

## Collaborative Cassava-Chip Supply Chain Mobile Application in Thailand

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**Abstract**—Cassava-chip is considered one of Thailand's most important economic crops and Thailand is the world's largest cassava products exporter. Thai government is prioritizing the cassava production in their "Mega farm" strategy in support of agricultural economic and collaboration between farmer, public and private sectors. The collaborative model is an integrated supply chain that manages the multiple stakeholders. Moreover, implementing the collaborative supply chain (CSC) has improve overall performance of the entire supply chain. The study aims to review existing literature on collaborative model and critical success factors in the agriculture supply chain context during 2008-2018 and the 20-year agriculture and cooperatives strategy (2017-2036). The six key collaborative success factors are identified: Business Management, Information Technology, Value Added Process, SC Relationship, Top Management Commitment, Partnership, Service Quality, Process, Resource Capability, Environment Uncertainties, Customer Satisfaction. The hypothesis will be tested by the linear regression analysis and develop the prototype of CSC mobile application to create the collaboration in cassava chip industry. Then, the result will be embedded into mobile application. The application will later be used to provide more appropriate third-party system to enhance the collaborative cassava chip supply chain in Thailand. The result shows that all components are supported by the hypothesis and user acceptance test.

**Keywords**—Cassava-chip collaboration, Collaborative Supply Chain, Agriculture mobile application

### 1 Introduction

Agriculture products now become an important role in world economy. Particularly, customer demands such as food and biofuel are produced from crops. Moreover, the supply chain of agricultural products has become a huge issue because the citizen increasingly concerned about the safety of the foods being is consumed. At present, the process of farming, distribution, transportation, and other activities are interested for consumers of agricultural products [1][13][37]. Further, consumer behavior as such involves issues related to public health, which is influenced by existing cases on contaminated products [8].

Thailand has well known its reputation as the leading an abundance of natural resources and global supplier of agricultural products. Cassava is considered as the most important economic crops in Thailand. An industrial crop has well-developed industry and market in the country, [22]. Thailand was ranked as the world's largest cassava products exporter with 33 million tons of annual production in 2016 which providing about 67% of the world market [27]. The cassava processing extends primary products to flour by chips and pellets in Thailand which is further processed into high value-added flour derivatives products. Furthermore, if the increasing demand of a cassava product is not supported by a good post-harvest handling, cassava waste would be a problem. Cassava wastes are possible to produce from harvest wastes. Those wastes might be potentially important resources if handled properly [9][16][23][24].

Increasing the efficiencies in a cassava supply chain is important to increasing productivity and reducing problems. Creating a more efficient supply chain involves productive engagement of the functional units in the supply chain and how the information around these units is managed. One of the ways to improve the efficiency in the cassava supply chain is the use of mobile application technology [10]. Mobile application technology in diverse business situations is growing in many developing countries; it provides different opportunities to transfer information and knowledge among players in the supply chain including the government. The use of mobile phones was initially mainly for urban residence but has found social and economic usefulness for the rural populace to obtain information on weather, market and other related issues [1] [7]. Although mobile applications rapidly proliferate, the complicated of application contents still be concerned [28] and how we can leverage the efficiency of mobile application to best serve users [14].

The paper is structured into six sections. In the second section, a review of the existing background literature on CSC and cassava chip industry in Thailand are presented. In the third section, a methodology is presented. The fourth section will show a result and adapt mobile application. Finally, the last section discussion and conclusion with proposed future research.

## **2 Literature Review**

One of the reasons why Thailand Government are supporting Cassava Ship because the Country is the world's largest cassava products exporter. Thus, it is essential to develop mobile application technology that is workable for cassava supply chain. Not only will help researchers better understand a Collaborative Cassava-Chip Supply Chain Mobile Application in Thailand (CCSC) setting, but it will also set a framework that will serve as a tool for farmers. In this section, current cassava chip industry in Thailand, the definition of collaborative supply chain and existing CSC frameworks in the literature are reviewed.

