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### Factors affecting supply chain collaboration in Thailand's dairy industry: pilot study

*Factores que afectan la colaboración en la cadena de suministro de la industria láctea de Tailandia: estudio piloto*

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#### ABSTRACT

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. This pilot study aims to develop conceptual frameworks in 9 areas as follows: performance and commitment, processes, measurement and evaluation, strategies, internal and external communication, long-term business, operations, cost reduction, learning and knowledge, and 32 identified factors by exploratory factor analysis. The verified model will be able to give a clearer understanding of the factors affecting supply chain collaboration that impacts Thailand's dairy industry.

**Keywords:** Supply chain collaboration, affecting factors, dairy industry, milk producers.

#### RESUMEN

El 90% de los productores de leche son pequeños agricultores. Además del control de enfermedades y las regulaciones sanitarias, apoyar a los productores de leche en la colaboración de la cadena de suministro puede desempeñar un papel importante en la mejora del éxito de la industria láctea. Este estudio piloto tiene como objetivo desarrollar marcos conceptuales en 9 áreas de la siguiente manera: desempeño y compromiso, procesos, medición y evaluación, estrategias, comunicación interna y externa, negocios a largo plazo, operaciones, reducción de costos, aprendizaje y conocimiento y 32 factores identificados por el análisis de factores exploratorios. El modelo verificado podrá brindar una comprensión más clara de los factores que afectan la colaboración en la cadena de suministro y que impactan en la industria láctea de Tailandia.

**Palabras clave:** Colaboración en la cadena de suministro, factores que afectan, industria láctea, productores de leche

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## INTRODUCTION

Milk and dairy products are cheaper than other sources of protein. Milk and dairy products have high nutrient content, supplying energy, proteins, aminoacids, 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 program. 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: raw milk is sourced from cooperatives and milk collection centers. The cooperatives, set up by small dairy farmers with an average of 15-20 lactating cows per farm, then supply the daily milk requirements to the co-operatives, and some cooperatives are manufacturers of milk products. The milk cooperatives are managed by the Dairy Farming Promotion Organization (DPO), a state enterprise tasked with promoting, supporting, and developing the growth of the industry. Some cooperatives only treat milk for direct consumption, while some also engage in the processing of milk products such as flavored milk and produce yogurt and cheese. Moreover, one of the 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. This project 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. Akintoye et al. (2000) surveyed supply chain collaboration and management by the leading construction industry contractors in the United Kingdom (Akintoye et al.: 2000, pp. 159-168). They found some awareness of supply chain collaboration and management; however, it was not high. Moreover, Aristides 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 (2014). 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 a significant improvement to the business, organization, or industry performances. Barratt (2004) also showed the scope of both vertical and horizontal supply chain collaboration [see table 2, below]. 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 five 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 (Barratt: 2004; Chen et al.: 2017, pp. 73-87).

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

## Research questions

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

## Research Objectives

This study aims to achieve a conceptual framework on supply chain collaboration in Thailand's dairy industry.

## LITERATURE REVIEW

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

### Definitions

**Table (1).** Definitions of Supply Chain Collaboration.

Authors	Definition
(Horvath: 2001)	Supply chain collaboration is the driving force of effective supply chain management among all parties in the value chain, whatever their size, function, or relative position
(Simatupang & Sridharan: 2002, pp. 15-30)	Two or more autonomous firms working together to plan and execute supply chain activities
(Wood & Gray: 1991, pp. 139-162)	Collaboration occurs when a group of autonomous stakeholders of a problem domain engages in an interactive process, using shared rules, norms, and structures, to act or decide on issues related to that domain
(Skjoett-Larsen, et al.: 2003)	Two or more parties in the supply chain jointly plan several promotional activities and work out synchronized forecasts, based on which the production and replenishment processes are determined
(Cohen & Roussel: 2013)	Companies within the supply chain work together toward mutual objectives through the sharing of ideas, information, knowledge, risks, and rewards
(Simatupang & 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 44 supply chain collaboration studies. 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 Factors for Supply Chain Collaboration.

