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Identifying Sources of Perceived Environmental Uncertainty Along Thai Rice Supply Chain

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Abstract

Uncertain factors cause to generate any unstable processes along supply chains, and then also reduce supply chain performance. Some sources of uncertainty of agri-food supply chains are distinct from general supply chains such as variable harvest and production yields, and a huge impact of climate conditions. Thus, it is crucial to deeply understand which distinct perceived uncertain factors in agri-food supply chain that can affect to its management and its performance in order to allow agribusiness to deal with these effects properly. The purpose of this study is to discuss the perceived environmental uncertainties in the context of rice supply chain in Thailand. The literature analysis found that supply, demand, process, planning and control, competitors' actions, government policy and climate uncertainty might have been perceived by Thai rice supply chain. The research method is a survey method with mail-out questionnaires to rice millers and rice exporters in Thailand. Descriptive statistics is employed to review which uncertain factors are greatly perceived within the rice supply chain. Major findings show that planning and control, competitor's action, government policy and climate uncertainty are mainly perceived along the supply chain. This confirms that as planning and control is highly uncertain, information technology is not implemented in Thai rice industry. Lack of appropriate IT tools can not deal effectively with environmental uncertainties. Additional, there is high competition in both rice domestic and international market leading to high unpredictable competitors' action. Government policies of developing countries are turbulent, and climate uncertainty is continually obvious in Thai rice industry.

Keywords

along, uncertainty, thai, rice, identifying, supply, sources, chain, perceived, environmental

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IDENTIFYING SOURCES OF PERCEIVED ENVIRONMENTAL UNCERTAINTY ALONG THAI RICE SUPPLY CHAIN

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ABSTRACT

Uncertain factors cause to generate any unstable processes along supply chains, and then also reduce supply chain performance. Some sources of uncertainty of agri-food supply chains are distinct from general supply chains such as variable harvest and production yields, and a huge impact of climate conditions. Thus, it is crucial to deeply understand which distinct perceived uncertain factors in agri-food supply chain that can affect to its management and its performance in order to allow agribusiness to deal with these effects properly. The purpose of this study is to discuss the perceived environmental uncertainties in the context of rice supply chain in Thailand. The literature analysis found that supply, demand, process, planning and control, competitors' actions, government policy and climate uncertainty might have been perceived by Thai rice supply chain. The research method is a survey method with mail-out questionnaires to rice millers and rice exporters in Thailand. Descriptive statistics is employed to review which uncertain factors are greatly perceived within the rice supply chain. Major findings show that planning and control, competitor's action, government policy and climate uncertainty are mainly perceived along the supply chain. This confirms that as planning and control is highly uncertain, information technology is not implemented in Thai rice industry. Lack of appropriate IT tools can not deal effectively with environmental uncertainties. Additional, there is high competition in both rice domestic and international market leading to high unpredictable competitors' action. Government policies of developing countries are turbulent, and climate uncertainty is continually obvious in Thai rice industry.

Keywords: perceived environmental uncertainty, agri-food supply chain, and Thai rice supply chain.

1 INTRODUCTION

In literature review, there has been extensive studying in a popular topic of strategic supply chain management in order to improve supply chain performance under the real situation. This is because in current business world, uncertain environment is crucial in both supply and demand sides to influence many companies in many industries to continuously adapt proper supply chain management in their nature of business. To improve supply chain performance such as reducing inventory cost, "controlling uncertainty" along a supply chain is one of three steps (benchmarking current performance, and planning changes) to achieve supply chain performance improvement (Davis 1993). To properly control uncertainty along a supply chain, it is essential to address which sources of uncertainty exist. Uncertain factors along a supply chain refer to supply, demand, process uncertainty (Ettlie & Reza 1992; Davis 1993), control and planning uncertainty (Childerhouse & Towill 2004), competitor uncertainty (Ettlie & Reza 1992) transportation uncertainty (Wilson 2007) which negatively impact on supply chain performance (Davis 1993; Bhatnagar & Sohal 2005; Paulraj & Chen 2007). On the other hand, customer, supplier, competitor, and technology uncertainty do not impact on supply chain management practices (Li 2002). Thus, uncertain factors are perceived differently across industries and countries.

