
An Exploratory study of factors affecting supply chain collaboration in Thailand's dairy industry

การศึกษาเชิงสำรวจของปัจจัยที่มีผลต่อความร่วมมือในห่วงโซ่อุปทานในอุตสาหกรรมโคนมของประเทศไทย

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Abstract

Thailand's dairy industry provides a source of protein for citizens; however, 90% of milk producers are smallholders. In addition to disease control and health regulations, supporting milk producers in supply chain collaboration can play a major role in improving the success of the dairy industry. Understanding the factors affecting this will lead to success in supply chain collaboration. This study gathered 95 variables from a literature review of 43 papers. Through the process of expert interviews, these were refined into 49 substantive variables. Furthermore, this exploratory study aims to develop conceptual frameworks. From an exploratory factor analysis, 27 factors were identified, and conceptual frameworks developed in 7 areas as follows: long-term business, measurement and evaluation, internal and external communication, joint operations, interaction, sharing, supply & demand. The verified model will be able to give a clearer understanding of the factors affecting supply chain collaboration that impacts Thailand's dairy industry and support its development by improving the important key factors.

Keywords: Supply chain collaboration, affecting factors, dairy industry, exploratory factory analysis

บทคัดย่อ

อุตสาหกรรมโคนมของประเทศไทยเป็นแหล่งโปรตีนสำหรับประชาชน อย่างไรก็ตาม 90% ของผู้ผลิตนมเป็นรายย่อย นอกเหนือจากการควบคุมโรคและกฎระเบียบด้านสุขภาพแล้วการสนับสนุนผู้ผลิตนมในการทำงานร่วมกันในห่วงโซ่อุปทานยังมีส่วนสำคัญในการปรับปรุงความสำเร็จของอุตสาหกรรมโคนม การทำความเข้าใจปัจจัยที่มีผลต่อสิ่งนี้จะนำไปสู่ความสำเร็จในการทำงานร่วมกันในห่วงโซ่อุปทาน การศึกษานี้รวบรวมตัวแปร 95 ตัวจากการทบทวนวรรณกรรมจากเอกสารงานวิจัย จากนั้นมีกระบวนการสัมภาษณ์ผู้เชี่ยวชาญเพื่อกลั่นกรองตัวแปรสำคัญจนเหลือจำนวน 49 ตัว นอกจากนี้การศึกษานำร่องนี้มีวัตถุประสงค์เพื่อพัฒนารอบแนวคิด โดยจากการวิเคราะห์ปัจจัยเชิงสำรวจพบว่ามี 27 ปัจจัยที่มีอิทธิพลต่อรอบแนวคิด และสามารถพัฒนารอบแนวคิดทั้ง 7 ด้านดังนี้ ฐุรกิจระยะยาว การวัดและประเมินผล การสื่อสารภายในและภายนอก ปฏิบัติการร่วม ปฏิสัมพันธ์ การแบ่งปัน อุปสงค์และอุปทานซึ่งจากการศึกษาครั้งนี้ได้สร้างแบบจำลองที่สามารถให้ความเข้าใจที่ชัดเจนยิ่งขึ้นเกี่ยวกับปัจจัยที่มีผลต่อความร่วมมือในห่วงโซ่อุปทานที่ส่งผลกระทบต่ออุตสาหกรรมนมของประเทศไทย โดยสามารถให้การสนับสนุนปัจจัยหลักที่สำคัญเพื่อการพัฒนาของอุตสาหกรรมต่อไป

คำสำคัญ: ความร่วมมือในห่วงโซ่อุปทาน, ปัจจัย, อุตสาหกรรมโคนม, การวิเคราะห์ปัจจัยเชิงสำรวจ

