

DEVELOPING CAUSAL LOOP DIAGRAMS FOR COFFEE SUPPLY CHAIN: SUPPORTING TO ENHANCE THE COMPETITIVE ADVANTAGES OF A VIETNAMESE COFFEE

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ABSTRACT

In this paper, researchers develop causal relationships among different variables that present enablers and outcomes – operating within many identified feedback loops. The resulting causal loop model provides coffee managers with a snapshot of the dynamic interactions among elements in the coffee supply chain, which helps to identify proactive action in implementing the coffee supply chain philosophy for increasing the competitiveness of coffee products. Based on this review and analysis, recommendations are made regarding application of the causal loop method in coffee supply chain management. Important future research directions are also indicated.

Key words: *Coffee supply chain, causal loop diagram, competitive advantages*

1. INTRODUCTION

In recent years, Vietnamese coffee enterprises have been seriously challenged in the race against international competitors for improving their competitiveness. Many firms have responded to the challenge by embracing a broad view of competitiveness. It is no longer solely the production, processing, exporting or retailing, but the strategy is beginning to emphasise the management of competitiveness in all phases and aspects of the coffee industry, from production to retailing. Thus, supply chain management is becoming a top priority in many Vietnamese coffee firms.

Supply chain management has been known as one of the most powerful operation paradigms for increasing competitive advantages of a product in the international market, including the improvement of customer value and satisfaction. It has also played an important role in the competitive strategy for integrating suppliers and consumers with the objective of improving responsiveness and flexibility of enterprises to meet the changing market requirements (Vrijhoef and Koskela, 2000). Supply chain management has been an increasingly applied operations paradigm for increasing overall organisational competitiveness (Gunasekaran and Ngai, 2004).

System dynamic modelling and systems thinking approaches have in recent years been widely applied in supply chain management, such as inventory decision and policy

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development (Meade and Sarkis, 1998; Swaminathan *et al.*, 1998; Georgiadis *et al.*, 2005), supply chain design and integration (Sabri and Beamon, 2000; Christopher and Towill, 2001), international supply chain (Houlihan, 1985; Akkermans *et al.*, 1999), and especially in studying complex logistic behaviour (Minegishi and Thiel, 2000). However, most of the literature discuss only the implication of one or two aspects of supply chain management, but does not cover the supply chain system in its entirety. Developing a comprehensive causal loop model for supply chain management to enhance the competitive advantages of coffee products has therefore been regarded as essential. The main objective here is to address issues related to the identification of the important variables in coffee supply chain management, through the use of relevant feedback loops to develop a framework for the Vietnamese coffee supply chain for enhancing the competitiveness of coffee beans on the international market. This study especially focuses on developing causal loop models for the four main factors that influence the competitive advantages of coffee products, namely cost, quality, customer satisfaction and the competitors in the international market. Future research directions are also identified.

2. THE VIETNAMESE COFFEE SUPPLY CHAIN

The Vietnamese coffee supply chain is structured in a complex web of interrelationships that links production and consumption. Thus, the coffee product goes a long way and changes many hands from the cherry stage to a cup of coffee. The four major players in the Vietnamese coffee supply chain include the producers, processors, intermediations and exporters (Figure 1).

In Vietnam, the producers sell the dry cherries to private traders, to agents of processing plants, or directly to processing plants.

