

## **The Impact of Structure of Interdependence on Supplier Performance in the Local Pineapple Processing Supply Chain in Thailand: a Mixed Method Research\***

P.T. Thongrattana  
Industrial Engineering Department  
Faculty of Engineering, Kasetsart University  
Bangkok, Thailand  
[fengprt@ku.ac.th](mailto:fengprt@ku.ac.th)

K. Aimdate  
Quality Assurance and Quality Control Department  
TT CORPORATION CO.,LTD,  
Bangkok, Thailand  
[chocol\\_taw@hotmail.com](mailto:chocol_taw@hotmail.com)

S. Wongweragiat  
Industrial Engineering Department  
Faculty of Engineering, Kasetsart University  
Bangkok, Thailand  
[suewongweragiat@gmail.com](mailto:suewongweragiat@gmail.com)

**Abstract**— This research aims at studying the impact of the interdependence structure of a local pineapple processing supply chain on supplier performance, which may help increasing value of low-grade pineapples. The study utilizes a mixed research methodology between quantitative and qualitative methods designed to enhance the cause and effect of the research outcomes. The sample groups are consisted of pineapple farmers, middle men, local processors and retailers in Prachuap-Khiri-Khan Province, Thailand.

The results from the quantitative method show that the interdependence structure has a positive effect on supplier performance. Total interdependence has more influence than dependence asymmetry does, in connection with improving supplier performance. According to interviews with the following four groups of participants, pineapple farmers, middle men, local processors and retailers, the ones who have total interdependence with their regular customers have high performance. The total interdependence creates trust among supply chain members, leading to regular pineapple purchases after launching to the market. This should be beneficial to suppliers because their inventory of fresh pineapples can be substantially reduced, while customers may be confident in quality, taste and price of fresh pineapples. This study may be served as guidance for developing an interdependence structure within the supply chain. Moreover, it may contribute to supplier performance improvement in different aspects, such as product quality, agreement on cost and service in fulfillment of the current and future demands.

**Keywords**—Pineapple Supply Chain, Mix research method

### I. BACKGROUND AND MOTIVATION

In current business condition, every supply chain has faced high competition in market. Their performance need to be improved to survive. Not only general supply chains, an agricultural supply chain is also on this same situation. Supplier performance is one important factor to maintain the whole supply chain performance and competitive advantage. Many previous researches have attempted to recognize factors that can improve supplier performance. The structure of interdependence that exists in the buyer-supplier relationship can affect supplier performance. The nature of interdependence is characterized by the structure of reciprocal dependence between two supply chain members, where dependence refers to one firm's need to maintain a relationship with another firm in order to achieve desired goals [1]. The supplier performance can be improved through the high level of total interdependence in the relationship with their customers. This is because the relationship is motivated to develop a cooperative long term relationship [2].

The pineapple processing supply chain is nominated as it can add value to a low grade of fresh pineapple. The pineapple is processed in local area as it can reduce transportation cost and time. This supply chain also can bring revenue in the local people. Moreover, a strategy of ministry of agricultural and cooperatives in year 2010-2014 had supported to develop cropping, processing and exporting pineapple sustainably. In preliminary data, the supplier performance is quite low as they face uncertainty yield and price of fresh pineapple in each year. This should be improved to meet requirement of ministry of agricultural and cooperatives. Prachuap-Khiri-Khun Province is a sample in this research as 43 percentage of total pineapple crop in this province.

Therefore, the aim of this paper is to identify the impact of the interdependence structure of a local pineapple processing supply chain on supplier performance. To achieve this research objective, a survey method is applied. The result of the survey method is guided to develop qualitative research method. The aim is to more understand to support the interdependence structure existing in this chain.

## II. CONCEPTUAL FRAMEWORK

The conceptual framework is proposed as a way of analysing the causal relationships among two main constructs (Fig. 1).