Introduction

Milk and dairy products are cheaper than other sources of protein. Milk and dairy products have high nutrient content, supplying energy, proteins, amino acids, minerals, and other micronutrients. The Thai dairy industry was founded in 1960, after some dairy cows were given to Thailand by the King of Denmark. The Thai King initiated the Dairy Farming Promotion Organization of Thailand and the Department of Livestock Development began a bovine insemination programme. Moreover, in 1971, native cows were bred with Holstein Friesians to develop dairy cows suitable for Thailand's tropical climate. Dairy in Thailand comes from 2 main sources: cooperatives and milk collection centers. Cooperatives set up by small dairy farmers with an average of 15-20 lactating cows per farm then supply milk to the co-operatives daily, and some cooperatives are manufacturers of milk products. The milk cooperatives are managed by the Dairy Farming Promotion Organization (D.P.O), a state enterprise. D.P.O has responsibility for promoting, supporting, and developing the growth of the industry. Some cooperatives only treat milk for direct consumption, while others also engage in the processing of milk products such as flavored milk and produce yogurt and cheese. Moreover, one of examples of industry development is the school milk project, established by the Cabinet in 1985 following farmers' protests in 1984 over unsold milk. The project was later expanded and today all children in public schools are provided with 200ml of free milk each day. It was intended to support the Thai dairy industry and increase Thai milk consumption per capita. However, despite such government initiatives, the dairy industry lacks information and understanding about supply chain collaboration. Understanding important factors or variables that lead to the success of supply chain collaboration can help Thailand's dairy farmers and industry achieve sustainability in the world trade environment.

Supply chain collaboration and supply chain management have been successfully implemented by many industries to varying degrees. Matopoulos et al. (2007) showed that supply chain collaboration is critical for the agri-food industry; however, there were some constraints to the implementation of supply chain collaboration, due to the nature of products in the industry, and the specific structure of

the segment. Supply chain collaboration also has a critical impact on business success, as identified by Ramanathan and Gunasekaran (2013). They studied the impact of supply chain collaboration on long-term partnerships in the textile industry, demonstrating its effect on the success of supply chain activities. Moreover, collaboration in the execution of supply chain planning also leads to wider collaboration in the future. Barratt (2004) reported that, although supply chain collaboration is known to be very difficult to implement, it still has a high potential to deliver significant improvement to business, organization or industry performances. Furthermore, the literature review and future research agenda by Chen et al. (2017) regarding supply chain collaboration for sustainability identified numerous areas of implementation. These can be classified into 5 groups to measure supply chain sustainability as follows: collaboration with suppliers, customers, competitors, other organizations, and internal collaboration. They also demonstrated a model of supply chain collaboration for sustainability, confirming that collaboration in the supply chain leads to business success.

However, for the dairy industry, it is obvious showing lack of information and understanding about supply chain collaboration. Understanding important variables that lead to success of supply chain collaboration, it can help Thai's dairy farmers and industry to be sustained in the world trade environment.

Research questions

There are many important factors that impact on supply chain collaboration. In this study, the question is: what factors in supply chain lead to success of supply chain collaboration?

Research objectives

This study aims to deliver a set factors that impact supply chain collaboration in Thailand's dairy market. Moreover, the researcher aims to achieve a conceptual framework on supply chain collaboration in Thailand's dairy industry. It will contribute initiative for government, co-operatives, D.P.O, and farmers. They can use the model to invest and reinvest in the right affective factors to the businesses.

Literature review

Supply chain collaboration is involved in many industries including electronics, commodities goods and automobiles for instance. Table 1 summarises some definitions of supply chain collaboration.

Definitions

Table 1. Definitions of supply chain collaboration.

Authors	Definition
Cohen and Roussel (2005)	Companies within the supply chain work together toward mutual objectives through the sharing of ideas, information, knowledge, risks and rewards
Simatupang and Sridharan (2008)	The process of working together among independent firms (two or more companies) along a supply chain in delivering products to end customers for the basic purpose of optimizing long-range profit for all chain members and creating a competitive advantage

Review of factors

To identify the key factors that lead to successful supply chain collaboration, data was collected from many supply chain collaboration studies, a key word was “success of supply chain collaboration”. This identified 95 variables leading to supply chain collaboration success in many industries, as shown in Table 2 below. However, in milk and related products, studies of supply chain collaboration are more limited.

Table 2. Important 95 factors for supply chain collaboration.

