CHAPTER 7

Conclusions and Recommendations

In this chapter, conclusions and recommendations will be presented according to the results consisting of three parts. The first section of the conclusions will deal with supply chain management of GAP vegetables managed by SCOR model, resulting in mutual understanding and improvement of GAP vegetable supply chain management. The second section deals with the construction and assessment of GAP vegetable management indicators by means of factor analysis to find areas which needed the improvement in the supply chain of GAP vegetables. Finally, the last section deals with management efficiency models constructed by means of the Bayesian Belief Networks (BBNs) to evaluate supply chain management and find proposed innovative practices in each marketing channel of GAP vegetables in each group.

7.1 Research methods

The data collection was obtained from questionnaires and focus groups from farmers who produced GAP vegetables under GAP standard in 5 groups, i.e., (1) *ocimum* as basil and sweet basil group, (2) sweet pepper as bell-pepper group, (3) goat and guinea pepper as chilli group, (4) *solanum melongena* as purple eggplant group, and (5) *momordica charantia* and *eryngium foetidum* as other GAP vegetable group (long and small eggplants, bitter gourds, parsleys, cowpeas, cabbages, and cauliflowers). Moreover, focus group discussions among middlemen, exporters, and government officers were organized to collect the information related to supply chain management of GAP vegetables.

166 samples interviewed by questionnaires were divided according to marketing channels where basil and sweet basil, bell-pepper, and purple eggplant groups were distributed in RP and company markets, other GAP vegetable group were distributed in supermarket and local food safety markets, and chilli group were distributed in local markets with 83, 42, and 41 farmers, respectively. Besides, focus group discussions were conducted among 58 farmers, 13 middlemen, 12 exporters, and 5 government officers. The samples for 2 approaches were randomized by means of stratified random sampling from districts, sub-districts to communities, according to database of the Office of Agricultural Research and Development Region 1 (OARD 1).

To achieve the objectives, this study uses soft system method (SSM) to co-construct the mutual understanding in order to adjust knowledge, attitudes, and practices of stakeholders in supply chain management through participatory approach with the conceptual models. The conceptual models were evaluated by Bayesian Belief Networks (BBNs). BBNs are the causal probabilistic networks linked to relation between parent and child nodes which are shown through the probability values in conditional probability tables (CPTs). The models described an interaction of many management variables according to supply chain operation reference model (SCOR model) consisting of plan, source, production, delivery, and return processes. The many variables were grouped as component factors by means of factor analysis. Each component factor is composed of a group of highly correlated variables, while there is a low correlation among different factors.

Besides, the BBNs models can indicate supply chain management efficiency of GAP vegetables and explain to maintain the already effective SCOR variables and to improve SCOR variables with new management practices. Hence, the improved and already effective SCOR variables in the models can achieve the efficient management, leading to proposed innovative practices of supply chain management.

7.2 Supply chain management of GAP vegetables

Supply chain management from upstream, midstream, to downstream levels of GAP vegetables could be concluded according to SCOR Model to co-construct the mutual understanding in GAP vegetable management, providing relevance and feasibility of proposed management with set of new practices.

Production plan was allocated by quota under contract between farmers and RP development centers or companies to practice monoculture planting. The assurance given contracts were required to continuously identify the kind and quantity of GAP vegetables throughout the year since outputs were purchased according to the plan at guaranteed prices. Nevertheless, other farms were managed without contract as they made use of seasonal rotation planting. By following GAP requirements, farmers produced safe outputs. The outputs were packed in plastic bags or baskets under Q mark, foam trays, and vacuum foil bags and distributed at Doi khum outlets and processing factories, department stores, and export markets, respectively. Moreover, the outputs were checked to detect chemical residue and listed by Radio Frequency Identification (RFID) and barcode systems. In addition, the outputs packed in plastic bags and weighed in kilograms were checked to detect chemical residue on shelves at department stores and local food safety markets. However, the outputs distributed in Bangkok and Chiang Mai provinces to other provinces were not checked to detect chemical residue regardless of whether the outputs were GAP vegetables or not because the outputs were purchased according to market demand, leading to the similar prices between GAP and non-GAP vegetables. Considering the delivery types, bikes or trucks were used to deliver outputs from farms to assembly sources and trucks or refrigerated trucks were used to deliver outputs from assembly sources to markets and from farms to markets.