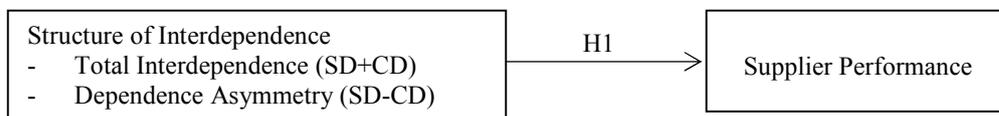


Fig. 1. A conceptual framework of the impact of the interdependence structure of a local pineapple processing supply chain on supplier performance

Fig. 1 presents the conceptual framework of this study, setting out the relationship between two constructs that are a major focus on this paper: interdependence structure and supplier performance

The structure of interdependence consists of total interdependence and dependence asymmetry. The former is an important factor to raise higher degree of partnership developing between two supply chain members which can improve supplier performance [3]. The sum of both firms' dependence is applied to measure the total interdependence (supplier dependence + customer dependence). The latter is found that can harm the development of partnerships as it leads to take exploitation between each other and unstable relationship [2]. This will reduce supplier performance and the whole supply chain performance. The level of dependence asymmetry is measured by the difference between suppliers' dependence on its customers and the customers' dependence on its suppliers (supplier dependence - customer dependence) [3]. Supplier performance in this research is focused on only cost return and business growth according to purchasing with their regular customers [4].

In the local pineapple supply chain in Prachuap-Khiri-Khan Province, Thailand, both structures of interdependence are exists but no evidences to confirm that they can improve or reduce supplier performance as found in previous research. To improve supplier performance in this chain, the following hypothesis is proposed: H1: The higher the level of structure of interdependence, the higher the level of supplier performance.

## III. RESEARCH METHODOLOGY

This research employs a mix research method in the explanatory sequential design that can be divided into two phases: a quantitative and qualitative method.

### A. Phase I

The quantitative research method has been selected with the suggested use of four criteria for maintaining efficient research: internal validity, external validity, reliability and objectivity [1, 5]. The impact of the interdependence structure of a local pineapple processing supply chain on supplier performance is tested by a survey method. The five-point Likert scale of questionnaire was adapted from [3] and [4]. However, as the questionnaire is translate from English to Thai language, pre-

testing with a group and a redesigning of the questionnaire is required in order to improve the quality of the answers Sekaran [6]. The pilot study was performed and the questionnaire was improved following the comments from the pilot-study participants.

A number of statistical techniques are employed to test assumptions and hypotheses in the framework. Two main types of statistical techniques are implemented in this study: validation and reliability of measures, and Partial Least Square Path Modeling (PLS).

1) *Sample and data collection*: Data were collected in March-April 2014. The 620 questionnaire were sent to pineapple farmers, middle men, manufacturers, processed pineapple retailers in Prachuap-Khiri-Khan Province, Thailand. The 252 questionnaires were returned, resulting a response rate of nearly 42.06% as shown in Table 1.

TABLE 1: The sample size of this research

Sample	The number of questionnaires	The returned questionnaires
Farmers	450	167
Middle men	70	20
Manufacturers	30	16
Retailers	70	14
<b>Total</b>	<b>620</b>	<b>217</b>

2) *Noparametric statistics*: As sample size is divided into 4 groups: farmers, distributors, processors, and retailers, the return questionnaires can be combined by Kruskal-Wallis H Test. The hypothesis is at least one population is different from others. The result of this test at  $\alpha=0.01$ . This hypothesis is rejected that the four population is not different. Therefore, the four sample size can be combined to be one sample size [7].

3) *Validation and reliability of measures*: Validity is the ability of a construct's indicators to measure accurately the concept under study [8]. Meanwhile, Reliability is "the consistency of a measure of a concept" [9, p71]. Reliability is concerned with the extent to which any measuring procedure yields the same results on repeated trials [10].

a) Convergent validity is indicated when there is a high correlation between measurement scores attained using two distinct instruments measuring the same concept [6, 11, 12]. Average Variance Extracted (AVE) is measured for convergent validity.

b) Discriminant validity of a reflective construct is assessed by Corrected Item-Total Correlation, which should be higher than 0.3 [13].

c) Cronbach's alpha is a scale reliability of internal consistency [14], which should be higher than 0.6.

d) Composite reliability is of more than 0.6 denotes an acceptable level of reliability [15]. The proportion of variance ( $R^2$ ) and factor loading of each measurement item (observed item) assess unidimensionality

The results of validity and reliability of the structure of interdependence (supplier dependence (SD) and customer dependence (CD)) and supplier performance (SP) are shown in Table 2, 3 and 4.

TABLE 3: Validity and Reliability Test of Supplier Dependence.

Variable	Corrected Item-Total Correlation	$R^2$	Factor Loading	Cronbach's Alpha	Composite Reliability	AVE
SD1	0.43	0.34	0.60	0.68	0.83	0.50
SD2	0.38	0.22	<u>0.47</u>			
SD3	0.53	0.43	0.66			
SD4	0.51	0.37	0.61			
SD5	0.34	0.22	<u>0.48</u>			

In Table 3, almost value of supplier dependence's validity and reliability test is in acceptable range, but SD2 and SD 4 have factor loading less than 0.5. However, the factor loading is 0.47-0.48 that is nearby 0.5 considering acceptable. Table 4 shows all validity and reliability of customer dependence are in acceptable range. Finally, validity and reliability test of supplier performance is performed very well.