Factors	Authors
Adaptation	Dania et al. (2018)
Alliance or conflict resolution	Kumar and Nath Banerjee (2012); Lemma (2015)
Business objective (financial/operational)	Ramanathan (2014); Ramanathan et al. (2011)
Collaboration with competitors, collaborative capacity sharing	Chen et al. (2017)
Collaboration with other organizations	Chen et al. (2017)
Collaborative performance system	Simatupang and Sridharan (2007)
Commitment	Dania et al. (2018); Banomyong (2018)
Communicating/communication and understanding	van der Heijden and Cramer (2017); Chen et al. (2017)
Continuous improvement	Dania et al. (2018)
Cost reduction/cost	Banchuen, Sadler, and Shee (2017)
Cross-functional collaboration - activities/ team	Chen et al. (2017); Lemma (2015)
Customer structural collaboration	Chen et al. (2017)
Decision synchronization - decision sharing	Chen et al. (2017); Banomyong (2018)
Delivery/delivery schedules	Nagashima et al. (2015); Banchuen et al. (2017)
Degree of collaboration	Ramanathan (2014)
Demand forecast accuracy/forecast accuracy	Nagashima et al. (2015); Ramanathan (2013)
Determining rewards and taking corrective action/evaluation and reward system	Kumar and Nath Banerjee (2012);
Environmental collaboration	Vachon and Klassen (2008)
External collaboration	Stank, Keller, and Daugherty (2001)
Feedback for Improvement (products and services)	Kumar and Nath Banerjee (2012);
Goal congruence	Chakraborty et al. (2014); Cao and Zhang (2011)
Inventory improvement/inventory cost	Kumar and Nath Banerjee (2012);
Incentive alignment	Herczeg, Akkerman, and Hauschild (2018);
Information exchange with customers and suppliers/access	Chakraborty et al. (2014); Chen et al. (2017); Verecke and Muylle (2006)
Information quality	Ramanathan et al. (2011)
Information sharing	Banomyong (2018); Raweewan and Ferrell (2018)
Infrastructure integration	Chen et al. (2017)
Maintaining standardized operations	Soosay et al. (2008)
Innovation/innovative supply chain processes	Cao and Zhang (2010)
Integrated information systems/information technology	Aschemann-Witzel et al. (2017); Prajogo and Olhager (2012); Herczeg et al. (2018)
Integrated supply chain processes	Chen et al. (2017)
Intelligence gathering and analysis	Horvath (2001)
Internal collaborative forecasting and planning	Stank et al. (2001); Nakano (2009)
Interorganizational systems	Zhang and Cao (2018)
Investment/joint investment	Ramanathan and Gunasekaran (2014)
Joint business planning	Chen et al. (2017);

Table 2. Important 95 factors for supply chain collaboration.

Factors	Authors
Joint efforts	Dania et al. (2018)
Joint organizational learning	Kumar and Nath Banerjee (2012)
Joint performance measurement	Min et al. (2005)
Joint problem solving	Min et al. (2005)
Joint production	Chen et al. (2017)
Joint teamwork	Ramanathan and Gunasekaran (2014)
Knowledge transfer and integration	Herczeg et al. (2017)
Leveraging resources and skills	Min et al. (2005)
Logistical and technological integration	Chen et al. (2017); Herczeg et al. (2018)
Loyalty	Kumar and Nath Banerjee (2012)
Material requirement planning	Kumar and Nath Banerjee (2012)
Measuring contribution of partners	Kumar and Nath Banerjee (2012)
Monitoring by customer	Chen et al. (2017)
Mutual shared interest/benefit/risks and rewards	Kumar and Nath Banerjee (2012); Chen et al. (2017); Lemma (2015)
New electronic commerce capability	Horvath (2001)
New product development	Kumar and Nath Banerjee (2012); Lemma (2015)
Offering flexibility	Cao and Zhang (2010); Banchuen et al. (2017)
On time production	Ramanathan et al. (2011)
Outsourcing	Huang et al. (2015)
People management and development	Stanley et al. (2008)
Performance measurement	Stanley et al. (2008)
Plan changing	Ramanathan and Gunasekaran (2014)
Planning and controlling product design	Ramanathan and Gunasekaran (2014)
Planning promotion	Ramanathan and Gunasekaran (2014)
Planning sharing replenishment	Ramanathan and Gunasekaran (2014)
Power	Dania et al. (2018)
Price	Ramanathan and Gunasekaran (2014); Lemma (2015)
Prioritizing goals and objectives	Kumar and Nath Banerjee (2012)
Process efficiency	Cao and Zhang (2010)
Process and system integration/process management	Chen et al. (2017); Soosay et al. (2008); Dania et al. (2018)
Processes	Ramanathan (2014)
Product promotion	Kumar and Nath Banerjee (2012)
Production and delivery systems	Herczeg et al. (2018)
Purchasing	Kumar and Nath Banerjee (2012)
Quality	Cao and Zhang (2010); Banchuen et al. (2017)
Redistribution	Aschemann-Witzel et al. (2017)
Relationship management and trust building	Chen et al. (2017); Van der Heijden & Cramer (2017)
Reliability of supply	Akintoye et al. (2000)
Resource sharing	Ramanathan and Gunasekaran (2014)
Retail and supply chain alteration initiatives	Aschemann-Witzel et al. (2017)
Supply chain mapping and role definition	Stanley et al. (2008)
Security capability	Horvath (2001)
Shared supply chain processes	Simatupang and Sridharan (2004)
Sharing responsibility for product recovery	Chen et al. (2017)
Stability	Dania et al. (2018)
Strategic project definition	Herczeg et al. (2018)
Structural coordination with suppliers	Vereecke and Muylle (2006)
Supplier collaboration	Chen et al. (2017)
Supplier development (e.g. Training, support)	Chen et al. (2017)
Supplier integration	Chen et al. (2017)