The unique characteristics of agri-food supply chain are "the biological agricultural production relating to nature, weather and uncontrollable natural forces, perish ability of products and environmental concerns" (Wijnands & Ondersteijn 2006, p.8). Characteristics of demand in agri-food supply chains are variability of consumer demand, misalignment of demand and activities along the chain and poorly managed daily demand (Taylor & Fearne 2006). Thus, some sources of uncertainty of agri-food supply chains are distinct from general supply chain that are perish ability of products, variable harvest and production yields, and the huge impact of climate conditions on upstream, and downstream sides (van der Vorst & Beulens 2002). To measure perceived environmental uncertainty in agri-food supply chain, Thai rice supply chain was nominated. Furthermore, the review of literature analysis indicates that there are seven uncertain factors including external and internal environments of organisations (supply, demand, process, planning and control, competitor, government policy, and climate) influencing Thai rice supply chain as identified in the study of a conceptual framework of rice supply chain in Thailand (Thongrattana, Jie et al. 2009). To clearly understand the environmental uncertainty of rice supply chain allow managers to maintain and improve the competition position by improving strategic decision making under higher levels of uncertainty (Lewis & Harvey 2001).

This paper contributes the knowledge to the existing supply chain management on environmental uncertainty in two main contributions. First, the research adapted and test a perceived environmental uncertainty measurement along the supply chain based on the previous studies (such as Miller (1993) and Lewis & Harvey (2001)). Second, the study considered to measure seven perceived uncertain factors that are highly relevant to rice supply chain members in Thailand. The findings can fulfil the gap of knowledge in perceived environmental uncertainty in particular agri-food supply chain in developing countries. As the gaps of knowledge in the existing uncertain factors on Thai rice supply chain analysed in literature analysis section, a critical research question is ***"To what extent are the seven uncertain factors perceived on partial rice supply chain in Thailand?"***

2 THAI RICE SUPPLY CHAIN

In many categories of Thai agricultural crop, rice is the most important agricultural crop in Thailand for the reason that rice is the most important in term of employment and trade (Meenaphant 1981). Rice farms make up over 50 percent of farm land use in Thailand, and rice farmers is around 56% of Thai population (IRRI 2002; Krasachat 2004). Thailand is the main rice exporter in the world rice market (David 1992) that can reach nearly 10 million tons in 2008 and targeted 8.5 million tons in 2009 (Office of Agricultural Economics 2009). The types of rice in Thailand can be classified by many criteria that are hardness of rice, crop season of rice, features of rice farm, and traded rice. For example, two groups of crop season rice: Rained rice or major rice (wet season) is planted during May-July, and harvested during November-December.

Rice supply chain in Thailand as shown in Figure 1 presents the paddy rice from farmers as suppliers of rice millers is transported to local millers after harvesting. The largest quantity of rained paddy rice (wet season) is purchased almost immediately from farmers to millers or paddy merchants after harvesting in January-April that can lead to a large surplus of rice, while off-season rice cropped in irrigated area launches to rice mills during June-September of each year (Thai Rice Foundation under Royal Patronage 2006; International Rice Research Institute 2007). Then, drying is the important process after harvesting because it affects directly to grain quality and result in losses (Gummert & Rickman 2006). The paddy rice can be purchased directly between farmers and rice millers, or indirectly between farmers and Thai government passing rice millers noted as the Government's rice mortgage scheme. Some paddy rice from farmers who crop rice for their own consumption is milled by small or local rice mills (capacity of 1-12 tons / 24 hour). Meanwhile, some paddy rice from a medium-large size of rice farm is milled by medium (capacity of 30-60 tons per 24 hours) and large mills (capacity of 100 tons per 24 hours), and then is refined and packed for domestic customers by retailers and for international customers by exporters straightforwardly. In another way, milled rice is transferred to rice distributors who manage storage system before distributed to retailers or exporters. The domestic demand is met by delivering milled rice through retailers. The international demand is fulfilled by passing rice through exporters for cleaning and packing again, or export merchant to international customers (Thai Rice Foundation under Royal Patronage 2006).

