Application of Interpretative Structural Modeling for Rural Post-Harvest Enterprise Design on Seafood Supply Chain

Mohammad Nadjikh
Bogor Agricultural University, President Director, KML Food Company, Indonesia

Abstract
This action research has the initiative to design a business model for rural post-harvest enterprises to overcome the problem of the supply chain for keeping the freshness of product and cost reduction. The business process should have an impact on increasing rural employment, fishermen income, and community prosperity. This research aims to design Miniplant as a social enterprise in a rural area, which combines business and public interests. Interpretative Structural Modeling technique (Saxena, 1992) based on expert survey and field observation was applied. It was found that major constraints facing Miniplant establishment are the business competition, seasonal raw material supply, and lack of handling knowledge and quality control skills of rural fishermen. The main development activity on Miniplant is looking for reliable local partners and skillful rural workforce. Through Miniplant business process, basic changes become possible including assurance for production continuity, seafood quality improvement, and availability of microcredit for fishermen. It is recommended to train factory workers on good manufacturing practices, especially for food safety purposes. A conceptual model has been established for sustainable supply and value chain management in the agro-industrial network that has been successfully practiced by KML Food Company by having 62 Miniplants all over Indonesia. In conclusion, about 90% of miniplant expenditures disbursed for raw material procurement directly delivered to fishermen, undoubtedly Miniplant model is justified in elevating rural prosperity since crab meat is high-value export commodities.

Keywords: Miniplant Model; Action Research; Interpretative Structural Modeling; Seafood Business; Supply Chain; Social Enterprises

1. Introduction

One of the most important factors of seafood industry is sustainability of raw materials supply and quality of seafood which meet export market standards for various destination countries. Traditional fishermen who live in a rural area have lack knowledge and skills to deliver products that meet global buyer’s requirements. Therefore, this action research has the objective to design a business model for rural post-harvest enterprises to overcome the problem of the supply chain for keeping of the product freshness and cost reduction. This business process should have also impact on increasing employment, fishermen income, and community prosperity.

Supply chain regarding to marine products is characteristic by high uncertainty of fishery producers supply and consumer demand, acquired integration of responsiveness to flexibility due to unexpected change in the business process. In agile supply chains, demand requirement and supply capabilities, i.e., products and process including resources, should be continuously attuned (Verdouw et al., 2011). Therefore, both front office and back office system need to be flexible and smoothly
integrated (Verdouw et al., 2010). Accordingly, the KML Food Company had looked for concrete and permanent solution by establishing rural post-harvest enterprises to link between coastal area and industrial park.

After more than 15-year observation through learning by doing and application at various area, the KML Food Company has identified critical problem and working to set up institutional solutions related to social enterprise and inclusive business. It was found that to establish marine rural supply chain, there are potential impact of policy conflict concerning indigenous culture, sustainability of natural resources, and competition among local traders. Ney (2009) suggests that solving such of messy problem is to implement policy solution that favors small-scale local activity regardless of wider economics and social implications. This paper explores value chain management evolving toward an integrated system approach, in which the concepts of logistic management were extended to incorporate industrial cluster integration.

The system design should focus on efficient streamlined pipelines that carry on fresh raw material to the global market in high volume at the lowest cost. The strategic plan needs a kind of intermediary infrastructure for continuous supply to predictable demand.

This study instrument combined soft system methodology with empirical experiences of KML Food Company, which intends to construct conceptual strategy that able to be executed in seafood supply chain network. There will be three major strategic processes: Intelligence, design, and choice (Hua and Savoailmen, 1994). The primary task for the intelligence phase is to find problem and opportunities and search for conducive environment of business decision-making. Then, alternative courses of actions will be developed and analyzed in the design phase. The choice of cluster design will be reached through selection of specific course of action from available alternatives. Then, follow-ups recommendations shall be formulated.

2. Methodology

The idea of intelligence in soft system approach is the ability to learn from experience permeates living system theory concerning purpose, goal, and meaning of complex situation. Nevertheless, the term intelligence is seldom used in its development and certainly is not a fundamental term on which other ideas are founder and related. Instead, the term information and communication form the foundation on which intelligence-related ideas are built (Kalaidjieva and Swanson, 2003).

This research was based on expert knowledge acquisition related to field experience and fact finding in the pilot of supply chain network of seafood industry. Basic method is empirical investigation of system reasoning in engineering and industrial application which has historical study of system principles development. Among other things, this means that empirical analysis of special case of system reasoning should have two-fold propose: (1) Reconstruction of the underlying system principles and (2) determining place of the case of system reasoning in the chain of historical development of system principles (Dubrovsky, 2004 and Checkland, 2000).

Definition of a system is a set of elements standing in interrelationship (Von Bertalanffy, 1969). The Miniplant business design has objective to establish conceptual interactive model with system principle. Hence, the case empirical modeling uses Interpretation Structural Model (ISM) technique (Saxena, 1992) to achieve solutions for supply chain problematic situation.

