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Factors Affecting Technology Transfer in the Philippines Food Processing Industry

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Abstract

Purpose: This paper explores the factors affecting technology transfer in the food processing industry in the Republic of the Philippines.

Design/methodology/approach: In achieving the above-mentioned purpose, survey questionnaires distributed randomly in different regions in the Philippines. Overall, 300 survey questionnaires were distributed but only 157 of these were answered. Statistical analysis techniques, including, exploratory factor analysis, were used to analyse the collected data in order to address the research objective.

Data analysis: Findings from the questionnaires were tabulated and subjected to quantitative analysis. The average and the standard deviation for each item were calculated. Factor analysis was applied. Principal axis factor analysis with VARIMAX rotation was conducted to assess the underlying structure for twenty nine (29) items of the survey instrument used.

Research limitations: The scope of the study was limited only to target the respondents from the Philippine food processing industry.

Findings: Analysis resulted in technology transfer constructed factors consisting of one outcome factor namely, Technology Transfer Value Added (AV), and four technology transfer enabling factors namely, Relation Building (RB), Transferee Characteristics (TE), Government Influence (GI), and Technology Characteristics (TC).

Originality/value: The paper provides an outlook about the main factors that affect the food processing industry in the Republic of the Philippines and can help in guiding and directing national policy and strategy for innovation and technology transfer.

Keywords: Technology transfer; Food processing industry; Factor analysis; Philippines

Introduction

The Philippines is a developing country and is touted as Asia's next Tiger economy [1]. Its economy is fuelled largely by the manufacturing industry. The most dominant manufacturing sector of the country is the food processing industry, which accounts for forty per cent (40%) of its total manufacturing output and contributes twenty per cent (20%) of the Philippines Gross Domestic Product, while employing at least 37% of the total Filipino workforce [2-4].

It is projected to grow further since the Philippines is fast becoming a regional staging area for food manufacturers seeking to penetrate the lucrative East and South Asian market for processed products [5]. Moreover, the Philippines' rapidly expanding production of processed foods and beverages (f&b) presents robust opportunities for U.S. exporters of agricultural raw materials and high value ingredients [6]. Efforts are also being made by the Philippine Government to "assimilate into the global mainstream culture Filipino dishes" [7]. The first quarter of 2012 alone showed a major increase of the export of processed food to the USA, Japan, Singapore, Malaysia, Indonesia, Thailand and china [8].

The Philippine Food Processing Industry is composed of the following major sectors: fruits and vegetables, fish and marine products, meat and poultry products, flour and bakery products, beverages, confectioneries, dairy products, food condiments and seasonings, food supplements, bottled water, snack foods and fats and oils.

In 2004, the Philippine Bureau of Food and Drags listed 11,601 food-processing establishments nationwide. Most of these companies are owned by a single proprietor common among micro, cottage and small industries that thrive on the ability of the Filipino workforce to manufacture high quality products coupled by the availability of domestic and duty-free imported raw materials mainly from USA, New Zealand, Australia, Canada, and China [9,10]). Out of this number, San Miguel Corporation, RFM Corporation, Universal Robina Corporation and a few others dominate the Philippine market and can compete equally with foreign players, while the rest struggle in keeping up with the technologies and knowledge required to remain competitive.

Studies such as that of Mohamed et al., and Waroonkun and Stewart [11,12] advocate that these companies can benefit from successful Technology Transfer (TT), since TT is viewed as a solution for improvement of these sectors.

Furthermore, the Philippine Government recognized the importance of technology transfer in the development of the country's economic industries that in 2010 it passed Republic Act 10055, otherwise known as the "Philippine Technology Transfer Act of 2009"that aims to promote and facilitate technology transfer among others [13].

However, several factors stand in the way for the majority of food

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industry players in the Philippines for them to fully enjoy the benefits of technology transfer. This study intends to identify these factors.

Conceptual Framework

Tanut Waroonkun [14] developed a conceptual model for international technology transfer wherein he identifies four main categories of enablers that can affect the technology transfer process. These enabler factors are:

- **Transfer environment**: concerned with the impact of country and project related factors on technology transfer process. This factor includes four observed variables namely: Complexity; Mode of Transfer; Government policy; and Government enforcement.
- **Learning environment**: concerned with relationship and communication between the transferor and the transferee in the technology transfer process in terms of: Relationship; Mutual trust; Understanding; Communication; Management; Team working; Training; Transfer technology to local sub-contractors; and Supervision,
- **Transferor characteristics**: concerned with origin/supplier characteristics in terms of: Willing to cooperate with local worker; Transferor's degree of experience; Transferor's Management; and Extensive knowledge base,
- **Transferee characteristics**: concerned with host characteristics (Philippine local company) in terms of: Willing to learn; Experience working with foreigners; Transferee's Management; and Adequate knowledge base,

Furthermore, he argues that the performance and interrelationship of these enablers affect the outcomes or value added of the technology transfer process. Waroonkun [14] has identified these outcomes as:

- **Economic advancement**, which is concerned with the impact on the improvement of the organization economic condition in terms of: Competitive; and Performance,
- **Knowledge Advancement** which is concerned with impact of Technology Transfer program on Transferee knowledge base in terms of: Improvement of knowledge of local workers; Gaining new knowledge; and Adaptation of new skill and
- **Project Performance**, which deal with the improvement of financial performance, schedule performance, and quality standards in terms of: Financial performance; Schedule performance; and Quality performance (Figure 1).