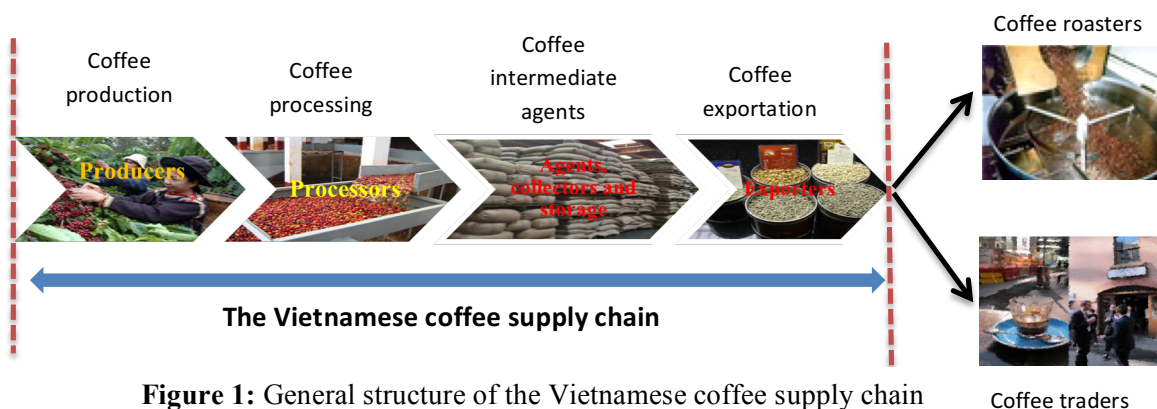


Figure 1: General structure of the Vietnamese coffee supply chain

Almost all coffee processing firms in Vietnam are primary processors. Primary processing involves the conversion of harvested coffee cherries into green coffee beans. After processing, the processors sell green beans to either agents, exporters or a larger processing plant, and in some cases they also sell directly to international customers (coffee roasters, traders, and brokers).

Collectors (intermediaries) form the next stakeholder group in the supply chain and are involved in many aspects of the chain. They may buy coffee at any stage between coffee cherries and coffee beans. They go directly to farmers' warehouses or processors to purchase coffee cherries and/or coffee beans, which they then sell on to larger coffee processors or exporters. Before selling to the larger processing companies or exporters, the collectors may do some of the primary processing work such as drying, grading or polishing of the beans to ensure standard moisture content, colour and bean size.

Exporters are the last stakeholders in the coffee supply chain. In Vietnam, the coffee export companies are not only involved in exportation, but in some cases they would also become involved in the processing and transportation of the beans. There are currently around 150 registered coffee exporters (Gonzalez-Perez and Gutierrez-Viana, 2012), who buy coffee beans from intermediate agents/collectors or processors and then sell to dealers, brokers or roasters. In fact, most of their export sales are to agents of multi-national traders who take the coffee over at the port and ship it to their clients.

3. RESEARCH METHODOLOGY

Causal loop diagrams (CLDs) are used to designate system elements and their relationships in the supply chain (from producers to retailers and between sellers and buyers). CLDs has become increasingly popular as a powerful methodology for obtaining insights into problems of supply chain management.

The steps followed in developing the CLDs are based on the guidelines of Cavana and Maani (2000). The main objective of this study is to use the model to assist determining how to increase the competitive advantage of Vietnamese coffee through supply chain management. Therefore, the following adapted steps were followed:

1. Identify main elements/variables that are involved in the coffee supply chain
2. Establish the links between related elements in the CLD of the coffee supply chain
3. Indicate the direction (polarity) on each link.
4. Identify and label the reinforcing or balancing loops in the diagram of the coffee supply chain system.
5. Identify key leverage points in the coffee supply chain where interventions could increase competitive advantages of the coffee.
6. Identify and develop systemic intervention strategies to manage the Vietnamese coffee supply chain more effectively.

A key feature of this process is to create diagram so that the CLD can be used as a basis for developing actions and implementing supply chain management strategies. In this study, developing a CLD for the Vietnamese coffee supply chain has been developed after detailed discussion held with coffee producers, intermediate agents,

coffee exporters, local officers and experts in a workshop conducted in the central highland of Vietnam, an area which is considered as the “coffee capital” of Vietnam (see figure 9). In the workshop participants were divided into small groups in which the participants were representing the same part of the supply chain. Second, individual groups were required to create a causal loop diagram for each individual stage or part of the supply chain in which both internal and external relationships between elements in the coffee supply chain were identified. In the next stage of the workshop, each stakeholder group was asked to review and added more variables to the CLD which had been developed by another group. Last, a general CLD that shows the correlations among coffee supply chain stages was developed by combining all the CLDs. This general CLD was revised by Vietnamese coffee experts who are familiar with the real Vietnamese coffee industry situation.