ISM is a process that transforms a model that might not be revealed and weakly explained into defined clearly and useful model. Characteristic of ISM is interpretive as the judgment of the group decision whether and how the different elements are related. It is structured on the basis of mutual relationship; and overall structure is extracted from the complex set of elements (Shahabadkar et al., 2012). It is a modeling technique, as the specific relationships and overall structure are portrayed in a digraph model (Attri et al., 2013). The ISM is typically implemented in tactical management of decision-making who forces managers to review perceived priorities and improve their understanding of the linkages among key factors.
3. Miniplant Establishment Program

To design an establishment program for Miniplant as part of supply chain management for seafood industry, this research implemented ISM technique. There are 12 expert respondents from various discipline and educational background. The panelist has been selected carefully based on their experiences and scientific knowledge. Framework needs to be constructed with which individual discipliner can provide quantifiable criteria and indicator related to sustainability. With a transdisciplinary approach, this research could produce diversity of solution in accordance with the specific environmental to cultural condition in each region. This ISM results presented as matrix and graph then utilized as system reasoning for Miniplant program guidelines.

3.1. Main obstacles for miniplant establishment

To find major obstacles in the realization of Miniplant concept, we could identify some elements, as shown in Figure 1. We could observe some elements with low dependency but have high driver power. The result is as follows:

   B1: Limitation of knowledge and skill levels of miniplant workers to handle raw material and processing of crab meat
   B3: Unfamiliarity of fishermen, concerning standard of quality export commodities
   B6: Seasonal local supply of raw material and discontinuity of the harvest time.

3.2. Possible change to encounter problems facing

To utilize ISM diagram for detection up possible change to solve problem, elements should be in high dependence and driver power. The result is as follows in Figure 2:

**Figure 1:** Matrix of obstacles elements

![Figure 1: Matrix of obstacles elements](image1)

**Figure 2:** Matrix of possible change elements

![Figure 2: Matrix of possible change elements](image2)
C3 : Improve and maintaining quality assurance and continuity of raw material supply to industry as part of value chain
C4 : Increasing microfinance institution trust and service to fisherman
C6 : Development and application of appropriate technology according to industrial requirement through on-site innovation and local wisdom.

3.3. Activity required to establish miniplant

We can observe in Figure 3, step-by-step activities should be done to establish Miniplant properly in a systematic way.

However, if refer to the system reasoning matrix, there are three key factors dealing with driver power dependence with high-level setting up, which are as follows:

1. Looking for local business partner as informal leader in the designated rural area
2. Enhancing job opportunities to woman labor for the Miniplant so that such engagement socially maintains
3. Training of employees concerning food safety and healthy environment.

3.4. Miniplant conceptual model

By analyzing ISM results and knowledge sharing among expert and practitioner, the conceptual model of Miniplant was formed based on system reasoning. Scheme of the House of Miniplant was constructed as diagrammatic expression of system input and output related to business process. The house of Miniplant as social enterprise is shown in Figure 4.

**Figure 3**: Interpretation structural model structure for strategy to establishment miniplant
By having this conceptual model, any industries based on maritime produces could design and establish kind of Miniplant as postharvest enterprise. It should have clear holistic vision and feasible calculated business process. For practical reference, there are 25 units Miniplant already managed by KML Food Company and 37 units Miniplant supervised by KML Food Company, spread all over Indonesia coastal regions.

4. Case Studies

To validate the Miniplant conceptual model, this research conducted case study in Madura Island where there are 9 units Miniplant for “Rajungan” (crab meat) developed by KML Food Company branch. Specific observation has done in Bangkalan Coastal Region to verify performance and scalability of the medium size Miniplant facility. It is located in Banyusangkah Village, fully operated since 2005.

Miniplant as small- and medium-sized enterprises factory is actually technology-based enterprise, where standard and engineering design is followed properly. Figure 5 shows the industrial process, whereas network system has division of cooking unit to collect nearby raw material from surrounding area. This home industry produced cooked raw material (responsible care [RC]) with strict quality control.

Appropriate technology was applied added by creative invention through learning by doing, such as in garbage disposal and crab meat picking apparatus. More than 60% process flow done by hand, and this practice attracts foreign buyer inspection who places high appreciation in delicate hand work of woman labors. Standard operation procedure is followed diligently to ensure quality for export requirement.

Normally, the production capacity of Miniplant is 250 kg crab meat inbox per day and requires up to 1 ton raw material. In fact, there are 9 units Miniplant in Madura Island which consolidate capacity sharing through supply chain network to cover more than 60% of available catching area.