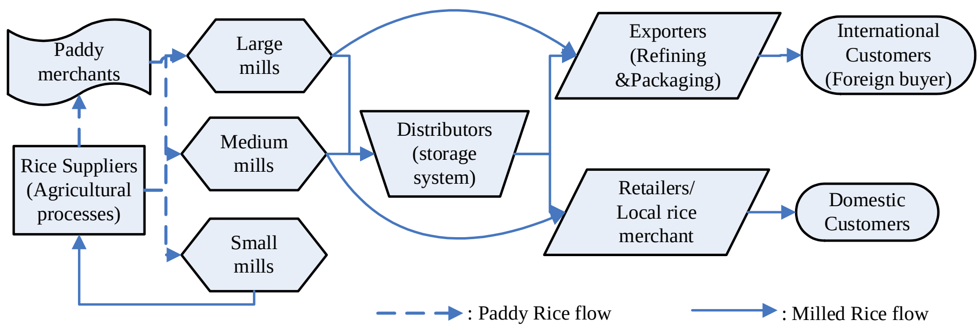

Figure 1: Rice and information flow (modified from Thai Rice Foundation under Royal Patronage 2006b)

3 PERCEIVED ENVIRONMENTAL UNCERTAINTY IN A SUPPLY CHAIN

Uncertainty refer to "the unpredictability of environmental or organizational variables that have an impact on corporate performance" (Miller 1993, p.694). Notably, the definition of environmental uncertainty in organisation theory summarised by Milliken (1987, p.134) are "an inability to assign probability as to the likelihood of future events, a lack of information about cause-effect relationship, and an inability to predict accurately what the outcomes of a decision might be" (Duncan 1972, p.318). In other word, environmental uncertainty is "an individual's perceived inability to predict something accurately" (Milliken 1987, p.136). In organisation perspectives, components of external environment are customers, suppliers, competitors, scio-politics, and technology, while internal environment are organizational personnel, functions and levels (Duncan 1972).

As a supply chain is a network of enterprises, individuals, facilities and information/ material handling systems that connect our supplier's supplier to our customer's customer (Frazelle 2002), the above environments from study of Duncan (1972) also exist in supply chain members. The external factors of organisations that are customers and suppliers can be viewed as internal factors of a supply chain.

Supply chain uncertainty is one of the three factors (location factor, and manufacturing practices) which affect to supply chain performance indicating to lead time, inventory level, time to market, quality, customer service and flexibility (Bhatnagar & Sohal 2005). In supply chain perspective, environmental uncertainty is the external factor as driving forces for supply chain management (Li 2002). Environmental uncertainty plaguing supply chain performance was mentioned in three main sources: suppliers, manufacturing, and customers (Davis 1993). The finding of the study of Bhatnagar and Sohal (2005) confirm the study of Davis (1993) that supply chain uncertainty which is comprised of supply, process and demand uncertainty are significantly effect on negative side of supply chain performance. Similarly, Childerhouse and Towill (2004) proposed the uncertainty circle concept that is divided into 4 sides: demand, supply, control and process. In a different view, Wilding (1998) consider dynamic behavior experienced by supply chains are caused by deterministic chaos, parallel interactions and demand amplification. They allude to never repeated behaviors of partners, uncertain requirements of transforming between low and high supplier performance, and unpredictable demand. In managerial perspective, environmental uncertainty can lead supply chain managers to perceive decision-making uncertainty in term of unpredictable decision outcomes related to lack of information, knowledge, and ability (Duncan 1972). The decision-making uncertainty (DMU) between retailers and suppliers was found that negatively impact on both financial and non-financial performance along supply chain (Hsiao 2006).

The unique characteristics of agri-food supply chain are "the biological agricultural production relating to nature, weather and uncontrollable natural forces, perish ability of products and environmental concerns" (Wijnands & Ondersteijn 2006, p.8). Likewise, Jack and Adrie (2002, p.415) state that the source of uncertainty of food supply chains can be "perish ability of and products, variable harvest and production yields and the huge impact of weather conditions on customer demand". In food supply chain, the identical four sources of uncertainty are supply, demand and distribution, process, and planning and control that are fluctuated with respect to quantity, quality and time (van der Vorst 2000). The linkages between climate and agricultural resources are significant in case of shifts in traditional patterns of weather and climate such as shift from drought to flood or other extreme climate events (Ogallo, Boulahya et al. 2000). The impact of climate change on agricultural production in both history and prediction has been widely examined in the world agriculture (Darwin, Tsigas et al. 1995) Another source of uncertainty is government policy uncertainty that forces firms to react its impacts in both risk and benefit. Especially in developing countries, government policies are unpredictable and turbulent (Badri, Davis et al. 2000). Government policy has played an important role in Thai agricultural production as well because agricultural products are very crucial in Thailand. GDP in agricultural section accounts for over 11% of Thai GDP. Additional, rice was the top five products exported from Thailand to the world market in 2008 (World Bank 2009). Undoubtedly, the government intervene rice industry in many views: production, trade, and export. The failure of a rice crop has led to starvation and political instability (Nielsen 2002).