4. CAUSAL LOOP DIAGRAMS IN VIETNAMESE COFFEE SUPPLY CHAIN MANAGEMENT

4.1. Identification of main variables

The key variables are indicated in the generic framework of the coffee supply chain model. These could be divided into two parts; one the enablers and the other the outcomes or results (Figure 2)

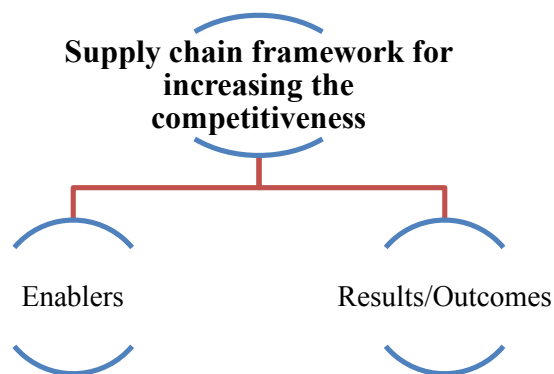


Figure 2: Coffee supply chain framework model

In this study, four variables have been identified as enablers namely; production, processing, intermediate agents, and exporting (Figure 3).

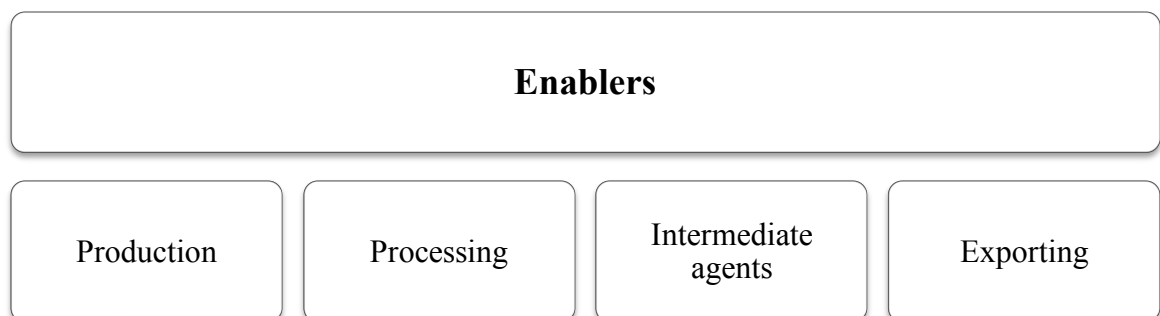


Figure 3: Identification of coffee supply chain enablers

In the context of the Vietnamese coffee supply chain, four variables have been identified as the main ones contributing to the competitive advantages of Vietnamese coffee product: the level of customer satisfaction, quality of the product, the competitors, and the price (directly impacted by cost) (Figure 4).

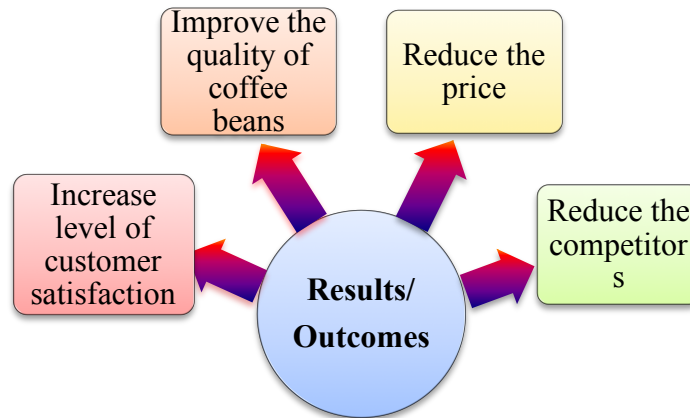


Figure 4: Identification of Vietnamese supply chain variables of results/outcomes

4.2. Developing CLDs

This study has developed causal diagrams of four key aspects which decided the competitive advantages of the coffee product (price, quality, customer satisfaction, and competitors). The results of the steps used to end up with a general diagram of the Vietnamese coffee supply chain are discussed in the following sections.

- ***Causal loop diagram of the cost in whole coffee supply chain***

The price of coffee product is decided by the total cost because a change in the total cost leads to the change in price. Price is the first aspect of the competitiveness of product. Therefore, many coffee firms try to give out pricing competitively to attain higher profit or larger market share than one's competitors as a desirable goal. In the causal loop diagrams of total supply chain cost (Figure 5), there are two positive feedback loops and two negative feedback loops that show correlations related to the cost of coffee product in supply chain.

