The improvement of the high value-added supply chain: a cordyceps beverage case study

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Abstract. A healthy food trend is becoming popular which makes people become more aware of taking care of themselves. This causes the growth of healthy business phenomena such as supplements and herb in Thailand. Cordyceps which is known as “winter worm summer grass” is a famous Chinese herbal medicine and very expensive because it is rare. People believe that it provides benefits for enhancing health and boosting energy. Today Thai farmers and entrepreneurs can cultivate cordyceps by themselves resulting in widespread use and lower the price. The objective of this research is to analyze a cordyceps beverage supply chain of a small-sized entrepreneur using Integration Definition for Function Modeling (IDEF0). It explains the overall flow of business and related activity of cordyceps beverage. Then we conduct an analysis of the current problems and recommend how to improve the efficiency of the supply chain. Currently, there is a lack of systematic data collection, no proper KPI and inventory policy and low forecast accuracy. We recommend the entrepreneur to use the spreadsheet for forecasting and record data, create KPI to evaluate performance, set standard and target. Establish an inventory policy to manage material and evaluate supplier’s performance. We hope our research will promote the entrepreneur to stay competitive in the dynamic market.

1. Introduction
A healthy food trend is becoming popular which makes people become more aware of taking care of themselves. This results in the growth of healthy business phenomena such as supplements and herb in Thailand [1]. Cordyceps which is known as “winter worm summer grass” is a famous Chinese herbal medicine and very expensive because it is rare. People believe that it enhances health and boosts energy. Cordyceps includes many species. The popular one for cultivating is Cordyceps militaris which contains a high dose of nucleosides which is the substances providing benefits mentioned previously. In general, the quality of cordyceps is identified by quantity and quality of substance “adenosines” which is part of nucleosides. The study found that cordyceps from cultivation has more nucleosides than cordyceps from natural. This happens because the cordyceps from cultivation was raised in controlled conditions from several trials to get the optimal result. In the past, cordyceps cultivating happens in the laboratory or for study only. Until recently, the research and development institute of Chiang Mai Rajabhat University arrange workshops for the general public [2]. Nowadays, Thai farmers and entrepreneurs can cultivate cordyceps by themselves resulting in widespread use and lower the price. This is a challenge to any party who involves in this business. Even though farmers and entrepreneurs have expertise in cultivating and developing but they lack proper supply chain management which causes raw material and packaging out of stock issues [3]. They also do not use the right technology to manage the system [4]. The objective
of this research is to analyze a cordyceps beverage supply chain of a small-sized entrepreneur. Then, we conduct an analysis of the current problems and recommend how to improve the efficiency of the supply chain.

2. Methodology
We conducted an in-depth interview with a small-sized entrepreneur [5]. The reason we selected this company because they are open-minded and willing to share information with us for study purpose. They also a well-known company in the mushroom business which not only makes a profit from selling products but also a learning center to teach people how to create a job which contributes to the country. This includes an interview by phone call, meeting in person and on-site observation in the farm and factory. Next, we identify the overall activity of the business by using Integration Definition for Function Modeling (IDEF0) which is the series of rectangular diagrams connected by arrows that explain the overall flow of business [6]. The related activities of cordyceps beverage are mentioned inside the diagrams. Arrows that point to the left side of the diagram are inputs, arrows point to the top are controls such as specification, regulation, and procedure, arrows point to the bottom are resources that require to operate activities and arrows point out of the diagram to the right side are outputs from activities. The outputs of the previous activities are the inputs of the successor activities. The solid lines of arrows are the current activities and the dash ones are the improvement that were suggested for implementing. We conduct an analysis of IDEF0 for 2 level which is level 0 and level 1. Level 0 is the big picture of the business including supplier, farm, factory, and customer [7]. Level 1 is about analysis more detail of the activity in the factory [8-9]. Finally, we use the Key Performance Indicator (KPI) principle to measure the outcome of each activity [10].

3. Results and Discussion
3.1. Company background
The entrepreneur is a mushroom farmer in Saraburi province. In the past, he cultivated fruits and ornamental plants, but the business did not go well. Then he started to do research about straw mushroom cultivation and then extended his research to various types of mushrooms such as pearl oyster mushroom, log white fungi and Yanagi mushroom. These mushrooms can make good profits to him at last. This mushroom farm does not only sell products but also being a complete mushroom cultivation learning center, that hosted many farmers, researchers, entrepreneurs and students who would like to learn from him. With his progressive nature and eager for knowledge, he proceeded to learn about Reishi mushroom and Cordyceps which are considered as medicinal mushrooms and have high profit due to it requires more complex processes for cultivation where not many people can do at that time. He successfully implemented these 2 new mushrooms in his farm later and became a well-known learning center of Reishi mushroom and Cordyceps.