<b>Factors</b>	<b>Authors</b>
Adaptation	(Dania et al.: 2018, pp. 851-864)
Alliance or conflict resolution	(Kumar & Banerjee: 2012)
Business objective (financial/operational)	(Ramanathan & Gunasekaran: 2014, pp. 252-259; Ramanathan et al.: 2011)
Collaboration with competitors, collaborative capacity sharing	(Chen, et al.: 2017, pp. 73-87)
Collaboration with other organizations	(Chen, et al.: 2017, pp. 73-87)
Collaborative performance system	(Simatupang & Sridharan: 2004; Simatupang & Sridharan: 2007, pp. 304-323)
Commitment	(Banomyong: 2018; Dania, et al.: 2018, pp. 851-864; Kumar & Banerjee: 2012)
Communicating/communication and understanding	(Barratt: 2004; Cao & Zhang: 2011, pp. 163-180; Chen et al.: 2017, pp. 73-87; Kumar & Banerjee: 2012; Soosay, et al.: 2008)
Continuous improvement	(Dania et al.: 2018, pp. 851-864)
Cost reduction/cost	(Banchuen et al: 2017, pp. 109-121; Ramanathan: 2013, pp. 431-440)
Cross-functional collaboration - activities/ team	( Barratt: 2004; Chen et al.: 2017, pp. 73-87)
Customer structural collaboration	(Chen et al.: 2017, pp. 73-87; Vereecke & Muylle: 2006)
Decision synchronization - decision sharing	(Banomyong: 2018; Barratt: 2004; Simatupang & Sridharan: 2004; Simatupang & Sridharan: 2007, pp. 304-323; Cao & Zhang: 2011, pp. 163-180; Chen et al.: 2017, pp. 73-87; Ramanathan et al.: 2011; Ramanathan & Gunasekaran: 2013, pp. 431-440)
Delivery/delivery schedules	(Banchuen, et al.: 2017, pp. 109-121; Ramanathan & Gunasekaran: 2013, pp. 431-440; Ramanathan et al.: 2011; Nagashima et al.: 2015)
Degree of collaboration	(Ramanathan Ramanathan: 2014, pp. 252-259)
Demand forecast accuracy/forecast accuracy	(Kumar & Banerjee: 2012; Nagashima et al.: 2015; Nakano: 2009, Ramanathan: 2013, pp. 431-440)
Determining rewards and taking corrective action/evaluation and reward system	(Kumar & Banerjee: 2012)
Environmental collaboration	(Vachon & Klassen : 2008, pp. 299-315)
External collaboration	(Stank, et al.: 2001, pp. 29-48)
Feedback for Improvement (products and services)	(Kumar & Banerjee: 2012; Ramanathan et al.: 2011)
Goal congruence	(Cao & Zhang: 2011, pp. 163-180)
Inventory improvement/inventory cost	(Kumar & Banerjee: 2012; Ramanathan et al., 2011)
Incentive alignment	(Simatupang & Sridharan: 2004; Simatupang & Sridharan: 2007, pp. 304-323; Kumar & Banerjee : 2012; Cao & Zhang:

	2011, pp. 163-180; Banomyong: 2018; Herczeg, et al.: 2018, pp. 1058-1067; Liao & Kuo: 2014, pp. 295-304)
Information exchange with customers and suppliers/access	( Barratt: 2004; Chen, et al.: 2017, pp. 73-87; Soosay et al.: 2008; Vereecke & Muylle: 2006)
Information quality	(Ramanathan et al.: 2011)
Information sharing	( Akintoye, et al.: 2000; pp. 159-168; Banomyong: 2018; Cao & Zhang: 2011, pp. 163-180; Fawcett, et al.: 2008, pp. 93-112; Liao & Kuo: 2014, pp. 295-304; Min, et al.: 2005; Ramanathan: 2013, pp. 431-440; Ramanathan: 2014, pp. 210-220; Ramanathan, et al.: 2011; Simatupang & Sridharan: 2002, pp. 15-30; Simatupang & Sridharan: 2004; Simatupang & Sridharan: 2007, pp. 304-323; Soosay, et al.: 2008)
Infrastructure integration	(Chen, et al.: 2017, pp. 73-87)
Maintaining standardized operations	(Soosay et al.: 2008)
Innovation/innovative supply chain processes	(Simatupang & Sridharan: 2008; Cao & Zhang: 2010, pp. 358-367)
Integrated information systems/information technology	(Akintoye, et al: 2000, pp. 159-168; Aschemann-Witzel, et al.: 2017, pp. 33-45; Herczeg, et al.: 2018, pp. 1058-1067)
Integrated supply chain processes	(Simatupang & Sridharan :2007, pp. 304-323; Chen, et al.: 2017, pp. 73-87)
Intelligence gathering and analysis	(Horvath: 2001)
Internal collaborative forecasting and planning	(Stank, et al.: 2001, pp. 29-48)
Interorganizational systems	(Cao & Zhang: 2018, pp. 146-157 )
Investment/joint investment	(Ramanathan et al.: 2011; Ramanathan & Gunasekaran, 2013, pp. 431-440; Soosay et al.: 2008)
Joint business planning	(Akintoye, et al.: 2000, pp. 159-168; Cao & Zhang: 2010, pp. 358-367; Chen et al.: 2017, pp. 73-87; Min et al.: 2005; Ramanathan: 2013, pp. 431-440; Soosay et al.: 2008)
Joint efforts	(Dania et al.: 2018, pp. 851-864)
Joint organizational learning	(Kumar & Banerjee : 2012)
Joint performance measurement	(Min et al.: 2005)
Joint problem solving	( Min et al.: 2005)
Joint production	(Chen, et al.: 2017, pp. 73-87)
Joint teamwork	(Ramanathan & Gunasekaran: 2013, pp. 431-440)
Knowledge transfer and integration	( Kumar & Banerjee : 2012; Cao & Zhang, 2011, pp. 163-180; Herczeg, et al.: 2018, pp. 1058-1067; Soosay et al.: 2008)
Leveraging resources and skills	( Min et al.: 2005)
Logistical and technological integration	(Chen, et al.: 2017, pp. 73-87; Herczeg, et al.: 2018, pp. 1058-1067)
Loyalty	(Kumar & Banerjee: 2012)
Material requirement planning	(Kumar & Banerjee: 2012)
Measuring the contribution of partners	(Kumar & Banerjee: 2012)
Monitoring by customer	(Chen, et al.: 2017, pp. 73-87)
Mutual shared interest/benefit/risks and rewards	(Akintoye, et al.: 2000, pp. 159-168; Barratt: 2004; Kumar & Banerjee: 2012; Chen, et al.: 2017, pp. 73-87)

New electronic commerce capability	(Horvath: 2001)
New product development	(Kumar & Banerjee: 2012)
Offering flexibility	(Banchuen, et al.: 2017, pp. 109-121; Cao & Zhang, 2010, pp. 358-367)
On-time production	(Ramanathan et al.: 2011)
Outsourcing	(Huang et al.: 2015, pp. 23-29)
People management and development	(Akintoye, et al.: 2000, pp. 159-168; Fawcett et al.: 2008, pp. 93-112)
Performance measurement	(Fawcett, et al.: 2008, pp. 93-112)
Plan changing	(Ramanathan & Gunasekaran: 2013, pp. 431-440)
Planning and controlling product design	(Ramanathan & Gunasekaran: 2013, pp. 431-440)
Planning promotion	(Ramanathan & Gunasekaran: 2013, pp. 431-440)
Planning sharing replenishment	(Ramanathan & Gunasekaran: 2013, pp. 431-440)
Power	(Dania et al.: 2018, pp. 851-864)
Price	(Kumar & Banerjee: 2012; Ramanathan & Gunasekaran: 2013, pp. 431-440)
Prioritizing goals and objectives	(Kumar & Banerjee: 2012)
Process efficiency	(Cao & Zhang: 2010, pp. 358-367)
Process and system integration/process management	(Barratt: 2004; Chen, et al.: 2017, pp. 73-87; Soosay et al.: 2008; Horvath: 2001; Dania et al.: 2018, pp. 851-864)
Processes	(Ramanathan: 2014, pp. 210-220)
Product promotion	(Kumar & Banerjee: 2012)
Production and delivery systems	(Herczeg et al.: 2018, pp. 1058-1067)
Purchasing	(Kumar & Banerjee: 2012)
Quality	(Banchuen, et al.: 2017, pp. 109-121; Cao & Zhang: 2010, pp. 358-367)
Redistribution	(Aschemann-Witzel, et al.: 2017, pp. 33-45)
Relationship management and trust-building	(Fawcett, et al.: 2008, pp. 93-112; Chen et al.: 2017, pp. 73-87)
Reliability of supply	(Akintoye, et al.: 2000, pp. 159-168)
Resource sharing	(Ramanathan & Gunasekaran: 2013, pp. 431-440; Cao & Zhang: 2011, pp. 163-180)
Retail and supply chain alteration initiatives	(Aschemann-Witzel, et al.: 2017, pp. 33-45)
Supply chain mapping and role definition	(Fawcett, et al.: 2008, pp. 93-112)
Security capability	(Horvath: 2001)
Shared supply chain processes	(Simatupang & Sridharan: 2004)
Sharing responsibility for product recovery	(Chen et al.: 2017, pp. 73-87; Wegener & Fabrigar: 2012)
Stability	(Dania et al.: 2018, pp. 851-864)
Strategic project definition	(Herczeg et al.: 2018, pp. 1058-1067)
Structural coordination with suppliers	(Vereecke & Muylle: 2006)
Supplier collaboration	(Chen, et al.: 2017, pp. 73-87; Ramanathan et al.: 2011; Vereecke & Muylle: 2006)