R1 (*price – level of customer satisfaction – coffee export – profit – investment – productivity – production/processing/transportation cost - price*) shows that the effect of price on customer satisfaction is significant. Since reduced price of coffee products in the foreign markets will increase the level of customer satisfaction. This can be explained that there are variations in purchasing power of consumer in the international market. The coffee export volume is strongly affected by customer satisfaction. Thus, an increase in the level of customer satisfaction will lead to

escalation in the coffee export volume. The profit of the coffee product increases as a result of increasing export volume. It is important to note that increasing profit in the coffee firms will lead to increased investment at all stages. The productivity of all elements in supply chain therefore will increase (including production, processing, packaging and transportation). As a result of increasing in coffee productivity, the costs of production, processing, packaging and transportation would also decline. The total coffee supply chain cost is determined by the costs of these components. The Vietnamese firms will be in a position to offer coffee at a lower price in the international markets if the cost of each unit is reduced. Price could therefore be used as a very effective marketing tool to increase the competitive advantages of the coffee product in the global markets.

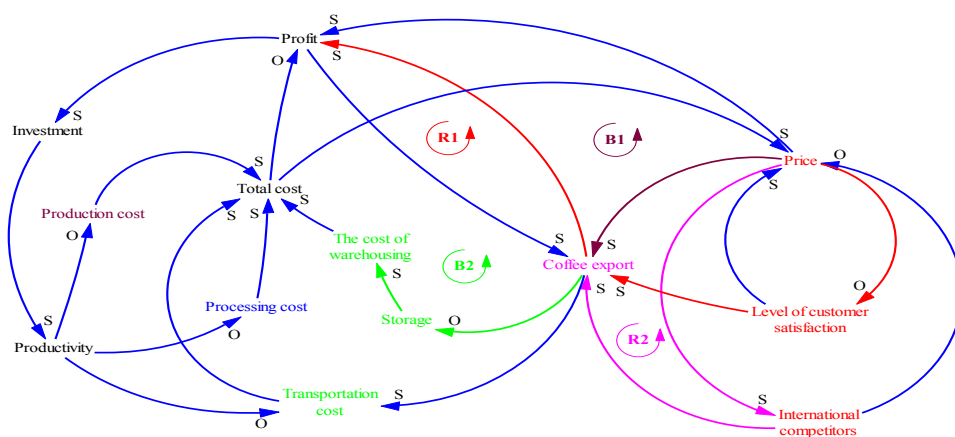


Figure 5: Causal loop diagram of the coffee supply chain cost

B1 and B2 are vicious cycles (Figure 5). B1 (*Total cost – Price – Coffee export – Profit – Investment – Productivity – Production/Processing/Transportation cost*) illustrates that reduced total cost of coffee supply chain leads to reduce coffee price in the international market, this can be explained that a product of the company with a cost advantage can be considerable flexibility to lower price. However, the decline of coffee price on the international markets will lead to a decrease in the coffee export volume because the coffee exporters have to consider the profit of the firm. Thus, the less coffee exports, the less profit they will receive. Reduced coffee profit requires supply chain members to cut down investment in all stages of the supply chain (production, processing and warehouse facilities). This will lead to a reduction in productivity in all stages since supply chain members have not enough fashioned facilities. The unit cost of coffee in all stages will increase as a cause of the decline of productivity. As a result of this, the total cost of coffee will again increase. Higher cost of Vietnamese coffee will lead to a reduction in the competitive advantages on the international coffee markets.

The B2 (balancing loop) formed by adding the variables storage and cost of warehouse (instead of variable of profit, investment, productivity and cost of different

supply chain members). The decline of coffee price on the global markets will have a negative effect on the coffee export volume. This is because when coffee export volumes reduce, it requires more warehouses for storage. This leads to an escalation of the cost of warehousing coffee. As a result the total costs in the coffee supply chain will rise. Finally, as a result of increasing in total cost, the coffee exporters have to sell their coffee at a higher price to remain profitable. Thus, in turn it affects the competitive advantages of Vietnamese coffee on the international markets.