3.2. Business process analysis of cordyceps beverage supply chain
The business process was analyzed by using IDEF0 level 0 or an organizational level as shown in Figure 1. The upstream suppliers are various suppliers who provide silkworms, rice, other ingredients, packaging, and label. The main raw material for preparing cordyceps cultivation is frozen silkworm for creating culture medium. According to their research, worms are selected by specific species and their age because it will provide the best nutrition and the optimal thickness to reduce the damage to the blender. The lead time of ordering frozen silkworm from local farmers is 30 days and the order quantity is 100 kg. Next, Sang Yod rice is obtained from Phatthalung province at a lot of 200 kg and an order lead times of 5 days. For the other ingredients, they were ordered from local vendors and markets which lead time of 3 days. All the materials will be stored in the central warehouse in the farm. At the mushroom farm, which is the main activity to cultivate cordyceps cultivation by the entrepreneur and his family using the machine, measurement equipment, and controlled temperature room which takes 75 days. The control of the cultivation is mushroom cultivation formula, work procedure, measurement standard, humidity, and recording. The Cordyceps will be dried and kept in the storage room. The
Cordyceps beverage manufacturer located near the farm produces the Cordyceps beverage and delivery to the customer. Then, customers are consumers or retailers who order the product via social media such as LINE, Facebook. Some customers order from an off-line channel such as phone calls and directly buy from the company. If there is an issue about the product, the customer will send details to the entrepreneur. After the entrepreneur review and decide that its defect product, the replacement product will deliver to the customer.

3.3. Business process analysis of cordyceps beverage factory

The business process of the cordyceps beverage factory was analyzed using the IDEF0 level 1 or activity level which composed of five major activities as explained in Figure 2. The first activity is planning which usually managed by the entrepreneur alone. The information on inventory, capacity and lead time were gathered before creating a production plan using a notebook. Normally, production starts when the finished goods inventory is lower than 500 bottles. Second, the source or procurement process is to order raw materials from the suppliers. Third is the production process or make, composed of mixing beverage, filling, sterilizing by retort and packing which will be finished within a day. The finished goods are kept in the warehouse. Fourth, the delivery will start when the customers place an order where the staff pack the product in the afternoon and outsourced the shipment to the logistic service provider on the same day. If the order arrives after 2 p.m., it will be delivered the next day. Finally, the return occurred if customers find defect products, they will contact the entrepreneur directly to get the new one.

3.4. Problem analysis and proposed strategies for an improvement

Currently, the entrepreneur records all data using a notebook and does not share information with employees and does not verify the calculation. Sometimes, packaging materials are a shortage and could not start production. There is only a single supplier for silkworm and some time, the worms are too old.
and their silks are too thick which can damage the blender. In addition, in the mold spreading period starting from October to November, the cordyceps cultivation activity cannot be done. At present, a key performance indicator (KPI) for the cordyceps cultivation is accepted within 10% of defects. However, the current defect rate is more than 10%. The defective Cordyceps become waste and no value-added. There is no KPI for packing on the delivery process. We summarized the problem and propose the improvement plan as shown in Table 1.

Table 1. Summary of current problems and the improvement plan.

| Activities   | Problems                                                                 | Improvement guidelines                                                                 |
|--------------|---------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| Plan         | Packaging material shortage                                               | Record data of demand, production, and inventory. Create a strategic forecast and inventory policy |
|              | Lack of systematic data collection                                        | Create a template to record data and use Google sheet to share information in the organization |
| Source       | A single supplier for silkworm                                             | Find an alternative supplier, perform supplier evaluation                              |
|              | Silkworms are out of standard                                              | Create an inspection standard, train employees to implement and evaluate the supplier |
|              | Lack of systematic data collection                                        | Create a template to record data and use Google sheet to share information in the organization |
| Make         | Cannot run the production during Oct-Nov due to the mold spreading        | Investigate the production site, establish a closed system such as a greenhouse to eliminate the contamination. Increase production output before the mold spreading |
|              | A high number of defects                                                  | Identify the root causes and implement improved processes for KPI                     |
|              | Lack of systematic data collection                                        | Create a template to record data and use Google sheet to share information in the organization |
| Deliver      | No KPI for the packing process                                            | Create KPIs for the packing process and do continuous assessment                      |
|              | Lack of systematic data collection                                        | Create a template to record data and use Google sheet to share information in the organization |

4. Conclusion
The business process of the Cordyceps beverage supply chain of the small-sized company has been analyzed. The major problems were caused by lack of data, proper forecast and suitable inventory management and standard process. In addition, most activities were managed solely by the entrepreneur himself. The suggestion was to improve the planning process by starting systematic data collection, creating a strategic forecast and inventory policy, finding an alternative supplier performing supplier evaluation, establishing proper KPIs and inspection standards. Other agri-businesses that have similar products may use this research as a guideline to improve their efficiency.

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