## 2.1 Current cassava chip industry in Thailand

Use Cassava chip factories are small-scale enterprises which belong to farmers or small businessmen and are located in close proximity to the growing area. The chipping factories are installed with simple equipment, consisting mainly of a chopper. Roots are loaded into the hopper of the chopping machine by a tracker; after chopping into small pieces, the chips are sun-dried on a cement floor. The final moisture content of chips should be below 14% and the sand content should not exceed 3%. Normally it takes 2.00-2.50 kg of fresh roots (with 25% starch content) to produce 1 kg of chips (14% moisture content). Chips are sold to pelletizing manufacturers who either directly export the chips/pellets or sell to traders. In most cases, the small chip factories sell their products to large factories that in turn sell a consolidated consignment to pellet manufacturers. Some portions of cassava chips are used locally for animal feed, as well as feedstock for producing bioethanol, an environmentally friendly, alternative energy for liquid fuel use as a blend with gasoline, i.e. gasohol in the transportation sector. In addition, the biofuel program being established in some countries, in particular China, has driven a marked increase in the export volume of cassava chips. As the high starch content of cassava chips is of value for biotechnological conversion, the demand for chips for this industry is still very promising [29].

Recently, the demand of cassava chips in Thailand has increased dramatically as a result of the national policy of bioethanol production for fuel uses [22]. To produce ethanol from cassava, the starch is initially converted to fermentable sugars, mainly glucose by enzyme or acid process. The sugars are then fermented to ethanol by yeast. To produce 1 liter of anhydrous ethanol, around 2.5 kg of dried chips (65% starch content, wb) are required; the conversion ratio, however, varies depending on processing efficiency; the most widely used process is Simultaneous Saccharification and Fermentation [33].

For production, Thailand's average growth rate of cassava planted area, harvested area and production from 2012-2017 reaching to 0.45, 0.36 and 0.95 % respectively [27]. Moreover, in 2017 Thailand has about 322 drying yards (cassava chip producer), and most of Thai manufacturers have high experience, knowledge including hi-tech machineries, and from market side, Thailand exports more than 85% of cassava chips while the rest is consumed domestically in ethanol, chemical and animal feed industry. Furthermore, according to [6], in 2018, Thailand is the biggest cassava exporter in the world with 53 percent of market share, and it has the highest exporting cassava chip value in the world with proportion of 90.52%. Thai cassava chip is mostly exported to China in 99.35% also. Therefore, the export of cassava chip plays the important role in Thailand especially to China [33].

## 2.2 Definition of Collaborative Supply Chain (CSC)

CSC refer to two or more independent companies plan to work together in order to execute supply chain operations with improve quality industry or success than when acting in individual. CSC relevant definitions can be identified by many researchers. [18][21] suggest a particular degree of relationship among chain members as a means

to share risks and rewards that result in higher business performance than would be achieved by the firms individually. [3] reports that logistics alliances offer opportunities to dramatically improve customer service and at the same time lower distribution and storage operating costs. [25] CSC defines as the cooperation among firms to allocate resources and capabilities to reach their customers’ needs.

CSC also results in performance improvement in the supply chain [5][35][36]. In demand chain management, the supply chain structure when aligned as per the needs of the customer would result in better performance. Hence there is a need to have tight integration of supplier and customer to make a supply chain successful [36][37]. In addition, firms should build collaborative relationships with their supply chain partners in order to achieve efficiencies, flexibility, and sustainable competitive advantage [15] [26].

### 2.3 Review of existing CSC frameworks

Previous literature reveals that there are various perspectives being used to describe a CSC Framework (Table 1). Some perspectives in one model are overlapped with others.

**Table 1.** Literature Review on CSC Framework

Component	Description	Literature review
Business Management	Managerial initiatives, Management capability, Organizational involvement Corporate culture; Quality leadership. Top management support managerial understanding, Role of organization, Organizational commitment, Management support.	[3][6][13][19][34]
Information Technology	Effective use of ERP and MRP system, Technology capacity, Quality of IT system, Reliability of hardware and software, IT strategy orientation, Application of information technology, Technological capability, ICT, Strategic use of IT.	[2][4][5][11][15][16][17][20][24][32][35][37][38]
Value Added Process	Key business process reengineering, Just-in-Time (JIT) methodology, Comprehensiveness flexibility, Outsourcing non-core activities Product recycling, Re-engineering material flow, Customer complaint management, Material flow management, Automation of authorization workflow, life cycle management, Redesign of the procurement process.	[2][5][12][13][17][32][35]
SC Relationship	Supply chain integration, Collaboration with partners, Supplier relation, Supplier management, Partnership with suppliers, Embracement of supplier, Business IT partnership, Customer-supplier relationship, Service relationship elements, Channel relationship, Inter-firm collaboration, Interdependent cooperation Standardizing and integration, Supply chain partnership selection,	[2][11][12][13][15][16][20][23][30][31]
Environment Uncertainties	Policies, Competitive nature, Clear goals,	[13][16][23]