- ***Causal loop diagram of the coffee quality in the coffee supply chain***

Coffee quality is considered as a key competitive issue in the global marketplace. If the quality of coffee increases, it will lead to an increase in customer satisfaction and consequently a higher price in the market (Figure 6). Therefore, coffee export volume will increase. As a result of increasing the export volume, the profit of coffee will increase in all stages in supply chain. When all members in the coffee supply chain receive high profits, they will continue to invest more in their chain (for production to increase coffee cherries quality, for processing technology to reduce duration of processing, for warehouse to maintain quality) to increase coffee quality.

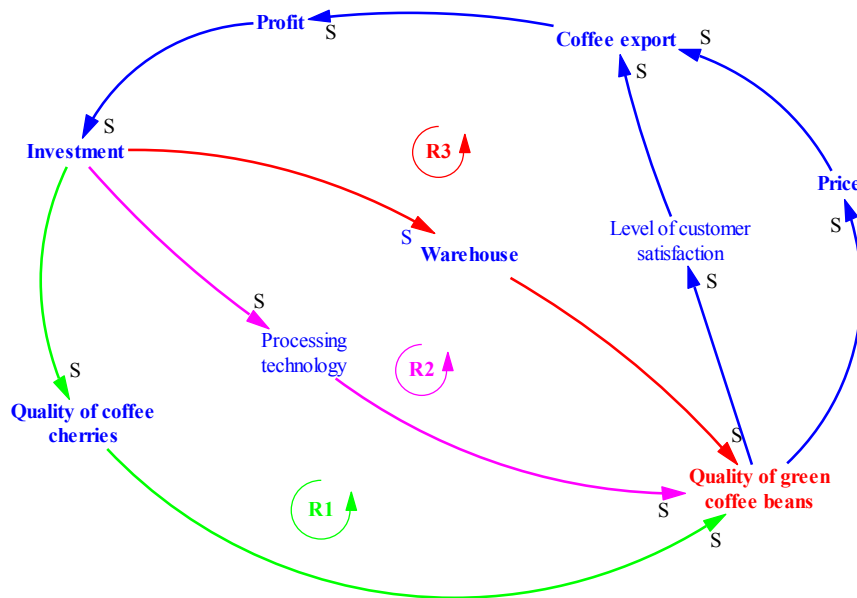


Figure 6: Causal loop diagram of the coffee bean quality in the supply chain

- ***Causal loop diagram of customers satisfaction in the coffee supply chain***

Customer satisfaction with the coffee is often seen as the pivotal role to a Vietnamese coffee company's success and long term competitiveness in the global market. It is also viewed as a central determinant, a key differentiator of customer retention and increasingly has become a key element of business strategy. The level of customer

satisfaction is often decided by three main factors, namely the quality, price and time it takes to deliver the coffee (Figure 7). A change in price will lead to a change in the level of customer satisfaction of the coffee. An increase in the level of Vietnamese coffee satisfaction will have a positive effect on coffee consumption, and therefore lead to an increase in coffee export volume. This in turn affects profitability. When the profit increases, the investment will be increased in all stages of the chain. This will lead to a reduction in price and an increase in the quality of coffee through increased productivity and better equipment and technologies.