Therefore, the uncertain factors are critical internal and external environment that drive firms to implement effective agri-food supply chain practices in order to remedy depressing supply chain performance. This study will consider seven distinct sources (supply, demand, process, planning and control, competitor, government policy, and climate) of uncertainty (Badri, Davis et al. 2000; van der Vorst 2000; Li 2002; Paulraj & Chen 2007) influencing Thai rice supply chain as identified in the study of a conceptual framework of rice supply chain in Thailand (Thongrattana, Jie et al. 2009).

4 METHODOLOGY

4.1 Data Collection and Sample

The final draft of questionnaire was then mailed to 698 rice mill companies and 177 rice exporters all around Thailand, but 46 questionnaires were returned from rice millers, and 36 questionnaires were returned from rice exporters due to, for instance, incomplete address, or business failure. From rice millers, 112 questionnaires were returned, but 14 of them were abandoned due to incomplete information, resulting in an effective response rate 15.26%. Meanwhile, from rice exporters, 29 questionnaires were received, but 7 of them were discarded due to incomplete information, resulting in an effective response rate 16.42%. These response rates are considered generally for survey in developing country (Ahmed, Mohamad et al. 2002). The final sample of rice millers included 8.16, 19.59, and 92.24 percent of small, medium, and large milling capacity respectively. 16.33 percent are both rice millers and rice exporters, and 83.67 percent are only rice millers. Additional, 62.24 percent have joined paddy rice mortgage scheme of the government for last 5 years. The average amount of paddy rice milled is 22,525 tonnes per year, and the average inventory of paddy rice is 8,540 tonnes per year in each rice millers. In the meantime, the average amount of paddy rice milled is 22,525 tonnes per year, and the average inventory of paddy rice is 8,540 tonnes per year in each rice miller. For rice exporters, their main international customers are Hong Kong, China, Germany, USA, Belgium and UAE. They export milled rice in average 8,300 tons, and the average inventory of milled rice is 1,300 tonnes per year in each rice exporter. 61-64 percent of the final sample (both rice millers and rice exporters) have implemented partially integrated supply chain, whilst 27-29 percent of them have implemented fully integrated supply chain.

4.2 Instrument development

To measure seven environmental uncertainties within Thai rice supply chain, the research develops and tests a perceived environmental uncertainty measurement from previous studies in any supply chains (Javidan 1984; Li 2002; Paulraj & Chen 2007), certain particular food supply chain (van der Vorst & Beulens 2002), rice industry (Bran & Bos 2005), specific developing countries (Badri, Davis et al. 2000) that have done the pilot study and Q sort method and were found to be valid and reliable. According to all statistical analysis in perceived environmental uncertainty measurement in the study of Lewis & Harvey (2001) undertaken using SPSS software, parametric statistics were applied to preference to non-parametric statistics because A 7-Likert scale and each factor composed of a number of items lead data to be assumed as a quasi-normal distribution (Borgatta & Bohrnstedt 1980).

4.2.1 Scale development

To measure uncertain factors in organization, the perceptions of them were considered in this study because managers make decisions on their perceived factors leading that the perceptions of these uncertain factors are more crucial than the objective uncertain factors (Duncan 1972; Bourgeois 1980). In addition, two attributes of uncertain factors are (i) degree of change or unpredictability, and (ii) complexity or diversity of environmental factors (Duncan 1972; Downey, Hellriegel et al. 1975). In this study, unpredictability of factors was focused. The reason is that the degree of unpredictable factors reflects more to variability of perceived uncertainty than complexity (Dill 1958; Duncan 1972). Moreover, unpredictable factors create more risk and difficulty for managers' decision making and affect to effective strategy making (Bourgeois 1978). Consequently, the summary of the characteristics of measured uncertain factors in this study is perception and degree of unpredictability. All seven uncertain factor measurements are concerned in certain aspects as summarised in Appendix A.

A 7-point Likert scale with end points of 'strongly disagree' and 'strongly agree' was applied to measure variables. Prior to data collection, the pilot testing was applied to lead the questionnaire to easily be completed, comprehensible, and unambiguous for the respondents' range of knowledge and responsibility (Flynn, Sakakibara et al. 1990). The feedback from the pilot study can "ensure the validity and reliability of measures" (Flynn, Sakakibara et al. 1990, p.262). As the questionnaire was translated from English to Thai by professional translators, and some of rice millers are uneducated, the pilot study with a small group of sample (12 samples) was conducted. The face-to-face survey with the first draft of questionnaire was performed no longer than 20 minutes to acquire feedback from participants to raise a better clarity, understanding, and the length of the question. Thus, after this pilot study and based on feedback received form these participants, the final draft of Thai version questionnaire was constructed. Then, a copy of the final Thai version questionnaire was mailed to around 698 rice millers and 177 rice exporters.