Component	Description	Literature review
	Customer focus, Market competence, Compatible goals, Government policy; Pressure from competitors, Perceived usefulness, Regulation, Support activation.	
Customer Satisfaction	Customer support, On-time delivery; Data quality, Superior product quality; Quality improvement, System quality; Quality management capability, Information quality; Service quality, Primary customer loyalty, Work performance quality, Service quality.	[2][5][7][13]

### 2.4 Proposed CCSC

From the literature review was provided in the previous section, those prior six components should be performed to be collaborative framework for cassava chip supply chain in Thailand. The collaborative components are business management, information technology, value added process, SC relationship, environment uncertainties, customer satisfaction. Therefore, this research was conducted by using a quantitative survey to verify on whether these components are contributing to the collaborative model which will influence the successful performance of chip supply chain in Thailand. Six hypotheses are developed for verifications. The research framework is presented in Figure 1, the details are described in Table 2 followed by Hypothesis.

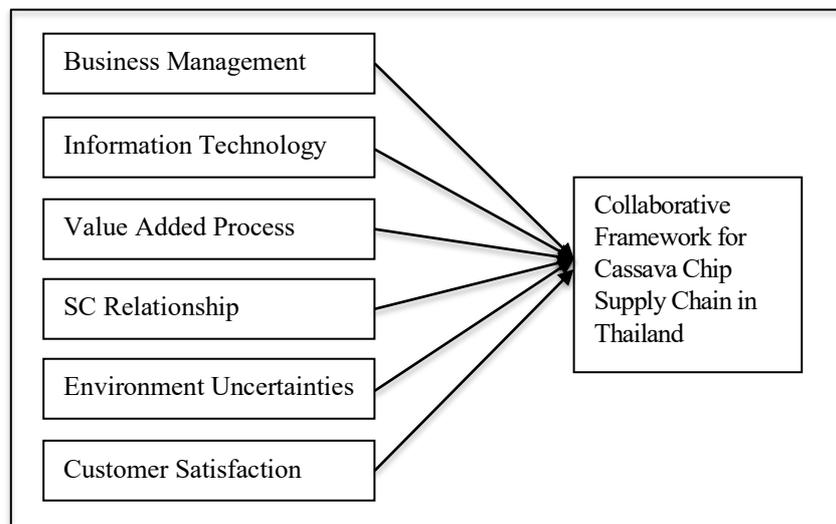


Fig. 1. CCSC Framework

The details in each component such as Business Management, Information Technology, Value Added Process, SC Relationship, Environment Uncertainties, Customer Satisfaction will be shown in table below;

**Table 2.** CCSC Framework description in Thailand

Components	Description
Business Management	Top management commitments are vital as the push organizational reach goals, and to incite the employees, they must force employee to motivate with the organization’s business objectives.
Information Technology	Information system will improve efficiency and effectiveness, ensuring accurate information, and improving communication
Value Added Process	Value added process are to improve their company and result business performance states that process improvement need identify an objectives, policies and assignation for the plan’s implementation.
SC Relationship	SC Relationship such as trust and partnership will indefinitely ease supply chain adoption among firms and stakeholders.
Environment Uncertainties	Governmental factor can be defined as critical success factor. Which all stakeholder will pay more attention on government-related activities such as regulations, policies, or certification.
Customer Satisfaction	To efficient-scale facilities by cost minimization, cost reductions in payment, and cost saving then, company will give more satisfaction and profit.

Therefore, all components of CCSC can be identified as 6 hypothesizes;

**Hypothesis 1:** Business Management influence cassava chip supply chain in Thailand competency which will encourage a successful CCSC.

**Hypothesis 2:** Information Technology influence cassava chip supply chain in Thailand competency which will encourage a successful CCSC.

**Hypothesis 3:** Value Added Process influence cassava chip supply chain in Thailand competency which will encourage a successful CCSC.

**Hypothesis 4:** SC Relationship influence cassava chip supply chain in Thailand competency which will encourage a successful CCSC.

**Hypothesis 5:** Environment Uncertainties influence cassava chip supply chain in Thailand competency which will encourage a successful CCSC.

**Hypothesis 6:** Customer Satisfaction influence cassava chip supply chain in Thailand competency which will encourage a successful CCSC.

