

Modelling a Supply Chain Network of Processed Seafood to Meet Diverse Demands by Multi-branch Production System

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Abstract. The demand for processed seafood has recently increased owing to diversity of taste and the crises of food supplies. Processed seafood companies have the potential to manufacture various products by combining fish varieties and processing methods. They also associate with many customers such as other food processing companies, food service industries, FMCG companies, and end users. This study aims to reveal the supply chain model of processed seafood to multi-customers by the multi-branch production system. A model is constructed to understand the practical system from a theoretical perspective. The main finding of the study is that four paths of the proposed network model between a seafood processing company and customers exist: (1) defrosting to processing, (2) cleaning to service, (3) processing to service, and (4) seasoning to retail. These findings clarify the supply chain network in the industry and help consider business opportunities.

Keywords: Food supply chain management · Seafood processing industry · Model approach

1 Introduction

Fish and seafood have recently become important materials to meet diversified customer needs resulting from the food crisis caused by population explosion and the requirement of seafood which is essentially healthy (i.e. low calorie count and nutrient intakes) and which provides convenient meals for a two-income family, a child-rearing family, and aging society in advanced countries. To match the resultant explosive demand, the globalization of the seafood supply chain has increasingly progressed with technological innovation. For example, the cold chain has expanded to maintain the freshness of materials through improvement of freezing technologies for transport worldwide [11]. A traceability system has been developed to obtain the trust of customers by informing them of the safety of materials by a physical sensor system and information technologies [6].

In the Japanese context, to aim for the creation of a tourism nation and for the next summer Olympic Games in 2020, an enrichment of the food supply chain is required. The Japanese dietary culture called ‘Washoku’, registered as a 2013 Intangible Cultural Heritage by UNESCO, must be a powerful weapon for executing the strategy. Processed seafood, one core ingredient of ‘Washoku’, is manufactured in small and medium enterprises (SMEs) mostly located in the area that experienced the Great East Japan earthquake (Higashi Nihon Daishinsai) on 11 March 2015. Furthermore, the occurrence of climate change including global warming and abnormal weather and over-fishing by neighbouring countries causes a decrease of marine resources in the Pacific Ocean. These SMEs operate on a small scale and sell processed seafood to identified customers according to their requirements. For the future, they must overcome difficulties and reinvent themselves to obtain new markets and customers worldwide through business innovation.

Many studies related to the seafood supply chain have presented new perspectives, including open innovation of seafood value chain [12], an international distribution system [1, 2], firm structure [4], quality assurance with labelled seafood products [7], a sustainable system [3], marketing and economic innovation [5, 9, 14], seafood supply chain management [10], and an inventory system [8]. However, there are not enough studies related to innovation of the business model which give an overall perspective to change the present business structure.

Based on the recognition of current practical and academic conditions, the present study aims to explore the business model of the processed seafood industry with the concept level as the starting point of the study. Specifically, the network between a food processing company and its customers is focused on understanding the exciting business style of the food processing company and grasping the possibility of cultivating routes to new customers.

2 Methodology

This study tries to draw the network structure between one food processing company and its candidate customers because a clarification of the relation among participants firstly needs to retrieve investment points for business expansion. The description is performed based on an observation and an interview of several seafood processing companies in the rebuilding project after the Great East Japan earthquake for three years. The authors of the present study have gradually understood these companies business structure through investigation and a trial-and-error method. This study presents the results. The method to build the described model is business modelling which reveals the following things pursuant to the aim of the study [15]:

The business model is emerging as a new unit of analysis.

- Business models emphasize a system-level, holistic approach to explain how firms ‘do business’.
- Firm activities play an important role in the various conceptualizations.

- Business models seek to explain how value is created, not just how it is captured.

This research also reference typical models related to a production system, such as make-to-order (MTO) and make-to-stock (MTS) models [13].

Four steps are adopted in this study. The first is based on the seafood cooking process. Seafood processing companies cook materials at the location of mass customers. The step will be useful to identify fundamental processes in a production system for seafood processing. The second is the deployment of candidates of a customer. They are other food processing companies, food service companies, fast-moving consumer goods (FMCG) companies, and consumers. This step describes the details of the four customers because the purpose of the step is to become aware of new customers that differ from existing customers. In the third step, a network model is constructed to visualize a possibility of new business through a combination of outputs in the first and second steps. The final step is a confirmation of the capability of the constructed network through an initial discussion of business expansion in the future. The flowchart of all steps is provided in Fig. 1.