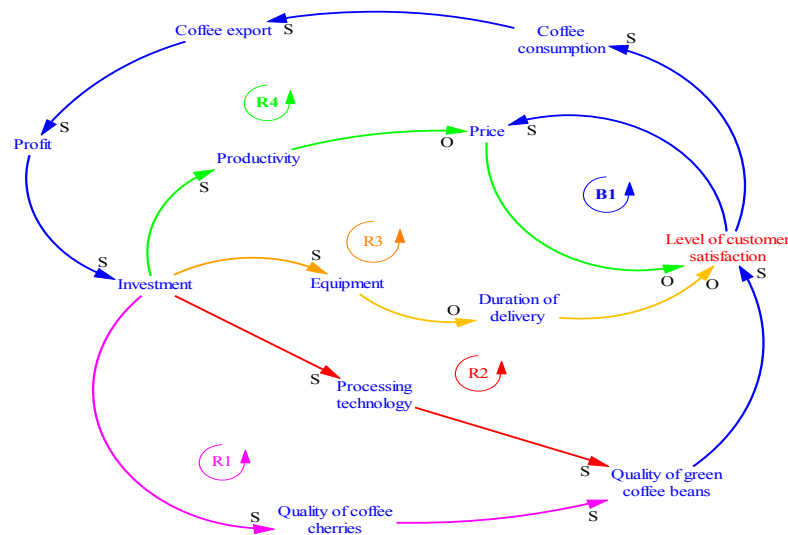


Figure 7: Causal loop diagram of customer satisfaction in supply chain

- ***Causal loop diagram of international competitors***

Competition firms play a central role for measuring competitiveness. Suppose the price of Vietnamese coffee rises to such levels that even the ideal consumer of Vietnamese coffee finds it uncompetitive, they would buy coffee products from other competitors instead of Vietnamese coffee. This would lead to a reduction of the export volume of Vietnamese coffee (Figure 8). Lower export volume fetches lower profit for coffee industry. As a result of this, the investment in all stages in the coffee supply chain will also reduce. If the investment in coffee industry reduces, then the quality of the coffee beans also decline. When the quality of coffee product declines, a number of Vietnamese coffee competitors will increase because many other producers in the world can also provide the same or even higher coffee quality compared to Vietnamese coffee. In this case, the Vietnamese coffee will lose its competitive advantage in the quality of coffee.

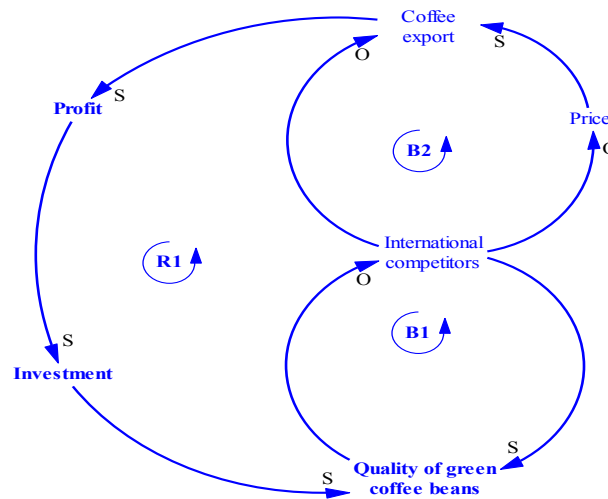


Figure 8: Causal loop diagram of international competitors in coffee supply chain

- **General causal loop diagram of the Vietnamese coffee supply chain**

A general causal loop diagram of Vietnamese coffee supply chain has been developed after detailed discussions with numerous experts from different stakeholder groups in the coffee industry. Various positive and negative feedback loops are shown in Figure 9.

Figure 9 shows that increased investment will tend to increase two aspects of coffee competitive advantages; one is the level of customer satisfaction and another is quality of coffee beans (see loops R1, R2 and R4). Both customer satisfaction and the quality of coffee are key competitive issues in the global marketplace. Increased investment will increase the quality of seed and fertilisers, and the effectiveness of irrigation systems in the production stage. This would lead to an increase in the quality of coffee cherries that directly affects the quality of coffee beans (see loop R1: *Investment – Coffee cherries – Quality of green coffee beans – Level of customer satisfaction – Consumption – Coffee export volume – Profit*). Increased investment also reduces the processing duration of coffee beans, because coffee firms can upgrade technologies in both dry and wet processing methods. This also leads to an increase of the quality of coffee beans (see loop R2: *Investment – Processing technologies – Processing duration – Quality of green coffee beans – Level of customer satisfaction – Consumption – Coffee export volume – Profit*). When the qualities of green beans improve, the consumption of coffee product will increase because the number of satisfied customers will increase. This will have a positive effect on coffee consumption in the global market, which will increase the demand for coffee to be exported. A higher volume of coffee export will bring higher profits for all stakeholders in the coffee supply chain. As a result of this, the investment ability of all channel members in the Vietnamese coffee industry continues to escalate. Thus the feedback loop between investment, quality of coffee beans, level of customer satisfaction, coffee consumption, coffee export and profit is a positive loop.