TABLE 4: Validity and Reliability Test of Customer Dependence.

Variable	Corrected Item-Total Correlation	R <sup>2</sup>	Factor Loading	Cronbach's Alpha	Composite Reliability	AVE
CD1	0.58	0.48	0.69	0.76	0.80	0.50
CD2	0.53	0.37	0.61			
CD3	0.65	0.65	0.81			
CD4	0.49	0.33	0.57			

TABLE 5: Validity and Reliability Test of Supplier Performance.

Variable	Corrected Item-Total Correlation	R <sup>2</sup>	Factor Loading	Cronbach's Alpha	Composite Reliability	AVE
SP1	0.62	0.49	0.70	0.88	0.90	0.50
SP2	0.54	0.27	0.52			
SP3	0.61	0.44	0.66			
SP4	0.65	0.55	0.74			
SP5	0.68	0.57	0.75			
SP6	0.64	0.51	0.71			
SP7	0.55	0.28	0.53			
SP8	0.65	0.38	0.62			
SP9	0.68	0.41	0.64			

4) *Partial Least Square Modelling (PLS-SEM)*: In the growing literature that discusses SEM, there is no complete guide to choosing the most appropriate form. Covariance-based SEM procedures, such as maximum likelihood, are theory-oriented, and emphasise the transition from exploratory to confirmatory analysis. PLS is primarily intended for causal-predictive analysis in situations of high complexity but low theoretical information [16]. In this study, PLS is employed because PLS can avoid the problem of small sample size [17]. The sample size of this study is 250 that is quite small. According to [18], the sample size of this research should be 10-20 times of the number of variables, or at least 180-360 samples.

#### B. Phase II

The qualitative research method is useful for comprehending the problem setting and focusing on culture, meaning or subjectivity. The explanatory sequential design starts with a survey method and then an interview method to clearly understand the result of this research. When the hypothesis in quantitative method is significantly supported, the semi-structured interview is applied to explain how the total independence can be developed in this supply chain. This will be policy recommendations for official and government in the future. The participants are ten farmers, nine middle men, seven manufacturers, and six retailers in Prachuap-Khiri-Khun Province. They are in local processing pine apple more than ten year. Some questions during interviewing is prepared and the interviewee will be asked questions to clearly answer from interviewers.

The questions are divided into three groups. First, the questions ask participants about type of structure of interdependence. This can clearly understand their situation under asymmetry or total interdependence. Then it can show relationship between their structure of interdependence and their performance. Secondly, the questions focus on the benefits of structure of interdependence that exist in participant's business. Lastly, the question relates to guideline how to develop total interdependence in this chain.

IV. RESULTS

The results from both methods: survey method and interview methods in following.

A. Hypothesis testing

The PLS algorithm and bootstrapping methods provided in SmartPLS software are applied to experiment with the hypothese. The result is presented in Fig 2.