4.2.2 The scale reliability

Reliability is "the consistency of the a measure of a concept" (Bryman 2003, p.71). In other words, the questionnaire repeatedly answered from the same respondents will yield the same result (Flynn, Sakakibara et al. 1990). Cronbach's alpha is the common technique to measure internal reliability for a set of two or more construct indicators, or multiple-item measures (Hair, Anderson et al. 1995; Bryman 2003). The degree of intercorrelation among items should be high (Flynn, Sakakibara et al. 1990). The value of it ranges between 0 and 1.0. The higher value, the higher reliability (Hair, Anderson et al. 1995, p.618). However, the role of thumb presents that the figure 0.7-0.8 denotes an acceptable level of reliability (Flynn, Sakakibara et al. 1990; Bryman 2003). However, for a exploratory work in this study, Cronbach's alpha was accepted at above 0.6 (Nunnally 1967). In SPSS output to test scale reliability of each factor, the values of Corrected Item-total Correlation are the correlations between each item and the total scores of the factor in the questionnaire. These values are linked to the values of Cronbach's alpha. Any particular items that the values of Corrected Item-total Correlation are less than 0.3 are encouraged to be deleted in order to increase the values of Cronbach's alpha, and also to purify items in each factor (Field 2005). The result of reliability of scale is presented in Table 1.

Table 1: Reliability of measurement scale

Construct	Cronbach's alpha when particular items deleted[1]	Number of retained items	Particular items deleted[2]
Supply	0.718	4	None
Demand	0.714	4	None
Process	0.63	3	PU2
Planning and Control	0.622	3	PCU4
Competitor	0.613	4	None
Government policy	0.851	4	None
Climate	0.934	5	None

[1] items are deleted when their Corrected Item-total Correlation are less than 0.3
[2] referring to code of items in Table A1

The Cronbach's alpha of these scales was found that was accepted in a degree of internal consistency range from 0.622 to 0.934 when PU2 (The amount of rice product is enough for distribution as required) and PCU4 (Information concerning changes of customer orders can not be distributed on time) were deleted. The careful examinations of the deleted items revealed that PU2 is not majorly relevant with only process uncertainty because whether the enough amount of rice product is ready to distribution as required or not depends on many factors such as supply uncertainty, not only process uncertainty. Since PCU4 is measured on information concerning changes of customer orders while PCU1, 2 and 3 focuses on information of stock level, PCU4 is less correlated with the total scores of the construct. Thus, it is decided to drop PU2 and PCU4 for further analysis.

4.2.3 The scale validity

Validity is ability of a construct's indicator to measure accurately the concept under study (Hair, Anderson et al. 1995). In this instrument development, the content validity as a judgment, not open to numerical evaluation, was examined by providing measurement items from the comprehensive literature review and the pilot study before data collection (Flynn, Sakakibara et al. 1990). Construct validity was measured by explanatory factor analysis (EFA) that ± 0.3 cut-off factor loading as minimum level of measurement items was eliminated (Hair, Anderson et al. 1995). As EFA was conducted using principal component as method of extraction and varimax as the method of rotation, the factor results are shown in Table 2. Kaiser-Meyer-Olkin Measure (KMO) varies between 0 and 1 that indicates how adequate the correlations are for factor analysis (Meyers 2006). The KMO value is greater than 0.5 as considered acceptable (Kaiser 1974). Bartlett's Test of Sphericity tests the null hypothesis that none of the variables is significantly correlated (Meyers 2006). In this study, a KMO coefficient is 0.672 considered acceptable, and Bartlett's Test is highly significant at $p<0.001$. Therefore, factor analysis is appropriate to be proceeded.