Table 2. Important 95 factors for supply chain collaboration.

Factors	Authors
Supplier involvement (e.g. product development)	Chen et al. (2017)
Supplier monitoring	Chen et al. (2017)
Supply chain capabilities	Liao and Kuo (2014)
Supply chain collaboration exchanges	Horvath (2001)
Supply chain metrics	Barratt (2004)
Supply-demand agreements	Herczeg et al. (2018)
Technology	Kumar and Nath Banerjee (2012); Salam (2017)
Top management support	Akintoye et al. (2000)
Trust	Dania et al. (2018); Banomyong (2018)

Methodology

Population and Sample

Dairy co-operatives, D.P.O. and dairy farmers are key stake holders of the industry. From a department of livestock report, there are 187 standard co-operatives and milk collecting centers in Thailand.

Samples are separated into two groups, corresponding with the two elements of this study (expert interviews and exploratory study), as follows:

1. Expert interviews: presidents of dairy co-operative communities and presidents of dairy co-operatives.
2. Exploratory study: presidents of dairy co-operatives, dairy co-operatives managers, D.P.O staffs, experts from universities such as veterinary school lecturers working in the dairy industry, Department of Livestock development officers and veterinarians who are support dairy farms and some farmers.

Data Collection

Qualitative Evidence: Expert Interviews

Our literature review has identified more than 95 factors potentially affecting supply chain collaboration in general. The list was narrowed down following interviews with dairy industry experts. We identified main experts in the industry and conducted interview sessions with them in 4 regions of Thailand. There were 11 interviews with industry experts from North-eastern, Eastern, Central and Western, the number of experts interviewed were 2, 5, 3, and 1 respectively.

Quantitative Evidence: Exploratory Study

A paper-based pilot group survey was conducted with managers of D.P.O.; academics such as 2 Deans of Veterinary Science; officers of the Department of Livestock development; managers of large farms in the central region; and members of dairy co-operative communities from 4 regions: North-eastern, Eastern, Central and Western, and dairy farmers. The survey was conducted in Nakorn Ratchasima, Chantha Buri, Prajeub Kirikun and Saraburi provinces in October-December 2020, using the Likert-scale from 1-9 (least to most important). The exploratory study had a sample size of 158.

Analysis

Expert Interviews

1. The index of item-objective congruence, developed by Rovinelli and Hambleton (1977), is a process by which content experts rate individuals, an evaluation using the index of item-objective congruence items based on the degree to which they measure specific objectives listed

2. In the interview for rating, each content expert will evaluate the item with a rating of 1 (for clearly measuring or clearly related), -1 (clearly not measuring or not related), or 0 (degree to which it measures the content area is unclear, or not sure) for each item. In the study, all 95 variables are suitable items to validate supply chain collaboration.

The Study Group

1. Descriptive analysis of respondents

2. Questionnaires from 158 respondents were gathered and tested for reliability statistics by Cronbach's Alpha to support the reliability of the variables.

3. Exploratory factor analysis was also used to test and explain the interrelationship of each variable and identify the construct of appreciation. Exploratory factor analysis is suitable for this purpose, as per Fabrigar and Wegener (2012).