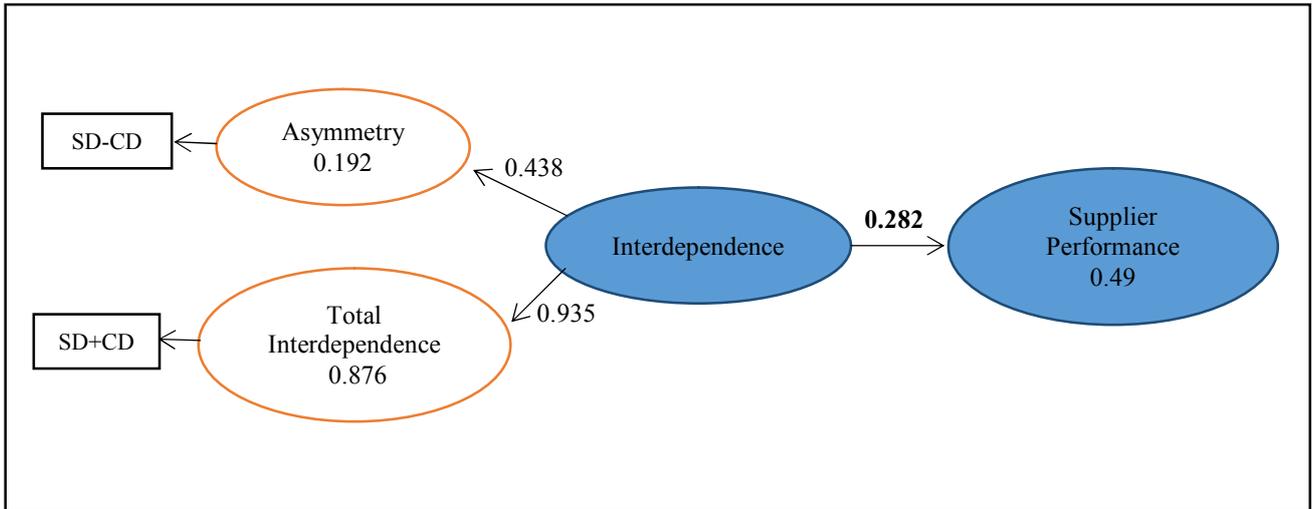


Fig 2. The Proposed Model – PLS Path Modeling

TABLE 6: Result for Proposed PLS-SEM

Hypothesis	Path coefficient	t-statistics
H <sub>1</sub> : structure of interdependence → Supplier performance	0.28	20.56*

\* t = 1.96 at α < 0.05.

Path coefficient is 0.282 and t = 20.56 are found to be significantly positive as shown in Table 6. The relationship between the structure of interdependence and supplier performance is significantly supported. Considering to the structure of interdependence, total interdependence is more affected than dependence asymmetry with path coefficient 0.935 and 0.438 respectively.

B. Interview Result

After interviewing ten farmers, nine middle men, seven manufacturers, and six retailers in Prachuap-Khiri-Khun Province, the results can be summarized:

- Farmers and middle men mainly have a closed relationship and total interdependence. They attempt to achieve the goal of business that add value and meet customer requirement. Therefore, some problems such as low quality of pineapple or uncertain amount and time of fresh pine apple launching to a market are cooperated between farmer and milled men to handle.

- Middle men and local manufacturers trend to have dependence asymmetry because local manufacturers require low cost of fresh pine apple. Therefore, local manufacturer try to purchase fresh pine apple with lowest cost. This mean that each year the local manufactures will purchase pine apple with different middlemen.
- Local manufacturers and retailers have a closed relationship as same as farmers and middle men. This is because retailers want high quality and good taste of processing pineapple that should purchase with regular manufacturers.

As the total interdependence can improve supplier performance, according to interview method there are three factors that can support these chain members to develop the total interdependence.

- Quality of pineapple: A good quality of pineapple meeting customer requirement will bring customers repeating order in every year. This can change irregular customers to be regular customers and then lead to long term relationship.
- Price commitment: In every year, suppliers concern about price of fresh pineapple because it is fluctuated. Over supply and low quality lead to low price. If suppliers can maintain high quality of product, customer also can commit the minimum price. This win-win situation starts to build the total interdependence and closed relationship.
- Transportation support: As fresh pineapple have a limited life cycle, a supplier who can provide vehicles to transport fresh pineapple from farm to suppliers' inventory

## V. CONCLUSION

This study supports the study of Rachel S. Duffy (2008) that the interdependence structure has a positive effect on supplier performance by the quantitative research method. Total interdependence as a part of the interdependence structure can improve supplier performance because it leads to long term relationship in this chain. Therefore, to support total interdependence in the local pineapple processing supply chain, the qualitative research method is performed. The results from interviewing with the four groups of participants, pineapple farmers, middle men, local processors and retailers show three factors: quality of pineapple, price commitment and transportation support. Farmers should improve or remain high quality of fresh pine apple lead to customers' royalty and then long-term relationship. A minimum price of fresh pineapple should be guaranteed by regular customers. Finally, fresh pineapple delivery should be operated by customers at a farm. This may contribute to supplier performance improvement. Like all other studies, this study has some limitations. The sample size is very small compared with the population, and focused only on one province in Thailand.