Supplier development (e.g., training, support)	(Chen, et al.: 2017, pp. 73-87)
Supplier integration	(Chen, et al.: 2017, pp. 73-87)
Supplier involvement (e.g., product development)	(Chen, et al.: 2017, pp. 73-87)
Supplier monitoring	(Chen, et al.: 2017, pp. 73-87)
Supply chain capabilities	(Liao & Kuo: 2014, pp. 295-304)
Supply chain collaboration exchanges	(Horvath: 2001)
Supply chain metrics	(Barratt: 2004)
Supply-demand agreements	(Herczeg et al.: 2018, pp. 1058-1067)
Technology	(Kumar & Banerjee: 2012)
Top management support	(Akintoye, et al.: 2000, pp. 159-168)
Trust	(Akintoye, et al.: 2000, pp. 159-168; Banomyong: 2018; Barratt: 2004; Chen et al.: 2017, pp. 73-87; Dania et al.: 2018, pp. 851-864)

## METHODOLOGY

### Population and Sample

Dairy co-operatives, the Dairy Farming Promotion Organization of Thailand (D.P.O.), and dairy farmers are key stakeholders 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 pilot group), as follows:

1. Expert interviews: heads of dairy co-operative communities and dairy co-operatives.
2. Pilot study: heads of dairy co-operatives, managers of the Dairy Farming Promotion Organization of Thailand (D.P.O.), academic experts such as veterinary school lecturers working in the dairy industry, Department of Livestock development officers, and veterinarians who are support dairy farms.

### 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 the main experts in the industry and conducted interview sessions with them in 4 regions of Thailand: North-eastern, Eastern, Central, and Western. There were 11 interviews with industry experts, as shown in table 3.

**Table (3).** Experts Interviewed In Each Region.

Region	No. of experts interviewed
North-eastern	2
Eastern	5
Central	3
Western	1
Total	11

**Quantitative Evidence: Pilot Study**

A paper-based pilot group survey was conducted with managers of the Dairy Farming Promotion Organization of Thailand (D.P.O.); academics such as the Dean of Veterinary Science, Walailuck University and the Dean of Veterinary Science, Mahasarakarn University; 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. 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 pilot study had a sample size of 64.

**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 by the researchers.
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 (the 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.

**Pilot Group**

1. Questionnaires from 64 respondents were gathered and tested for reliability statistics by Cronbach's Alpha to support the reliability of the variables.
2. 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) (Wegener & Fabrigar: 2012).

**RESULTS**

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 that are suitable to use for explaining supply chain collaboration in the dairy industry.

**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

Outcomes from expert interviews: the 49 variables were reliability tested with the 64 pilot group samples. The results show that the 49 variables are suitable to explain supply chain collaboration with the Cronbach's Alpha score = 0.954.



Exploratory factor analysis was conducted to understand and identify the constructs from this pilot group. The extraction method was principal axis factoring with rotation method by direct noblemen. The extraction from dimension reduction shows nine constructs extracted. Finally, the 49 variables were refined to 32.

From the test, the Kaiser-Meyer-Olkin measure of sampling adequacy score was 0.541, confirming that the data from the samples were appropriate to be used.