There is full system of Miniplant which collects RM and operate end to end processing from No. 1 to No. 10, but system reason to make wide catching area requires cooking station network. These cooking stations conducted process No. 1 to No. 5 up to RC with different style of operational management. The network purpose is to get close to the catching area, as well is strengthening relation with local fisherman. This network is very effective to maintain supply chain in the Miniplant through production planning and inventory control technique.
5. Results and Discussion

It was proof by evidence that the Miniplant system has capacity and facility to improve fishermen prosperity. Income generation is not only from a profitable crab harvesting but also due to job opportunity for women in the village to work at Miniplant.

Having business model of Miniplant as constructed through ISM procedure, and learning from case studied at Madura Island, there are several research findings which can be expressed as system reasoning enable for Miniplant development.

5.1. Local business partner

There are important factors to find reliable and loyal business partner who will manage and lead day by day of Miniplant operation in connection with local fisherman participation. First, partner candidates
must understand vision of KML Food Company and pass the capability test during 3-months probation period. Second, informal leader has familiarity and strong engagement with local fisherman. Next is trustworthy, know business ethic and creative problem solver.

The average workers work in one unit of Miniplant about 150 persons with income about USD 120/month/person. The average income of fishermen is about 4 kg or equivalent with USD 285/month. Ney (2009) stated that environmental protection is a very costly business, and only economic growth can provide necessary resources to tackle the expansion task of greening the economy.

5.2. Appropriate technology

The Miniplant business process as part of food producers should take special attention of green technology which can deliver hygiene environment and clean production. The application of preservation technology must be synchronized with employee skill and attitude to maintain product quality and cold chain effectively. Dynamic improvement and technology changes should be encouraged by logical engineering and local wisdom, especially for sanitation rules and quality control. Greenberg and Mayamin (2013) mentioned that learning by doing is how to change not what you do but what you think.

5.3. Miniplant planning

Key element in the building of Miniplant is good knowledge about raw material potential and geographical site which enable to recruit sufficient number of women employees. Further, rural infrastructure must be adequate including water, electrical, and road. Amount of active fisherman should comply with Miniplant scalability where fishing vessel and fishing gears are available properly.

5.4. Finance arrangement

Big challenge for managing cash flow in the coastal region is lack of saving awareness and high consumptive attitude which can lead to money lenders unfairness. The Miniplant manager together with local partner must coordinate down to earth financial scheme which able to provide daily working capital for fisherman, as well as keeping part of their income to be saved for future needs. Retained income is for equipment maintenance or household expenses needed so that be able to keep loyalty along supply chain network. Field and Field (2002) stated that a more effective technique frequently will be able to system that takes advantages of firm’s normal monetary incentives in such a way as to lead them to pollute less and poverty alleviation.

5.5. Digital information

Traceability is a must for seafood industry, especially for export market, because it could satisfy consumer preference and helps to solve buyer complaints if any. The Miniplant is supported by digital information appliances using modern identification trade codes for each crab meat as required by buyer and regulators. Schwab (2016) stated that in digital revolution, employment still will growth in low-income marginal occupation. System impact involves the transformation of entire system, across and within, country, company, industry, and society as a whole.

5.6. Sustainability efforts

As inclusive business relies on renewable natural resources, the seafood company should maintain the adequacy of supply chain. The Miniplant management has tasks to educate and giving enough incentive to fisherman to preserve raw material stock. For example, they utilized bubu as traditional fishing apparatus, a kind of reversible trap devices that can sort small crab and throw back to sea. This practice opposes wide net catching application which usually harvest crab with all size. Sustainability effort recently is supervised by Indonesian Association of Crab Meat Producer with collaboration with governmental authorities. Larkin (2013) mentioned that no industry is local anymore, and neither is any environmental problem and as important, no industry as limited to its present-day activities.
5.7. Recommendation

Miniplant is small-scale enterprise with economic and social value creation such as increasing fisherman quality of life; therefore, the management should conduct good manufacturing practice while still increasing profitability. Investment for one unit of Miniplant is about USD 70,000 with working capital around USD 10,000. The analysis of business investment resulted the payback period is around 27 months, break event point is about 1200 kg/crab meat/month, and benefit–cost ratio is 1.82 with discount factor 10% and 5-year project term; therefore, the Miniplant is considered feasible project.

Since most of raw material cost and procurement expenditure is handled by fisherman as a package, these must be reliable business arrangement executed by the local partner and supervised by Miniplant managers. Consolidation of supply at Miniplant network must be well performed to fulfill real capacity and business scalability, resulting in normalize income generation.

As food safety is the heart of the food business, trained staff and disciplined factory labors are necessary for minimize production risk and rejection while moving up to global standard and sustainability regulation. The company should act as offtaker in various contracts conducted by Miniplant managers as well as local partner; therefore, intensive monitoring system must be implemented.

In conclusion, about 90% of miniplant expenditures disbursed for raw material procurement directly delivered to fishermen, undoubtedly Miniplant model is justified in elevating rural prosperity since crab meat is high-value export commodities. Miniplant business process is able to transform raw material from remote catching area into global market with high-quality product.

References