## REFERENCES

- [1] G. frazier, "On the measurement of inter-firm power in channels of distribution.," *Journal of Market Research*, vol. May, pp. 158-166, 1983.
- [2] C. Yilmaz, B. Sezen, and O. Ozdemir, "Joint and Interactive effects of trust and (inter) dependence on relational behaviors in long-term channel dyads," *Industrial Marketing Management*, vol. 34, pp. 235-248, 2005.
- [3] R. S. Duffy, "Toward a better understanding of partnership attributes: An exploratory analysis of relationship type classification," *Industrial Marketing Management*, vol. 37, pp. 228-244, 2008.
- [4] S. A. Cai, Z. Yang, and M. Jun, "Cooperative norms, structural mechanisms and supplier performance: Empirical evidence from Chinese manufacturers," *Journal of Purchasing & Supply Management*, vol. 17, pp. 1-10, 2011.
- [5] N. K. Denzin and Y. S. Lincoln, *The SAGE handbook of qualitative research*: Sage Publications, 2005.
- [6] U. Sekaran, *Research methods for business : a skill-building approach*, 4th ed. New York: Wiley, 2003.
- [7] S. Siegel and C. N. John, *Nonparametric Statistics for The Behavioral Sciences*. New York: McGraw-Hill, 1998.
- [8] J. F. Hair, R. E. Anderson, R. L. Tatham, and W. C. Black, *Multivariate data analysis: with readings*, 4th ed. Englewood Cliffs, NJ: Prentice-Hall, 1995.
- [9] A. Bryman, *Business research methods*. Oxford: Oxford University Press, 2003.
- [10] E. G. Carmines and R. A. Zeller, *Reliability and validity assessment*. Beverly Hills, CA: Sage Publications, 1979.
- [11] W. M. K. Trochim and J. P. Donnelly, *The Research Methods Knowledge Base*, 3rd edition ed.: Thomson Custom Pub, 2006.
- [12] D. Straub, M.-C. Boudreau, and D. Gefen, "Validation guidelines for IS positivist research," *Communications of the association for Information System*, vol. 13, pp. 380-427, 2004.
- [13] A. P. Field, *Discovering statistics using SPSS*. London: Sage Publications, 2009.
- [14] G. A. Churchill, "A Paradigm for Developing Better Measures of Marketing Constructs," *Journal of Marketing Research*, vol. 16, pp. 64-73, 1979.
- [15] M. Piliyakun, "PLS Partial Least Square Path Model," presented at the เอกสารประกอบการประชุมวิชาการสถิติและสถิติประยุกต์, Thailand, 2010.
- [16] K. G. Joreskog and H. Wold, "The ML and PLS Techniques For Modeling with Latent Variables: Historical and Comparative Aspects," in *Systems Under Indirect Observation: Causality, Structure, Prediction*. vol. 1, K. G. Joreskog and H. Wold, Eds., ed North-Holland, Amsterdam, 1982, pp. 263-270.

- [17] J. Henseler, C. M. Ringle, and R. R. Sinkovics, "The Use of Partial Least Squares Path Modeling in International Marketing," in *Advances in International Marketing*, vol. 20, R. R. Sinkovics and P. N. Ghauri, Eds., ed Bingley: Emerald 2009, pp. 277-320.
- [18] R. E. Schumacker and R. G. Lomax, *A beginner's guide to structural equation modeling*. Mahwah NJ: Lawrence Earlbaum, 1996.

#### BIOGRAPHY

Phatcharee Toghaw Thongrattana is a full-time lecturer in the Department of Industrial Engineering at Kasetsart University, Bangkok, Thailand. She earned a B.S. degree in Industrial Engineering from Suranaree University of Technology, Thailand., M.S.degrees in Industrial Engineering from Kasetsart University, Thailand, and Ph.D degree in Supply Chain Management from Wollongong University, Australia. Her research interests are agricultural supply chain management, inventory control and operation research.

Aimdate Kritsana is a Quality Assurance Engineer at air operates assembly plants, Thailand. She holds a Bachelor of Industrial Engineering degree from Srinakarinwirot University, Master of Industrial Engineering degree from Kasetsart University. She has published conference papers at Industrial Engineering Network (IE network) 2015. She has done thesis with Dr. Patcharee Tokeaw Thongrattana about Thai Local Pineapple Supply Chain at Prachupkirkhan Province. Her research interests include supply chain management, manufacturing. She is a member of Council of Engineers and gets Licensed for Professional Practice (Associate: Industrial Engineer).

Sudaratana Wongweragiat is a full-time lecturer in the Department of Industrial Engineering at Kasetsart University, Bangkok, Thailand. She earned a B.S. degree in Operations Research and Industrial Engineering from Cornell University, U.S.A., and M.S./Ph.D. degrees in Industrial Engineering from Purdue University, U.S.A. She has published journal and conference papers. She has completed a research project with Western Digital (Thailand) Co.Ltd. Her research interests include data mining, forecasting, optimization, scheduling, ergonomics, safety and healthcare. She is currently a committee member of OR-NET.