### 3 Methodology

In order to come up with a proposed CCSS framework and hypothesis verification process, this research comprise of the three stages outlined below (sections 3.1 to 3.3).

#### 3.1 Literature review

Review the existing CSC with adopted for conducting CCSC Framework with six components; business management, information technology, value added process, SC relationship, environment uncertainties, customer satisfaction that focus on the Cassava-Chip Supply Chain.

### **3.2 Survey questionnaire**

Survey questionnaires created from reviewing components of proposed CCSC were distributed and collected from 350 participants referred to CCSC in Thailand. The sample focused on farmers, banks and service providers as stakeholders in the supply chain. Questionnaire in Thai language is consisted of 3 parts:

- Demographic data of the respondent
- Five points Likert-scale rating of 6 components that are perceived to be usable for assessing the hypotheses

The sample focused on cassava chip farmers and agricultural services. The data collection occurred during October 2018 to February 2019 using a questionnaire with a five-point Likert scale. The questionnaire was sent directly to participants who responded through a survey by e-mail and was sent to participants that had not answered the survey

- Open-ended remarks and suggestions

Responses from Part 3 are used to develop CSCS mobile application of the study. The questionnaire was sent directly to participants who responded through a survey by e-mail and was sent to participants that had not answered the survey. the result analyzes relation through the linear regression analysis using SPSS.

### **3.3 CCSC mobile application development**

Develop an CCSC in Thailand using Android version 5.2, Visual Studio 2015, WordPress 4.9.x on SQL Server 2012, jQuery, HTML, Java script and Chart were to be a CCSC mobile application installed.

## **4 Result**

Budiman, R. (2013). Utilizing Skype for providing learning support for Indonesian distance Survey questionnaires created from reviewing components of proposed CCSC framework were distributed and data collected from 298 participants referred to CCSC in Thailand. The response rate was 298 participants from 350 (85%) participants.

The result will be depended on methodology by using Linear Regression Analysis. This research used linear regression models to test the components of CSC framework. This analysis validated our instrument and the multi-item scales, as shown in the Appendix. Testing hypothesis will be demonstrated further validation.

### **4.1 General information**

The total respondents were 298 persons; 177 (59.4%) were male and 121 (40.6%) were female. the highest of respondents aged between 36-45 years old were 158 per-

sons (53%) followed by age of 26-35 years old were 79 persons (26.5%), over 45 years were 50 persons (16.8%) and aged under 26 years old equal 11 persons (3.7%). Furthermore, most respondent had a master degree with 207 persons (69.5%).

#### 4.2 Testing hypothesis

From the research output of Linear Regression Analysis (see appendix), the components of CCSC will be demonstrated in the table 3.

**Table 3.** Descriptive Statistics

Components	Mean	Std. Deviation	N
CSC	4.51	.501	298
Business Management	4.53	.501	298
Information Technology	4.53	.500	298
Value Added Process	4.56	.498	298
SC Relationship	4.57	.496	298
Environment Uncertainties	4.33	.476	298
Customer Satisfaction	4.77	.501	298

The result from Linear Regression Analysis used SPSS to test hypotheses. It can be synthesized into three groups of result. The first group with the highest priority is Customer Satisfaction have the highest average equal to 4.77 with standard deviation 0.496, a statistical significance of 0.00 is less than 0.05. The second group with medium priority comprises SC Relationship, Value-Added Process and Information Technology equal to Business Management which has an average of 4.57 with standard deviation 0.496, 4.56 with standard deviation 0.498, 4.53, deviation of 0.500 and 501, this group has statistical significance less than 0.05 respectively. The last group with minimum priority is Environment Uncertainties is lowest average equal to 4.33 with standard deviation 0.476, a statistical significance of 0.03 is less than 0.05. It was clear that all components were supported the hypothesis.

## 5 Discussion

This research aimed to study a component of CSC which supported implement CSC in Thailand by investigating the relations between six components such as business management, information technology, value added process, SC relationship, environment uncertainties, customer satisfaction with CSC Model, a statistical significance need to less than 0.05. The result clearly demonstrated that all components were supported the hypothesis by statistical result that described below related output of Linear Regression Analysis.

This research also aims to develop the prototype of CCSC mobile application to create the collaboration in cassava chip industry. All components are also needed to support cassava chip stakeholder such cassava chip farmer, agricultural co-operative, agricultural service provider, buyer. The mobile application should be developed to

create the supply chain relationship with cassava chip stakeholders. The CCSC mobile application prototype was developed based on six components. Users in mobile application are divided into five main groups are 1) Cassava chip farmer, 2) Agricultural co-operative, 3) Agricultural service provider, 4) Buyer, and 5) Application administration. The cassava chip farmer interfaces show personal and geo-information (see Figure 2).