Finally, no outputs were returned since they were safe according to GAP standard, especially in terms of chemical residue. Another factor was the buyers were regular, longtime customers and transaction depended on trust and good relationships between the buyers and sellers.

Comparing membership in an upstream level management, it indicated that farmers who were members of RP development centers or companies and farmers who were non-members were different. In GAP vegetable production, farmers who were Royal Project's or companies' members were closely supervised by supporting officers, while farmers who were non-members independently produced the outputs themselves, resulting in having the chemical residue on GAP vegetables. In middle stream and downstream level management, the outputs from Royal Project's or companies' members were distributed to the certain markets with guaranteed prices, while the outputs from non-members were sold in markets without guaranteed prices. Non-members' GAP vegetables were sold together with non-GAP vegetables, resulting in similar prices. As a result, this situation did not encourage farmers who were non-members to produce GAP vegetables.

Moreover, data from companies were obtained with little cooperation and contacting the officers took a longtime since the action was sequentially managed to prevent the information leakage. Because of the strictness in production, farmers did not make a contract continuously. For example, if the outputs do not adhere to the agreement, companies can immediately reject purchases and it became the responsibility of farmers who had to manage their outputs, leading to the pressure on farmers and the contract cancellation between farmers and companies. From this situation, the number of companies' members in this area dropped over the years and the companies have had to expand its membership to remote areas.

Bell-pepper, basil and sweet basil, and purple eggplant production was practiced by monoculture planting according to contract in each year to obtain the outputs continuously. The outputs of these groups were checked to detect chemical residue for many times from farms to packing plants to make them safe under GAP standard. Through the process, these outputs were trimmed and graded in farmers' fields, trimmed and graded again in factories, resulting in the waste of outputs. This caused the loss of income of farmers. Outputs were then packed in package under Q mark to be distributed in outlets, department stores, and processing factories where these markets were RP and company markets and the outputs strictly corresponded with GAP standard

by using RFID system. Nevertheless, chilli group and other GAP vegetable group were practiced by rotation planting depending on the seasons. These outputs of other GAP vegetable group were trimmed and graded in fields or other specifically provided areas, packed in foam trays, plastic bags, and weighed in kilograms before being delivered to supermarket and local food safety markets. Moreover, the outputs were checked to detect chemical residue on shelves in the local food safety markets and department stores, leading to traceability by barcode system. However, outputs of chilli group have not checked residual chemicals in local markets. Compared to the outputs in chilli group and other GAP vegetable group, traceability and strictness in chemical residue detection of the outputs in basil and sweet basil, bell-pepper, and purple eggplant group was stricter. Traceability is important for sharing information in terms of where GAP vegetables were produced, who produced them, how they were produced, when they were produced, and where the GAP vegetables were packed. The information contributes to benefits for all partners in GAP vegetable supply chain, providing coordination between producers and customers. These activities led to trade advantages (Rujapa et al., 2006) with added value in the GAP vegetables (Kamonchanok, 2004).

In terms of the delivery types, refrigerated trucks were used to deliver the outputs from assembly sources to processing factories and destination markets to keep the outputs fresh but this approach meant the high cost of delivery. Therefore, refrigerated trucks should be carefully considered in order to achieve efficiency. In addition, bikes or trucks were rather used to deliver outputs from farms to assembly sources and from assembly sources to markets. According to Sanan and Rapeepan (2012), Parthana et al. (2009), and Chutidej (2012), the cost was reduced by adjusting the time of transportation to the better efficiency in terms of demand correspondence and punctuality (Sittiporn, 2005 and Boonchai, 2003).