Results

Descriptive analysis of survey respondents, Most of the respondents, 84.81%, are working in dairy cooperatives as presidents, managers, cooperatives committees, while 10.13% are DPO staffs, moreover, respondents are dairy farmers, veterinarian from department of livestock development, professors from universities, and employee contributed 2.53%, 2.53%, 1.27% and 0.63% of sample respectively. Furthermore, respondents are male 62.66% while females are 37.34%. Geography distribution, majority of respondents are in Saraburi province with 30.38%, Prachuap Khiri Khan and Nakhon Ratchasima contributed 21.52%, 15.82% respectively. While Phetchaburi province, Ratchaburi, Nakhon Pathom, Suphan Buri, Khon Kaen, Mahasarakham, Chanthaburi, Loei Province, Lamphang, Nakhon Si Thammarat and Bangkok contributed 10.76%, 5.70%, 4.43%, 2.53%, 2.53%, 1.90%, 1.90%, 0.63%, 0.63%, 0.63%, 0.63% respectively.

The index of item-objective congruence was conducted from 11 experts in Thailand's dairy industry. The results of the analysis are shown in Table 4. There are 49 variables which are suitable to use for explaining supply chain collaboration in the dairy industry.

Outcomes from expert interviews: the 49 variables were reliability tested with the 158 respondents. The results show that the 49 variables are suitable to explain supply chain collaboration with the Cronbach's Alpha score = 0.981.

Exploratory factor analysis was conducted to understand and identify the constructs from this initial group. The extraction method was principal component analysis with rotation method by varimax. The extraction from dimension reduction shows 8 constructs extracted. Finally, the 49 variables were refined to 27.

Table 3. KMO and Bartlett's Test result

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.925
Bartlett's Test of Sphericity	Approx Chi-Square	9148.536
	df	1176
	Sig	.000

Table 4. The index of item-objective congruence score for supply chain collaboration testing.

Level of IOC score	No. of variables
Variable with IOC score = 1	37
Variable with IOC score > 0.7 - < 1	7
Variable with IOC score > 0.6 - < 0.7	5
Variable with IOC score > 0.5 - < 0.6	0
Variable with IOC score < 0.5	46
Total variables	95

From the test, the KMO measure of sampling adequacy score was 0.925, confirming that the data from the samples were appropriate to be used. In addition, Bartlett's Test significance value in Table 3 is 0.000, that less than 0.05. The data set of samples was suitable for the EFA process.

Furthermore, 8 constructs contributed 78.648%, showing that the quality of the result can be accepted. From the extraction by 8 constructs were extracted shows in table 5. Moreover, the result of analysis, list of 7 constructs and 27 factors from Exploratory Factor Analysis shows in table 6 with loading factors. In this analysis, using cut off points of loading factor at 0.6, Thus, construct 8 was ruled out.

Table 5. Total Variance Explained

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	25.926	52.910	52.910	25.678	52.404	52.404	8.335
2	3.504	7.152	60.061	3.251	6.635	59.039	12.078
3	2.233	4.557	64.618	1.977	4.035	63.074	13.838
4	1.817	3.708	68.326	1.557	3.178	66.252	13.368
5	1.718	3.506	71.832	1.439	2.936	69.188	7.809
6	1.256	2.564	74.396	.997	2.035	71.223	15.885
7	1.072	2.187	76.583	.756	1.543	72.766	2.325
8	1.012	2.065	78.648	.749	1.528	74.294	15.611

Extraction Method: Principal Component Analysis.

Table 6. Constructs developed from exploratory study by rotated component matrix of PCA

Constructs	Factors	Loading
Long-term business	Price	.736
	Loyalty	.721
	Top management support	.678
	Quality	.655
	Joint problem solving	.649
	Relationship Management and Trust Building	.645
	Joint organizational learning	.603

Table 6. Constructs developed from exploratory study by rotated component matrix of PCA

Constructs	Factors	Loading
Measurement and evaluation	On time production	.793
	Prioritizing goals and objectives	.741
	Mutual sharing interest, benefit, risks, and rewards	.644
	Supply chain metrics	.615
Internal and external communication	Environmental collaboration	.861
	Demand forecast accuracy Forecast accuracy	.817
	Information sharing	.814
	Alliance or Conflict resolution	.814
Joint Operations	Joint teamwork	.793
	Joint production	.776
	Technology	.764
	Cost reduction Cost	.726
	Integrated information systems Information technology	.689
	Joint Efforts	.658
	Joint business planning	.629
Interaction	Delivery/ Delivery schedules	.652
	Communicating Communication and understanding	.616
Sharing	Shared supply chain processes	.799
	Sharing responsibility for product recovery	.700
Supply and demand	Supply demand agreements	.738