Moreover, 32 variables contributed 84.856%, showing that the quality of the result can be accepted.

**Table (5).** Constructs Developed From Pilot Group Study.

<b>Performances and commitment</b>	Collaborative performance system
	Commitment
	Continuous Improvement
	Delivery schedules
	Maintain operations
<b>Processes</b>	Innovation Innovative supply chain processes
	Integrated information systems Information technology
	Shared supply chain processes
	Sharing responsibility for product recovery
<b>Measurement and evaluation</b>	Mutual sharing interest benefit risks and rewards
	Supply chain metrics
<b>Strategies and direction</b>	Power
	Purchasing
	Stability
	Strategic project definition
	Technology
	Top management support
<b>Internal and external communication</b>	Alliance or conflict resolution
	Demand forecast accuracy forecast accuracy
	Environmental collaboration
	Information sharing
<b>Long term business</b>	Joint problem solving
	Loyalty
	Price
	Quality
<b>Operations</b>	Joint production
	Joint teamwork
	Supply chain collaboration exchanges
<b>Cost reduction</b>	Cost reduction cost

<b>Learning and knowledge</b>	Joint organizational learning
	Knowledge transfer and integration
	Prioritizing goals and objectives

## CONCLUSION

The study shows that the supply chain collaboration factors affecting Thailand's dairy industry constitute 32 variables with nine constructs.

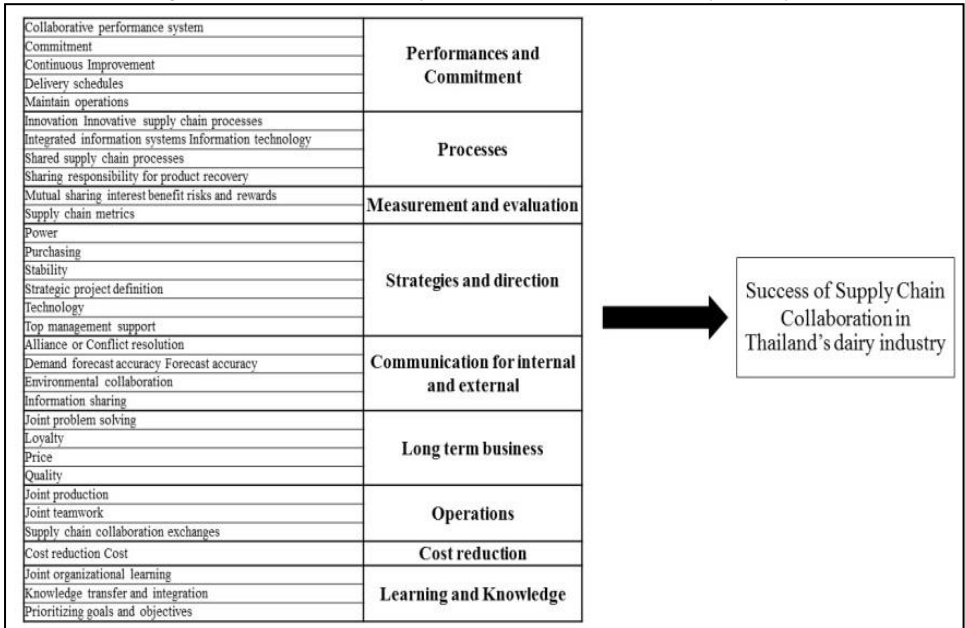
**Table (6).** Comparison Supply Chain Collaboration Constructs.

Authors	Supply chain collaboration constructs
(Chen, et al.: 2017, pp. 73-87)	Internal collaboration Collaboration with supplier Collaboration with customer Collaboration with competitors Collaboration with other organization
(Ramanathan & Gunasekaran: 2014, pp. 210-220)	Collaborative planning Collaborative execution Collaborative decision making
(Cao & Zhang: 2011, pp. 163-180)	Information sharing Goal congruence Decision synchronization Incentive alignment Resource sharing Collaborative communication Joint knowledge creation

As shown in figure 1, the developed framework identifies the key issues for Thailand's milk industry. In comparison with another study (Chen et al.: 2017, pp. 73-87), as seen in table 6, 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 (Cao & Zhang: 2011, pp. 163-180).

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.

**Figure 1.** Framework for Supply Chain Collaboration in The Dairy Industry.



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