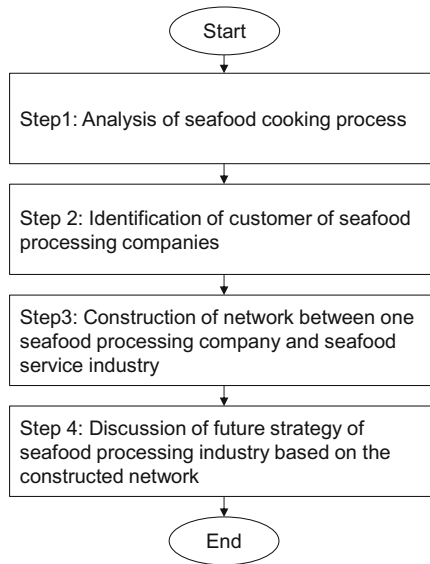


Fig. 1. Research procedure.

3 Construction of Seafood Supply Chain Model

This section describes the result of each step illustrated in Fig. 1.

3.1 Seafood Cooking Process (Step 1)

The journey to develop a processed seafood business model in this study starts with the understanding of daily eating habits as follows. The main processes to eat seafood have not changed from ages past, as shown in Fig. 2: fishing, cleaning, processing, seasoning, and eating. The middle three processes exist mainly to add value to fresh fish. These can be omitted and exchanged in the cooking process. Many techniques and skills are included to make the materials taste even better. The detailed explanation of each type is as follows:

(1) Fishing process

This process is considered a preparation part for processed seafood production involving obtaining the materials. The quality level of the materials depends on size, weight, appearance, freshness, variety, and so forth. Over-fishing and climate change seriously affect a haul of fish. A fishing quota by multiple nations and enclosed aquaculture with the newest biotechnologies are countermeasures for sustainable marine resources.

(2) Cleaning process

The complicated body of fish and seafood causes a decline in the productivity of seafood processing. It is basic and important to protect customers' safety from dangerous parts which they cannot eat (i.e. hard fish, thick bone, and the internal organs of a fish including poisonous substances). The variety of processes includes carving, boning, scaling, and filleting. Accurate filleting of large fish like salmon requires immense skill with yield rate and waste disposal.

(3) Processing process

This process is the main portion of seafood processing. Representative methods of the process are grilling, reducing, frying, steaming, and drying. The selection of each method relates to a core business of a seafood processing company with a large investment in production facilities. The design of the process profile of production by the selected method is a company secret relating to the organoleptic feel of processed seafood because many companies adopt the common categories of methods noted above.

(4) Seasoning process

This process is the portion that adds tastiness and flavour-value to a processed item. In Japan, there are five traditional popular seasonings, such as sugar (Sato), salt (Shio), vinegar (Su), soy sauce (Shoyu), and soybean paste (Miso). They characterize the taste of Japanese seafood called 'Washoku', which was registered as a 2013 Intangible Cultural Heritage by UNESCO. Chemical seasoning widens the possibility of new ways to enjoy processed seafood.

(5) Eating process

This is the final process to synthetically evaluate the quality of the four processes by consumers. In this stage, not only the taste of processed seafood, but also a dishing, including a selected plate and a side dish, influences the total impression. The family styles of advanced countries, such as a two-income family, a child-rearing family, and the aging society, also require the convenience of a microwave oven and reheat pouches.

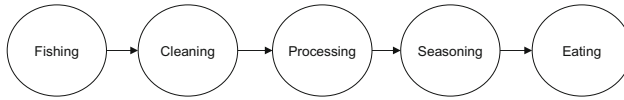


Fig. 2. Basic process to eat seafood

In the present age, the division of the five processes between fisheries and consumers depends on consumers’ requirements. It indicates the following five models proposed in Fig. 3.