7.3 Construction and assessment of GAP vegetable management indicators

In this study, SCOR model related to many management variables was evaluated by means of factor analysis in order to obtain the certain key indicators as explained by component factors. Each component factor is composed of a group of highly correlated variables, while there is a low correlation of variables in different component factors. From the process, the result found that GAP vegetable management indicators in each vegetable group were composed of two important component factors**,** with different sets of indicators as follows;

For basil and sweet basil vegetable group, component factors consisted of farm-to-market delivery factor and assembly-to-market delivery factor. In bell-pepper vegetable group, component factors consisted of attitude and access to inputs factor and farm-to-assembly delivery factor. In purple eggplant vegetable group consisted of quality factor and attitude factor. In other GAP vegetable group, component factors consisted of delivery factor and GAP knowledge factor. In chilli vegetable group, component factors consisted of access to inputs and markets factor and attitude and production types factor. And for all GAP vegetable group, component factors consisted of mode of production factor and delivery and GAP knowledge factor.

GAP vegetable management indicators grouped as component factor led to key indicators. The key indicators consisted of positive and negative factor loading values in each component factor which should focus on these values in order to obtain the convenient management.

7.4 Supply chain management models of GAP vegetables

7.4.1 Management efficiency models

The first and second component factors according to factor loading values were used to evaluate the management efficiency called SCOR. SCOR was also evaluated by satisfaction levels which consisted of the positive and negative factor loading values related to each component factor.

In the management efficiency of all GAP vegetable groups was at a medium level with the highest probability of occurrence. Evaluating the management efficiency in each marketing channel, it was found that management efficiency of outputs distributed in RP and company markets according to evaluating each component factor and satisfaction levels were at a medium and a high level, respectively, while that of output distribution in supermarket and local food safety markets and local markets were at a high and a medium level, respectively with the highest probability of occurrence. The management efficiency in the positive factor loading values of all GAP vegetable groups and output distribution in each marketing channel was higher than the model as mentioned above at a medium level. Therefore, the supply chain management of GAP vegetables should focus on the positive factor loading values in each component factor, contributing to the better management efficiency although negative factor loading values of component factors should also be assessed due to the possibility of occurrence of a decline in management efficiency.

The evaluated management models were considered by sensitivity values in each component factor and in some satisfaction levels related to each component factor. The highest sensitivity value of the satisfaction level node of suitable delivery from assembly sources to markets was in all GAP vegetable groups. Regarding output distribution in RP and company markets, the highest sensitivity value was found in farm-to-market delivery node and attitude and access to inputs node when the model was evaluated by component factor, while the highest sensitivity value was found in the node of satisfaction levels of suitable delivery from farms to markets when the model

was evaluated by satisfaction levels related to each component factor. Similarly, the highest sensitivity value was found in delivery node in supermarket and local food safety markets and satisfaction levels of output distribution in local markets when the model was evaluated by component factors and satisfaction levels related to each component factor. It indicated that these component factors, satisfaction levels of suitable delivery from farms to RP and company markets, and satisfaction levels of output distribution in local markets contributed to the rapid change of management efficiency due to the minimal change of sensitivity value.

7.4.2 Management scenarios

The management scenarios were simulated so that the highest efficiency and possibility of occurrence of the better management efficiency could be conducted. The management scenarios of all GAP vegetable groups and each marketing channel were conducted with component factors and satisfaction levels related to each component factor.

1) All GAP vegetable groups

Management scenario was conducted by considering each component factor and satisfaction levels related the component factor at a very high level. The mode of production factor was related to practices by rotation planting without contract and the outputs were preliminarily trimmed and graded in fields and again in factories. The delivery and GAP knowledge factor was related to knowledge levels of farmers in a high level and trucks were used to deliver the outputs from assembly sources to markets. Furthermore, satisfaction level with the negative factor loading values was also designated at a very high level, indicating that RP development centers or companies and educational institutes cooperated to recommend input sources and the encouragement of inspecting the chemical residue in the outputs corresponded with GAP standard at a high level in the mode of production factor. In addition, trucks were used to deliver the outputs from farms to assembly sources in the delivery and GAP

knowledge factor. According to the scenario, the management efficiency was at a very high level with the highest probability of occurrence.