Fig. 2. CCSC mobile application prototype

The CCSC mobile application allows agricultural service providers to add their services with service cost to the system. It also allows agricultural co-operative and buyer to add their contact and information for farmer selling their cassava chip. All of activities can be chosen by cassava chip farmer in mobile application which is managed by administrator (see Figure 3).

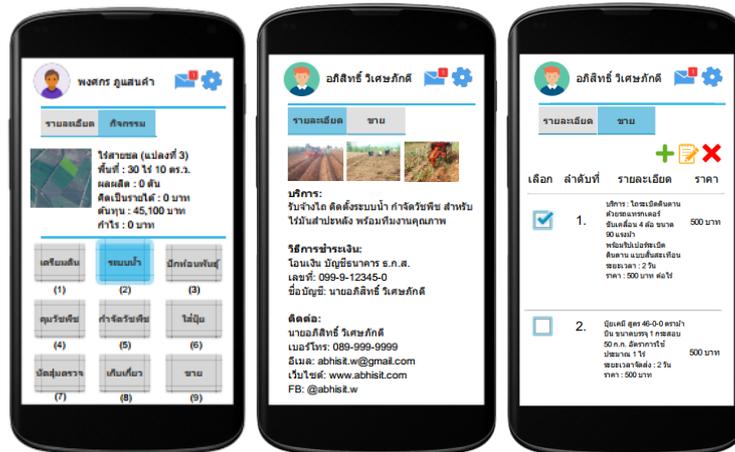


Fig. 3. Collaborative activities in CCSC mobile application

## 6 Conclusion

The concept of CCSC is a collaboration of stakeholders in cassava chip to increase farmer income in Thailand. However, there is no research identifying components and develop to mobile application which becomes the key activity to transform the previous farmer work process to a farmer digitalized process this research proposed a new workable CCSC, developed from Linear Regression Analysis that derived six components.

This research can be concluded that the research contributes useful information to cassava chip supply chain especially cassava chip farmers in Thailand on what components can be used for influent CSC model in the supply chain. The result was clear that all components such as business management (H1), information technology (H2), value added process (H3), SC relationship (H4), environment uncertainties (H5), customer satisfaction (H6) by statistical result in this research. However, due to its importance, researchers think that it should still be included as the part of CCSC. Finally, the prototype of CCSC mobile application was developed based on regression analysis. The mobile application can use for collaboration of cassava chip supply chain. The application will be a paradigm shift of cassava chip farmer in Thailand and the process result will be more accurate.

However, this research limit to cassava chip in Thailand and the result for all components was a comparatively rough scale for statistical analysis. Moreover, recommendation for practice and future research, for the practice should use technology acceptance model to measured users' attitudes of the model and the perceived usefulness of the model. For future researchers should expand and further study on scale for other agriculture in Thailand such as palm oil and rice

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## 9 Appendix

**Table 4.** Linear Regression Analysis Result

Model		Unstandardized Coefficients	Standardized Coefficients	Beta	t	Sig.
		<i>B</i>	<i>Std. Error</i>			
1	(Constant)	-.185	.369		.500	.617
	CSC	.520	.037	.520	14.03	.000
	Business Management	.098	.037	.097	2.671	.002
	Information Technology	.643	.219	.638	2.931	.004
	Value Added Process	-.126	.037	-.125	-3.406	.001
	SC Relationship	.582	.044	.545	13.292	.000
	Environment Uncertainties	-.133	.044	-.113	-3.016	.003
	Customer Satisfaction	-.229	.053	-.229	-4.278	.000

Linear Regression Analysis  
Model Summary<sup>b</sup>

Model	R	R Square	Adjusted Square	Std. Error of the Estimate
1	.809 <sup>a</sup>	.654	.643	.299

a. Predictors: (Constant), Business, InfoTech, valueAdded, SCrelation, Environment, Customer

b. Dependent Variable: CSC

ANOVA <sup>a</sup>					
Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	48.717	9	5.413	60.495	.000b
Residual	25.770	288	.089		
Total	74.487	297			

a. Dependent Variable: CSC

b. Predictors: (Constant), Business, InfoTech, valueAdded, SCrelation, environment, customer