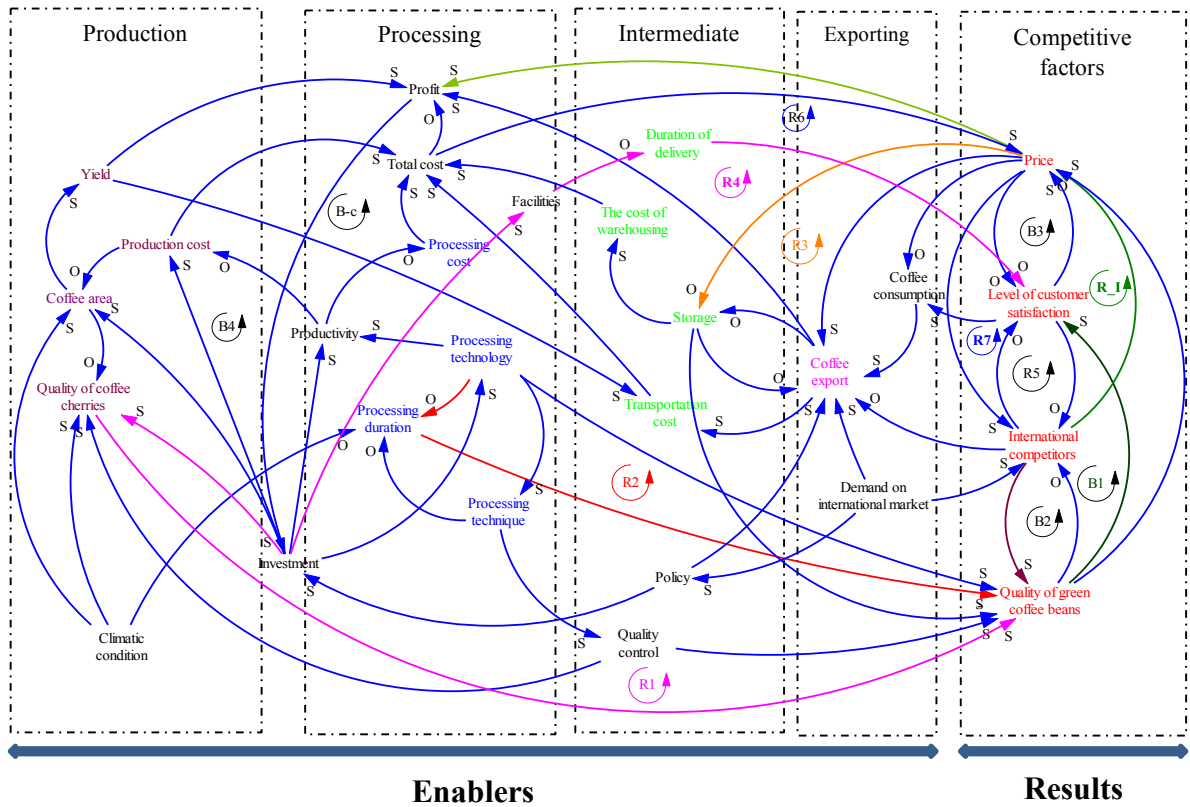


Figure 9: Causal loop diagram of Vietnamese coffee supply chain

Customer satisfaction is strongly affected by investment. Increased investment in facilities and equipment will affect duration of delivery coffee product from producer to final customers (see R4: *Investment – Facilities – Duration of delivery – Level of customer satisfaction – Consumption – Coffee export volume – Profit*). The facilities and equipment are critical in securing a constant flow of coffee products from supplier to the final customers, in not only achieving timely delivery, but also in maintaining coffee product quality at high levels. Thus, if coffee firms have good enough facilities and equipment, the duration of delivery will reduce. This leads to the consumption of coffee product will increase. Increase coffee consumption leads to increase the profit for Vietnamese coffee supply chain via increasing the volume of coffee export. When profit increases, the investment in all stages of supply chain will also increase. This, in turn, will increase the competitive advantages of Vietnamese coffee product by improving the level of customer satisfaction. This feedback loop is a reinforcing (or positive) loop.