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

Discussion and Conclusion

The study shows that the supply chain collaboration factors affecting Thailand's dairy industry constitute 27 variables with 7 constructs. It can answer the research questions that, these 27 factors have strong impact to supply chain collaboration in Thailand's dairy industry. In practical, these 7 constructs from EFA result are Long-term business, Measurement and evaluation, Internal and external communication, Joint Operations, Interaction, Sharing, Supply & demand. These 7 topics are major concern of the dairy industry nowadays.

Table 7. Comparison supply chain collaboration constructs.

Authors	Supply chain collaboration constructs
Chen et al. (2017)	Internal collaboration, Collaboration with supplier, Collaboration with customer, Collaboration with competitors, Collaboration with other organization
Ramanathan and Gunasekaran (2014)	Collaborative planning, Collaborative execution, Collaborative decision making
Cao and Zhang (2011)	Information sharing, Goal congruence, Decision synchronization, Incentive alignment, Resource sharing Collaborative communication, Joint knowledge creation

As shown in figure 2, the developed framework identifies the key issues for Thailand's dairy industry. In comparison with another study (Chen et al., 2017), as seen in table 7, this framework can be explained more precisely in terms of activities rather than organizations or parties. On the other hand, Ramanathan and Gunasekaran (2014) and Cao and Zhang (2011) focused on activities within the same concept of this framework. Furthermore, Ramanathan and Gunasekaran (2014) presented a valuable overview of the collaborative framework to explain supply chain collaboration in general; however, the framework proposed herein is specific for the dairy industry. In addition, Cao and Zhang (2011) showed some alignment of the constructs affecting supply chain collaboration in Thailand's dairy industry, such as learning and knowledge, and internal and external communication; however, the proposed framework is more specific in leading activities of supply chain collaboration. The study is achieving a conceptual framework on supply chain collaboration in Thailand's dairy industry as per mentioned in research objective. This is recommended from researcher to be introduced the framework to Thai dairy farmers and all stakeholders to improve the dairy industry, create competitive advantages for the nation.

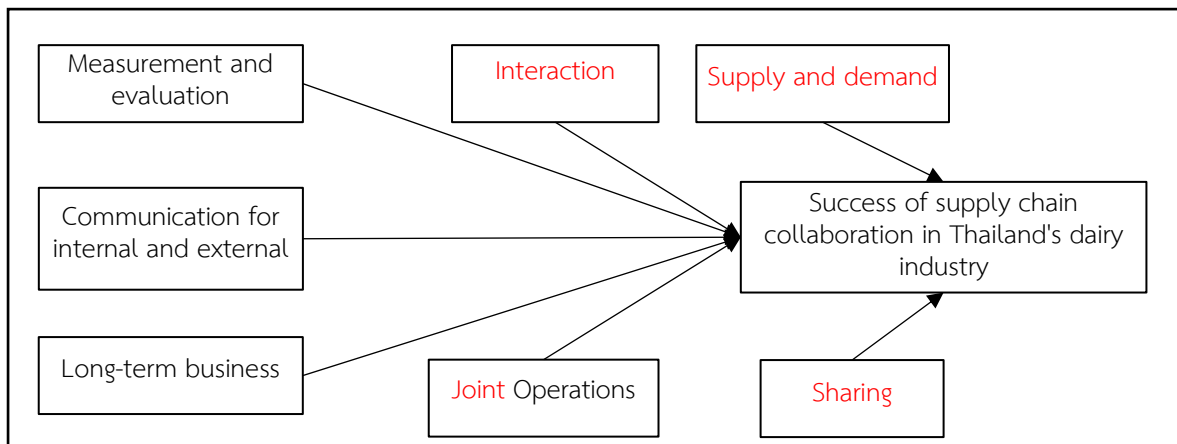


Figure 2. Framework for supply chain collaboration in the dairy industry.:
Developed from EFA result

For further studies, the researchers recommended to expand sample size and do the confirmatory factor analysis with Structural equation modeling (SEM); however, this study had some limitations such as the study conducted during COVID-19 pandemic, it led to restrict movement of people, then it was quite hard to collect data from Thai farmers in the up country.

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