2) Distribution in each marketing channel

Management scenarios in each marketing channel were designated according to scenario analysis of all GAP vegetable groups.

2.1) RP and company markets

Purple eggplant group was practiced by rotational planting with a mixed plan (between contract and no contract) and basil and sweet basil group was practiced by rotational planting. Cooperating with RP development centers or companies, agricultural cooperatives, chemical shops, friends, and other sources such as training units provided input supply to produce bell-pepper group. According to process, purple eggplant group was trimmed and graded in factories to prevent wastes. In bell-pepper group, trucks were used to deliver from farms to assembly sources and also used to deliver from farms or assembly sources to the markets in basil and sweet basil group and having GAP certification was important to distribute bell-pepper and purple eggplant groups in the markets.

2.2) Supermarket and local food safety markets

Other GAP vegetable group distributed in the markets was practiced by rotational planting and farmers who produced the outputs had knowledge level in a very high level. Regarding delivery, trucks were used to deliver the outputs from farms to assembly sources. Additionally, output correspondence of other GAP vegetable group with GAP standard was in a high level.

2.3) Local market channels

Chilli group was practiced by rotational planting without contract. Cooperating with RP development centers or companies, agricultural cooperatives, chemical shops, friends, and other sources such as training units provided input supply to produce the outputs. Regarding delivery, trucks were used to deliver the outputs from farms to local markets where having GAP certification was important to sell.

Furthermore, the satisfaction levels with the negative factor loading values were determined at a very high level to improve the management. It indicated that output distribution in RP and company markets was emphasized in plan process to produce bell-pepper group in rotational planting with a mixed plan and RP development centers or companies and educational institutes recommended input supply to produce basil and sweet basil group and purple eggplant group. Additionally, the encouragement of inspecting the chemical residue in the output distributed in the markets had to correspond with GAP standard at a high level. For distribution in supermarket and local food safety markets, trucks were used to deliver outputs from farms to assembly sources, while RP development centers or companies cooperated with educational institutes to recommend input supply to produce chilli group. Processing chilli group was trimmed and graded in factories to prevent wastes before being delivered to local markets. According to the scenario, the management efficiency was also in a very high level with the highest probability of occurrence.

3) Management efficiency models: discussion

The reduced SCOR variables in the model were evaluated by the component factors according to factor analysis since they were not considered by each SCOR variable. Reduced SCOR variables were explained by component factors examined by the factor loading values (Songlin and Ruihong, 2010), contributing to the ability to determine the repercussion between child and parent nodes directly

In addition, the most significant SCOR variables had an effect on the management efficiency considered by the highest sensitivity values. Moreover, the reduced SCOR variables with the negative factor loading values were carefully processed in the supply chain management due to the possibility of a decrease in management efficiency. So that, the negative factor loading values in each component factor were improved by new management practices to obtain the better management.

7.5 Recommendations for further actions

Sharing the information of GAP supply chain management was related to the production and marketing of GAP vegetables from farms to markets with SCOR model consisting of SCOR variables. The production information should include the sources, kinds of GAP vegetables, and quantity of GAP vegetables. Marketing information should contain distribution channels in accordance with market demand. The integration was important to manage the production according to GAP standard, the setting of fair prices, and the decision regarding the best dates for delivering and receiving products. If farmers can set the price to create bargaining power and the outputs correspond with GAP standard, the price mechanism can be effective. Moreover, the production of GAP vegetables according to GAP standard should be different from that of non-GAP vegetables, resulting in the market opportunities for all parties. The success of integration depends on stakeholders. Both agencies should create strategies which do not overlap with each other to develop approaches continuously for agricultural and marketing assistance to stakeholders in the GAP vegetable supply chain.

SSM is able to co-construct and develop the mutual understanding in the context of actual GAP vegetable supply chain system (rich picture) among stakeholders through participatory approach according to 7 stages of SSM. Additionally, the study developed the HAS, model, and collective implementation in order to expectedly adjust their actions and collaborate with each other as suggested by the conceptual model at intervention points in problem situations, contributing to relevance and feasibility of proposed management with set of new practices according to SCOR model. The

proposed new practice management was related to many SCOR variables both positive and negative factor loading values by means of factor analysis.