Increased investment will lead to a reduction in the price of coffee product (also note that price is an important factor in the competitive advantage of coffee product. It is influenced by the costs which incurs across the coffee supply chain). A reduction of coffee price means that its competitiveness increases because price is one of the key determinants of customer satisfaction. If the firms increase investment, they can invest

on modern technologies in all stages of supply chain (machines in the production, types of technology in the processing, facilities and equipment in transportation and storages, and infrastructure etc.) which have high productivity (see loop B_c: *Investment – Productivity – Cost – Price – Coffee export volume – Profit*). As a result, the cost of all stages in supply chain (production cost, processing cost, transportation cost, storage cost) will decline. Thus, the total cost of coffee product will also decline. When the total cost reduces, the price of product will reduce because coffee exporters are willing to offer at lower price while they still receive profit as their expectation. Increased volume of coffee export is a result of reducing the price. This can be explained that the lower price will attract various objective customers who have different purchase powers. Increased coffee export volume will lead to increase in the profit which is a major factor effect on increasing investment of all channel members. Thus the feedback loop between investment, productivity, cost, price, coffee export and profit is balancing (or negative) loop.

Investment is also strongly effected by international competitors; an increase in the number of competitors in the global market not only requires an increase in the coffee quality, but also a decrease in the coffee export price to maintain the competitive position of Vietnamese coffee on international markets (see loop R_I: *International competitors – Price – Coffee export volume – profit – Investment – Quality of green coffee beans*). This is a bottle neck of Vietnamese coffee industry. The coffee product is high competition in global market because there are numerous coffee producers and processors as well as traders in the world. Thus, if the numbers of competitors who enter the international market increases, the Vietnamese coffee firms have to offer a lower price that is comparable to the competition. However, the decline of coffee export price leads to the decrease in export volume because the Vietnamese coffee export companies have to reconsider their export strategy to maintain their profit. The profit of coffee firms is strongly affected by export volume. Therefore, the decrease in coffee export volume will lead to a reduction in the profit which has a direct effect on the investment of all stakeholders in the supply chain. A decrease in the quality of coffee beans is a result of a reduction in seed investment, facility and equipment investment, and technology investment of all coffee channel members. The lower quality of Vietnamese coffee in the global market will increase the competitors because many other coffee trader can provide the coffee product as high quality as that of Vietnam. The loop R_I is therefore a reinforcing loop.

The price which is affected by the cost of all stages in supply chain (production cost, processing cost, transportation cost, storage cost) not only affects customer satisfaction, but also competition in the international market (see loop B3 and R7 in the figure 9). The negative feedback loop B3 (*Price – Level of customer satisfaction*) shows the effect of price on the level of customer satisfaction. The price is one of the key determinants of customer satisfaction because buyers will prefer a low priced product to a high priced product. Thus, the coffee exporters will always want to offer lower price to the customer for achieving high customer satisfaction.

The loop R7 (*International competitors – Price*) illustrates that, the increase of coffee price in the international market will leads to an increase in the number of coffee providers. This is evidence that the coffee traders tend to export their product to get higher profit rather than they sell in the domestic markets when the coffee price in the global market is high. In contrast, the decline of international coffee price will lead to the decrease in the number of coffee exporters in the oversea markets.

The aforementioned causal loop diagrams of coffee supply chain provide an insight into understanding the dynamic interactions among subsystems of the Vietnamese coffee supply chain. It builds an understanding of these relationships, and it allows coffee firms to take proactive action to ensure effective implementation of coffee supply chain philosophy. In the CLD of Vietnamese coffee supply chain can be extended and involved to looking for leverage points which then can be intervened for evaluating various long term strategies to ensure more effective implementation of the coffee supply chain philosophy and increase the competitiveness of Vietnamese coffee products.

5. CONCLUSION

The causal loop diagrams in this study serve as a simple visual representation of complex relationships between key variables and factors of different stakeholders in Vietnamese coffee supply chain. One developed, the model can be used to identify potentially high leverage interventions that could be affected to four aspects of the competitive advantages namely the level of customer satisfaction, the quality of product, the competitors, and the price of product. A general causal loop diagram of whole coffee supply chain has been developed between these sets of enables and results and is the basis for continued analyses and researches to looking for intervention strategies to increase the competitive advantage of Vietnamese coffee products. Therefore, in a forthcoming paper these relationships and influences will be tested by using Bayesian Belief Networks (BBNs) model to intervene in the key leverage points in the coffee supply chain to enhance the competitive advantages of Vietnamese coffee product.

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