As factor analysis is an exploratory tool, to identify how many factors should be extracted, the Kaiser-Guttman criteria (Eigenvalues greater than 1.0) together with scree plot (indicating the point of inflexion on curve) (Cramer 2003; Field 2005). Thus, six factors are extracted as shown Table 2. Careful analysis of factor loading that is above 0.3 shows that Factor 1, 4, and 6 are clearly represented by five climate uncertainty items, three process uncertainty items, and three planning and control uncertainty items respectively. There are two areas of particular interest in the other factors. Firstly, the one item (SU2) of supply uncertainty appears to load on Factor 1 (grouped with climate uncertainty), and Factor 3 (grouped with demand uncertainty), whilst the other items (SU1, SU3 and SU4) load on Factor 5. Unsurprisingly, although this may indicate that the item of '*the properties of rice from rice producers can greatly vary with in the same batch*' might be correlated with climate uncertainty, it was decided to drop SU2 for late analysis because its factor loading is greater than 0.4 on more than one factor in order to remain appropriate internal consistency reliability of the instrument. Hence, Factor 3 is represented by four demand uncertainty items. Secondly, the items of competitor uncertainty and government policy uncertainty load on Factor 2. This indicates that the apparent characteristics between competitor uncertainty and government policy uncertainty become less distinct as this area of environmental uncertainty in Thai rice supply chain.

4.2.4 Independent Sample t-Test for analysis of the supply chain

The two sample groups of Thai rice supply chain members: rice millers (N=98) and rice exporters (N=22) administered in the perceived environmental uncertainty instruments to

Table 2: Results of rotated factor pattern for retained items of uncertain factors in Rice supply chain.

Item	Factors					
	1	2	3	4	5	6
SU1					**0.67**	
SU2	***0.47***		**0.54**			
SU3					**0.63**	
SU4					***0.41***	
DU1			**0.81**			
DU2			**0.57**			
DU3			**0.5**			
DU4			***0.47***			
PU1				***0.48***		
PU3				**0.6**		
PU4				**0.72**		
PCU1						**0.72**
PCU2						**0.79**
PCU3						**0.67**

Item	Factors					
	1	2	3	4	5	6
CU1		**0.58**				
CU2		**0.63**				
CU3		**0.74**				
CU4		**0.51**				
GU1		**0.63**				
GU2		***0.44***				
GU3		**0.53**				
GU4		**0.51**				
CMU1	**0.91**					
CMU2	**0.9**					
CMU3	**0.88**					
CMU4	**0.85**					
CMU5	**0.75**					
Eigen value	7.8	2.9	2.41	2.07	1.66	1.4
% of Variance	26.9	10	8.31	7.13	5.72	4.82
Cumulative % of variance	26.9	36.9	45.2	52.3	58.1	62.9

determine. If the perceived environmental uncertainties from different rice supply chain members are represented to different by Independent Sample t-Test, the rice industry sector aggregation was performed. A Two-tailed independent Sample t-Test was implemented to determine the mean difference between two independent groups. Two assumptions: normality and homogeneity of variance assumption were tested prior to apply this test. Firstly, normality assumption was tested by statistical approach: Shapiro-Wilk test at significant level 0.001 (Meyers 2006) due to N < 2,000 (Sheskin 1997), and graphical approaches: histograms and normal probability plots (Meyers 2006) of each factor in each independent group. With both approaches, the results show that all seven factors of rice millers and rice exporters were normally distributed. Secondly, the homogeneity of variance assumption was tested by the Levene’s test at significant level 0.05. The result shows that the assumption is not violated for all seven factors as depicted in Table 3. The mean of perceived competitor uncertainty (significant level 0.05) and the mean of perceived government policy uncertainty (significant level 0.01) are different between Thai rice millers and rice exporters. Thus, supply, demand, process, planning and control, and climate uncertainty are perceived inconsistently in term of variation between both rice supply chain members.

5 RESULTS

As the partial rice supply chain in Thailand was measured in seven environmental uncertainties, Figure 2 and Table 4 show the level of uncertainty values range from 3.75 to 5.65. The perceived uncertain factors can be divided into two groups. The first group is the high level of perceived uncertainty consisting of planning and control, competitor, government policy, and climate uncertainty. The second group is the lower level of perceived uncertainty composed of supply, demand and process uncertainty. Government policy uncertainty is perceived in the highest level, while process uncertainty is perceived in the lowest level by both rice millers and exporters. Likewise, for government policy and competitor uncertainty, rice exporters are significantly perceived higher than rice millers that the independent sample t-test in Table 3 supports this funding.