The negative factor loading values of SCOR variables in component factors should be improved by these new management practices. Moreover, any SCOR variables in component factors which were already the effective management should be maintained. Hence, both new management practices and the already effective management contributed to the better management efficiency.

From the study, interaction among variables in SCOR model influenced one another were assessed as satisfaction levels in 5 levels, i.e., very high, high, medium, low, and very low. The satisfaction levels resulted in the evaluation of management efficiency of GAP vegetable supply chain by means of Bayesian Belief Networks (BBNs). BBNs is analytic tool of decision and is good prediction accuracy under uncertain and complex system by using probability as a measure of uncertainty and values of SCOR variables are performed as probability distributions.

Normally, SCOR model was used in a closed system such as engineering fields, but SCOR model was applied in this study considered as opened system related to system thinking. System thinking concept was used through the concept of system boundary, system hierarchy, and system properties. System boundary and system hierarchy assisted stakeholders in mutual understanding related to structure and arrangement in the context of actual GAP vegetable supply chain system from upstream, midstream, to downstream levels, while system properties indicated interaction of interrelationship among factors. Under system thinking concept led to assessment management efficiency of GAP vegetable supply chain in Chiang Mai province, leading to the better management with the relevance and feasibility of proposed innovative management. According to the study, it could be concluded that the study only followed Stage 1 (rich picture), 2 (culture analysis), 3 (definition of relevant system), and 4 (modeling relevant systems) in SSM process leading to management efficiency model of GAP vegetable supply chain through SCOR model,

except for Stage 5 (comparison of conceptual models with the real world), 6 (formulation of changes), and 7 (take action) since these stages must be cooperation with multi-organizational groups for application in the management model of GAP vegetable supply chain, resulting in expectation of stakeholder adaptation in the management. Furthermore, the efficient management in GAP vegetable supply chain can be operated as follows;

1) The development of concept framework and tools can clarify factor interaction in structure from subsystem to system corresponding with demand and condition of practices in supply chain management.

2) Participatory approach among stakeholders is necessary to share the management information continuously from diagnosis, testing, to evaluation phases.

3) Using quantitative model for decision making can result in the achievement and the ability of a model that can predict and support long term effects on management under qualitative and quantitative data related to physical, biological, social, and economic knowledge, human behaviors, and problem changes.

Finally, the supply chain management of GAP vegetables indicating the management of stakeholders can operate with collective and adaptive approach in order to create systematic management through interaction of SCOR variables by BBNs models and this initiative results in future studies concerning basic science, technology development, hard system, and simulation model.

7.6 Recommendations for future studies

The model can continue feedback to verify correctness of interaction in management indicators called SCOR variables and probability by survey, leading to formulation of changes and implementation. Additionally, this study is a starting point of GAP vegetable supply chain management from upstream, midstream, to downstream levels through conceptual model and can further develop to future studies related to

1) Classifying management cost according to plan, source, production, delivery, and return in SCOR model to assess accurate management.

2) Evaluating optimal management efficiency from other technique such as regression analysis with factor scores of component factors.

3) Comparing difference of management efficiency of management practices in other agricultural activities.

4) Using other techniques such as regression analysis to determine probability values in states of parent and child nodes and assessing management cost in BBNs models

5) Modeling management by other models such as decision tree, simulation model, neural network.

6) Comparing the management models of GAP vegetable supply chain with the real world by answering questions such as, “Does the activity in the model exist in the real world? How is it done? By what criteria is it judged?” to changes that are relevant and meaningful to correspond with stakeholders’ needs and wishes, leading to adjustment in stakeholders’ action with collective implementation.

Furthermore, choosing the Decision Support System (DSS) should be appropriately used to achieve an objective set and the objective achievement should be effectively analyzed by using the suitable method and determining the suitable data.