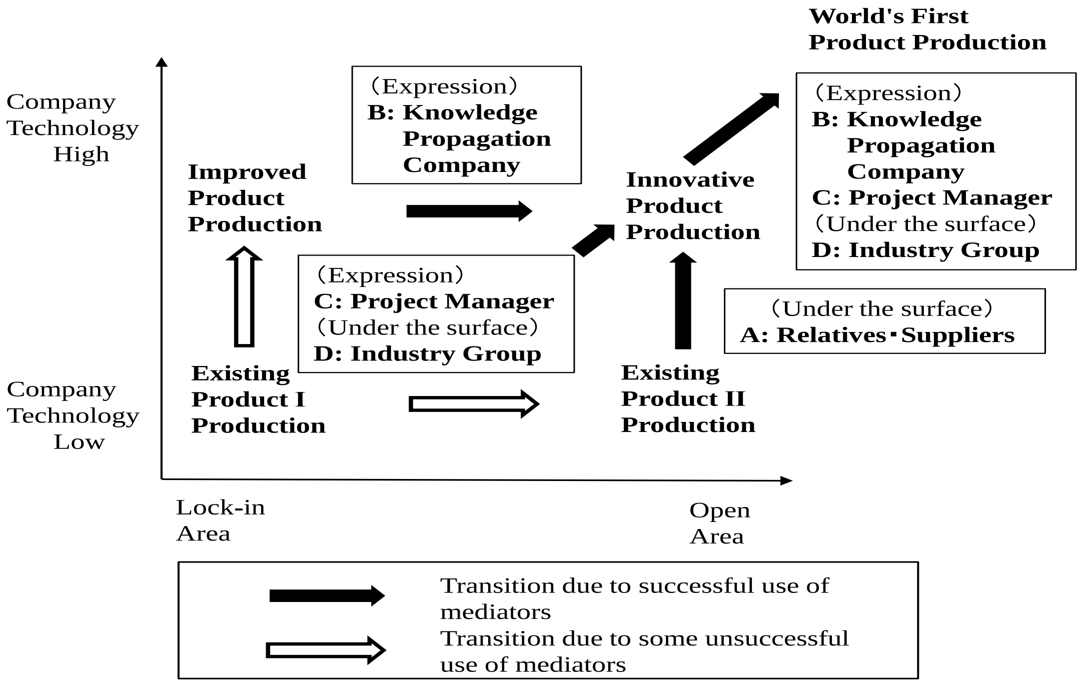

Figure 8. Production Process Model Utilizing Mediators

The development from the existing product I production to the innovative product production is shown in Figure 8, whereby the companies utilize each mediator according to the characteristics of the area and the technological capabilities of the companies. In this Figure 8, the goal is to move from the situation of existing product I production in the lower left to innovative product production in the upper right. If the project is implemented in the lower left situation and Mediator CD is used, the project will form a network in the area including the company, and if an innovative product is created, the position will shift to the upper right. If the company is unable to obtain its own products and remains in the existing product production without improving its technological capabilities, and other companies in the area obtain innovative products through project and the area becomes open, the company will move to the right position. The company then consults with Mediator A, who has cognitive proximity to close the technology gap with other companies in the area, and aims to transition to a higher position on a one-to-one basis. On the other hand, if, as a result of implementing the project in the lower-left situation, the company obtains an improved product outcome on its own, but the entire area fails to produce an outcome, the company moves to the upper position. Then, with the technical skills acquired through the project, they will work directly with the companies (partners) and aim for the right position by acquiring knowledge from the companies with high technology behind the partners (Mediator B). The company will then be in the upper right position, where it has obtained an innovative product for itself, occupying the position of Mediator B. In addition, it will be possible to utilize Mediator BCD through further project and aim to develop the world’s first product with a strong three-mediator system.

5. CONCLUSION

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This study showed that, with regard to the status of network formation for acquiring knowledge in product innovation in the traditional production area, small and medium-sized companies in the cases collaborated with actors inside and outside the production area. For the companies, location in a metropolitan area with a high concentration of peers and research institutions and participation in a cluster project that encourages collaboration with actors presented an advantage in network formation.

To form networks of the companies, mediators are used. As the mediators, not only universities, research institutes, and core companies that have been focused on in the past, but also relatives, business partners, companies that manufacture parts, public institutions, and industry groups that are cognitively close have become. Looking at the role they play, mediators are not only responsible for receiving requests and connecting actors, but also for being partners and mediators, propagating the knowledge of companies and research institutions through themselves, managing projects (vertical connections), and providing a place to encourage connections between actors (horizontal connections).

Based on the fact that there are multiple types and roles of mediators, we then presented a model for realizing product innovation through the use of mediators according to the characteristics of the area and the technological capabilities of the companies.

6. RECOMMENDATIONS

In order to realize product innovation in the future, small and medium-sized companies in the traditional production area should be open-minded, find a mediator that suits the situation of the area and the company, and actively utilize the mediators to collaborate. This is also the case in the regional industrial policies of the national government and local governments, which are required to analyze the regional situation, discover possible mediating actors accordingly, and provide support for them.

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