Table 3: Results of Independent samples test for a comparison of mean uncertainty between two rice supply chain members

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
SU	Equal variances assumed	.312	.577	.066	118	.948	.02010	.30515	-.58418	.62438
	Equal variances not assumed			.062	29.510	.951	.02010	.32180	-.63756	.67776
DU	Equal variances assumed	.474	.492	-.887	118	.377	-.26206	.29547	-.84717	.32305
	Equal variances not assumed			-.928	32.796	.360	-.26206	.28240	-.83675	.31263
PU	Equal variances assumed	3.427	.067	-1.153	118	.251	-.33519	.29081	-.91108	.24070
	Equal variances not assumed			-1.407	41.059	.167	-.33519	.23816	-.81614	.14576
PCU	Equal variances assumed	.384	.537	-.002	118	.998	-.00062	.25015	-.49598	.49475
	Equal variances not assumed			-.003	33.953	.998	-.00062	.23251	-.47316	.47192
CU	Equal variances assumed	2.284	.133	-3.196	118	.002	-.85622	.26791	-1.38675	-.32568
	Equal variances not assumed			-3.844	40.013	.000	-.85622	.22274	-1.30638	-.40605
GU	Equal variances assumed	2.645	.107	-1.921	118	.057	-.62106	.32337	-1.26142	.01931
	Equal variances not assumed			-2.423	43.543	.020	-.62106	.25637	-1.13789	-.10423
CMU	Equal variances assumed	2.413	.123	-.507	118	.613	-.18182	.35845	-.89164	.52800
	Equal variances not assumed			-.474	29.111	.639	-.18182	.38352	-.96608	.60245

Table 4: Descriptive Statistics of seven uncertain factors in rice millers and exporters

Factors	SC member	N	Mean	Std. Deviation	Std. Error
SU	Rice millers	98	4.32	1.27	0.13
No SU2	Rice Exporters	22	4.30	1.38	0.29
	Total	120	4.32	1.29	0.12
DU	Rice millers	98	4.31	1.27	0.13
	Rice Exporters	22	4.57	1.18	0.25
	Total	120	4.35	1.25	0.11
PU	Rice millers	98	3.82	1.29	0.13
No PU2	Rice Exporters	22	4.15	0.94	0.20
	Total	120	3.88	1.23	0.11

Factors	SC member	N	Mean	Std. Deviation	Std. Error
PCU	Rice millers	98	4.94	1.08	0.11
No PCU4	Rice Exporters	22	4.94	0.96	0.21
	Total	120	4.94	1.06	0.10
CU	Rice millers	98	4.73	1.18	0.12
	Rice Exporters	22	5.59	0.88	0.19
	Total	120	4.89	1.18	0.11
GU	Rice millers	98	5.02	1.44	0.15
	Rice Exporters	22	5.64	0.99	0.21
	Total	120	5.13	1.39	0.13
CMU	Rice millers	98	5.00	1.49	0.15
	Rice Exporters	22	5.18	1.65	0.35
	Total	120	5.03	1.51	0.14

6 DISCUSSION AND CONCLUSION

The measurement instrument of perceived environmental uncertainty in this research developed from the previous studies was tested to contain adequate reliability and validity as same as the measurement instrument development of Miller (1993) and Lewis & Harvey (2001). The findings are clear evidences that the high level of planning and control, competitors, government policy, and climate uncertainty are experienced by Thai rice supply chain. In addition, the rice exporters perceive higher uncertainty than rice millers. This probably reflects that since rice exporters deal with international market and manage many tiers of suppliers, they face the higher level of uncertainty than their upstream side of the supply chain.

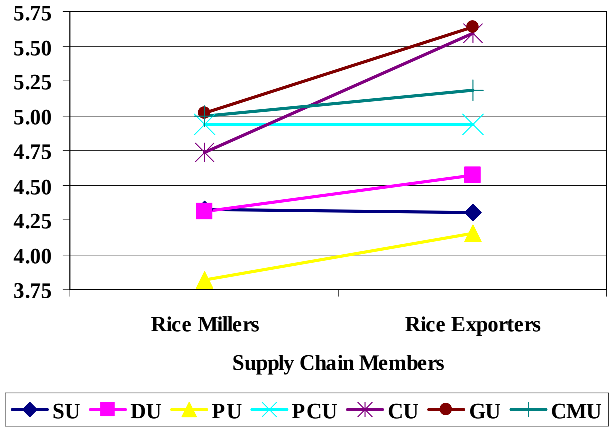

Figure 2: Graphs showing the level of perceived environmental uncertainty along partial Thai rice supply chain (rice millers and rice exporters)