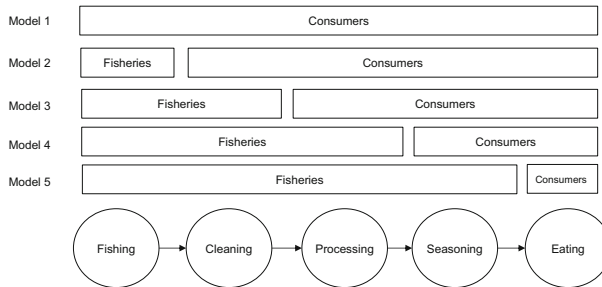


Fig. 3. Division of roles between fisheries and consumers

Consumers do not need support from fisheries in Model 1, which constitutes a hobby. In the case of Model 2, the fishing industry will exist in a market near a fishing port with consumers. In the three models consisting of two processes and more by fisheries (i.e. Models 3 to 5), the division of roles occurs among three industries: (I) fishing industry, (II) seafood processing industry, and (III) seafood service industry including restaurant and retail businesses. The division is considered based on the two following assumptions:

- The fishing industry is necessarily in charge of the fishing process.
- The orders of the three industries do not become reversed.

Nineteen sub-models of the three models are summarized in Table 1. Models 3, 4, and 5 contain 3, 6, and 10 sub-models. Processed seafood is sold directly to consumers or through a mail-order system and internet service when the sub-model consists of (I) the fishing industry and (III) the seafood service industry. (II) The seafood processing industry asks (III) the seafood service industry to sell their products in addition to the above-mentioned selling methods when these two entities exist in the sub-model. This table shows that (II) the seafood processing industry can choose, in theory, appropriate sub-models from the alternatives. The flexibility seems to suggest the possibility of expanding the business of each seafood processing company.

Table 1. Sub-models of Models 3 to 5

Model	Fishing	Cleaning	Processing	Seasoning	Note
3	I	I	-	-	Selling directly to customers
	I	II	-	-	Selling by a service industry or directly to customers
4	I	I	I	-	Selling directly to customers
	I	I	II	-	Selling by a service industry or directly to customers
	I	I	III	-	Selling directly to customers
	I	II	II	-	Selling by a service industry or directly to customers
	I	II	III	-	Selling directly to customers
	I	III	III	-	Selling directly to customers
5	I	I	I	I	Selling directly to customers
	I	I	I	II	Selling by a service industry or directly to customers
	I	I	I	III	Selling directly to customers
	I	I	II	II	Selling by a service industry or directly to customers
	I	I	II	III	Selling directly to customers
	I	I	III	III	Selling directly to customers
	I	II	II	II	Selling by a service industry or directly to customers
	I	II	II	III	Selling directly to customers
	I	II	III	III	Selling directly to customers
	I	III	III	III	Selling directly to customers

(I) fishing industry, (II) seafood processing industry, and (III) seafood service industry.

3.2 Customers of Processed Seafood Industry (Step 2)

Customer candidates for (II) the processed seafood industry are rich in variety. The main candidates are four types of seafood service companies: other food processing companies, food service companies, fast-moving consumer goods (FMCG) companies, and consumers. The explanations of each type are as follows:

(1) Other food processing companies

These customers use the product supplied from seafood processing companies as one material of their final products. For example, raw materials are supplied from a company which manages a large-capacity frozen warehouse to store them cheaply and in huge quantities. Cleaned materials (i.e. seafood paste and fish cut into small cubes) also have high value for customers who do not have technical know-how.

(2) Food service companies

These customers are food service companies including restaurant businesses; home-delivery services; services for the provision of meals by a school, hospital, or welfare facilities. They basically have a kitchen which has the capacity for making and serving meals with materials supplied from seafood processing companies to their customers. Moreover, if their business model is a franchise chain, they construct a supply network with a central factory which executes the middle processing of materials for speedy and effective servicing of meals at all their shops.

(3) FMCG companies

These customers are types of FMCG companies (e.g. a convenience store, supermarket, shopping mall, or department store). They mainly offer two services. One is the direct sale of goods supplied from seafood processing companies. The other is the sale of a daily dish including simple processed/cooked materials. Their customers are end users who live near these small shops. FMCG companies obtain large sales accumulated across their many branches, but the number of end users is limited for one store.

(4) Consumers

Seafood processing companies usually do not directly access end users except in face-to-face sales like at a regional festival and special sales once a year. They contact end users to sell their products through a mail-order system with mass-communication and a system of online electronic commerce. This opportunity will increase in the era of the internet.