According planning and control uncertainty scale referring to 'on time and correction of information involved inventory and production availability', this can conclude that information technology is not implemented in Thai rice industry. Lack of appropriate IT tools such as Electronic Data Interchange (EDI), can not deal effectively with uncertainty of environment (Bensaou 1997). Referring to the high level of competitor uncertainty, it can state that there is high competition in both rice domestic and international market leading to high unpredictable competitors' action. The intensive competition with other rice production countries such as Vietnam introducing rice in the sense of low price and low quality of rice exist (Nielsen 2002). For the government policy uncertainty, the high level of it is likely to support that government policies of developing countries are turbulent and unpredictable (Badri, Davis et al. 2000). That the rice supply chain members perceive the high unpredictable climate uncertainty is continually obvious in Thai rice industry. This supports that climate is one vital factor not only directly and indirectly affect most agricultural system and socio economic system especially in developing countries where agricultural system mostly depends on rainfall and lack of technological adaptations (Darwin, Tsigas et al. 1995; Ogallo, Boulahya et al. 2000), but also its uncertainty is manifest in organisation level along the rice supply chain.

The implications for researchers are that the focus on perceived environmental uncertainty in the Thai rice supply chain should collect data from rice farmers who are rice producers in order to comprehend uncertain factors for the entire rice supply chain. In this study, data from farmers are ignored because the population of rice farmers in Thailand is over 30 million people (IRRI 2002) that questionnaire distribution can consume a plenty of time and cost. Furthermore, most of them are uneducated. Face-to-face survey might be implemented to collect data from farmers for the further study. The implications for managers are that to clearly understand the environmental uncertainty of supply chain allow manager to maintain and improve the competition position by improving strategic decision making under higher levels of uncertainty (Lewis & Harvey 2001).

7 APPENDIX A

Table A1: The measurement items of uncertain factors in Thai rice supply chain.

Uncertain factors	Aspects of measurement	The question in the questionnaire	References
Supply	Quantity	**SU1:** Rice quantity from rice producers is unpredictable	(van der Vorst 2000; Li 2002; Paulraj & Chen 2007)
	Quality	**SU2:** The properties of rice from rice producer can vary greatly with in the same batch **SU3:** Rice quality from rice producers is unpredictable	
	Time	**SU4:** Rice producers' delivery time is unpredictable	
Demand	Quantity	**DU1:** The volume of customer demand is difficult to predict	(Li 2002; Paulraj & Chen 2007)
	Quality	**DU2:** Customers' rice preference changes over the year	
	Time	**DU3:** The lead time[1] of customer order is unpredictable **DU4:** Master production schedule has a high percentage of variation in demand	
Process	Quantity	**PU1:** Yield of rice processing (e.g. milling, packing) can vary **PU2:** The amount of rice product is enough for distribution as required	(van der Vorst 2000)
	Quality	**PU3:** The quality of rice after processed (e.g. milled, storied) can be changed	
	Time	**PU4:** The throughput time of rice processing can vary	
Planning and Control	Quantity	**PCU1:** Information of stock level of rice and rice production capacity is complete at this moment	(van der Vorst 2000)
	Quality	**PCU2:** Information of stock level of rice and rice production capacity is accurate	
	Time	**PCU3:** Information of stock level of rice and rice production capacity is timely **PCU4:** Information concerning changes of customer orders can not be distributed on time	
Competitor	Actions	**CU1:** Competitor's actions are unpredictable **CU2:** Competitors often introduce new product/price unexpectedly	(Li 2002)
	Domestic market	**CU3:** Competition is intensified in domestic market.	
	International market	**CU4:** Competition is intensified from different countries	
Government policy	Rice production	**GU1:** Government policies in rice production directly impacting on your firms are unpredictable	(Javidan 1984; Badri, Davis et al. 2000; Bran & Bos 2005)
	Rice trading	**GU2:** Government policies in rice trading (e.g. FTA, tax) directly impacting on your firms are unpredictable	
	Paddy rice mortgage scheme	**GU3:** The paddy rice mortgage scheme from government regulation is unpredictable over the year	
	New government	**GU4:** The new government regulation is introduced unexpectedly	
Climate	Drought	**CMU1:** Drought occurrences are unpredictable in each year **CMU2:** The duration of drought is unpredictable over the year	(Cruz, Harasawa et al. 2007)
	Flooding	**CMU3:** Flooding occurrences are unpredictable in each year **CMU4:** The duration of flooding is unpredictable over the year	
	Temperature	**CMU5:** The temperature is vary unpredictably over the year	

[1] lead time: duration time from costumers placing their order to their requested product shipment.

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