3.3 Network Between Seafood Processing Company and Seafood Service Industry (Step 3)

Figure 4 illustrates the relationship between one seafood processing company and seafood service companies. The left side of the figure is a typical production system in a seafood processing company. This system mainly consists of four processes: defrosting, cleaning, processing, and seasoning. The first one is a process to prepare frozen materials and deliver them to maintain their freshness while restraining freezer burn if possible, by a fishing company, and to maintain a sufficient inventory. The other three processes add appropriate values to the defrosted materials described in the previous section. The notable characteristic of the system is a multi-branch production system with the potential to supply semi-processed products as final products to customers.

Owing to the capability of the industry, candidate customers are rich in variety, as shown in the right side of the figure. Main candidates are the four types of seafood service companies mentioned above (i.e. other food processing companies, food service companies, FMCG companies, and consumers). While centring on seafood processing companies, they should consider all combinations between processes of seafood processing and four types of seafood service companies. In particular, the following four paths are useful for food service companies to realize their service while reducing initial workloads.

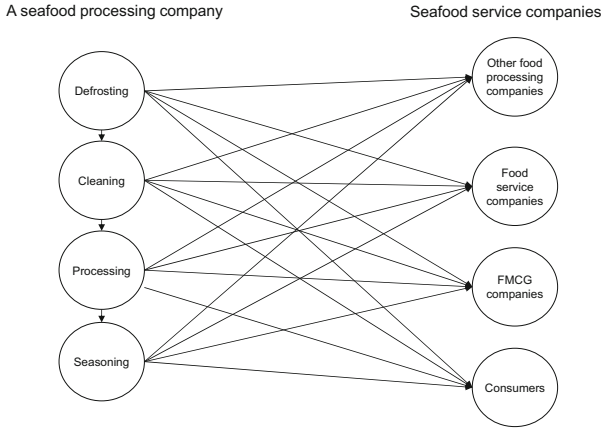


Fig. 4. Relationship between a seafood processing company and seafood service companies.

(1) A path from defrosting to processing (DTP)

In this path, seafood processing companies supply frozen/defrosted materials to other food processing companies. The added-value is a supply system of materials sufficient both in quality and quantity. Seafood processing companies must improve the refrigeration capacities of inventory and transportation. Owing to these functions, other food processing companies outsource procurement operations.

(2) A path from cleaning to service (CTS)

In this path, seafood processing companies supply frozen materials to seafood service companies. The added-value is a system to clean masses of fish and seafood. The seafood processing company must improve its capability through training of skills related to the operation and its automation. Owing to this function, food service companies will concentrate on creative cooking and close servicing, which are considered to be their core functions.

(3) A path of processing to service (PTS)

In this path, seafood processing companies supply processed materials to seafood service companies. The added-value is a mass production system of processed seafood. Seafood processing companies should improve the main process in their business. Owing to this function, food service companies will provide effective and uniform services to their customers with simple cooking.

(4) A path of seasoning to retail model (STR)

In this path, seafood processing companies supply seasoned materials to FMCG companies. The added-value is a mass supply system of processed seafood. Seafood processing companies should improve the main processes in their business. Owing to this function, retail companies can sell various moderately priced and tasty items to end users every day.

3.4 Future Strategy for Seafood Processing Company (Step 4)

To confirm the utility of the constructed network model in the previous sections, a future strategy of seafood processing companies will be considered in this section.

Most SMEs continue to do business along one path of the network model described in the proposed network in Fig. 4. They may consider the path as the only possibility for their business with limited management resources. However, they should understand two characteristics of their industry.

One is the flexibility of their production system. It is possible to supply products from any process in their production system. For example, if the current path of the network model is STR, semi-products of the path become fully final products for the other three paths (i.e. DTP, CTS, and PTS) without large facility investment. The other is that they have many candidate customers. If the current path of the network model is CTS, the same product could be supplied by PTS. The development of a new path is naturally difficult, even if the potential of the path is recognized. However, it will be a valuable trial to expand business in the future.

The utility of the proposed network is confirmed because it is useful to consider a subject to realize new business possibilities with the characteristic production system based on the above discussion.

4 Concluding Remarks

This study aims to reveal the supply chain model of processed seafood to multiple customers via a multi-branch production system. The findings consist of four paths: (1) DTP, (2) CTS, (3) PTS, and (4) STR. They clarify the supply chain network in the industry and consider the opportunity of the business. A future study could provide a mathematical formulation of the network model to quantitatively simulate and evaluate the impact of each path.

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