Research Method

The scope of this research was limited only to target the respondents from the Philippine food processing industry. The decision and judgment were made to only solicit responses from this sector since this research is concerned with the effectiveness of technology transfer process within the local food processing industry.

Moreover, in order to carry out the analysis, the following statistical assumptions shall be used:

1. independent variables can be correlated to the outcome of dependent variables;
2. no important variables will be omitted;
3. data in robust manner.

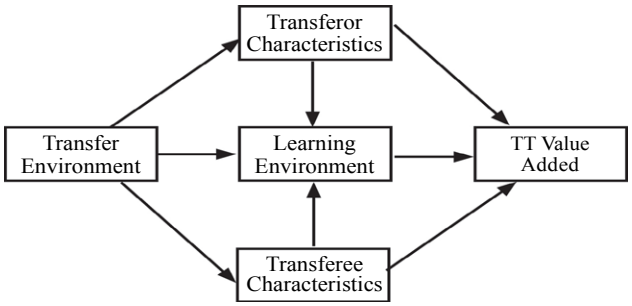

Figure 1: Conceptual model for technology transfer in food processing industry adapted from Waroonkun (2007).

The survey questionnaire was chosen as the data collection instrument in this research. It was developed based on the literature review, and in consultation with food industry experts. Furthermore, this instrument was developed with the inspiration of the questionnaire used by Waroonkun [14] and subjected to careful examination by selected food processing industry personnel.

The survey questionnaire contained two separate sections. The first section solicited the respondents' personal information to establish their demographic and professional profiles. Here they were also asked to rate the success of technology transfer in the Philippine food processing industry.

Section two (questionnaire survey) contained two parts with 29 questions (items) in total. Part one examined the Technology Transfer Process Enablers and their associated sub-factors, including: Transfer Environment, Learning Environment, Transferor Characteristics, and Transferee Characteristics. Part two focused on measuring the Outcome of the Technology Transfer strategy in the following categories: Economic Advancement, Knowledge Advancement, and Project Performance.

Respondents were requested to rate these variables in two separate columns (A and B) in terms of Importance (Column A) and, Effectiveness (Column B) using a Five-Point Likert Scale. Column A asked respondents for their opinion about statements related to Technology Transfer, ranging from 1=strongly disagree to 5=strongly agree. These results were used to determine the importance/significance of each variable.

Column B required determining respondents' perception of the impact of Technology Transfer factors in the food processing industry environment, based on their experience. Column B has two parts. The first part is for rating the Enabler Factors with 1=strongly negative to 5=strongly positive as the range of selection available to the respondents. The second part of column B was for rating the Outcome, with the values rating from 1=very low to 5=very high. These results were essential for determining the effectiveness of Technology Transfer in the food processing industry in the Philippines. They enabled connecting links between variables to be established.

When companies involved in the processing of food products were identified through online and traditional databases include those of Department of Trade and Industry (DTI) and Department of Science and Technology (DOST) – Philippines, the survey instrument were distributed via email or hand carried to the respondents. Descriptive statistics methods, including the mean value and standard deviation were used for each Enabler and Outcome variable in the research questionnaire.

These were condensed and summarized into more defined data sets using Exploratory Factor Analysis. The general purpose of Exploratory Factor Analysis (EFA) is to identify the common factor (separate from the specific factors) and explain their relationship to the observed data [15]. Usually, factor extraction is done by means of Principal Components Analysis (CPA), which transforms the original set of variables into a smaller set of linear combinations that account for most of the variation of the original set. The Principal Components (PC) were extracted so that the first Principal Component accounts for the largest amount of the total variation in the data.

The m^{th} principal component $PC_{(m)}$ is that weighted linear combination of the observed variables X,

$$PC_{(m)} = \omega_{(m)1}X_1 + \omega_{(m)2}X_2 + \cdots + \omega_{(m3)p}X_p$$

which has the largest variance of all linear combinations that are uncorrelated with all of the previously extracted principal components [16].

Reliability test was performed and assessed by means of calculating Cronbach's alpha (α), which is a coefficient of reliability (internal consistency). Thus, Cronbach's alpha uses metrics of the number of variables that is believed to be the constituents of the factor and the correlations between them:

$$\alpha = \frac{N\bar{r}}{1+(N-1)\bar{r}}$$

Where: N is the number of variables

$\bar{r}$ is the average inter-variable correlation of all the variables.

Cronbach's alpha (α) ranges from zero to one, the higher the average inter-item correlation, the grater the value of α, reflecting a higher internal consistency for the index. By most accounts, a value of α in excess of 0.9 considered a very good level of scale reliability and internal consistency; in many cases, a value of 0.7 considered acceptable [17]. Moreover, research carry out by Zain et al., [18] accepted Cronbach's alpha value ranging from 0.45-0.93. Similarly, Fang et al., [19] accepted Cronbach's alpha values ranging from 0.56-0.91.

More various tests are required for the appropriateness of the factor extraction, including the Kaiser–Meyer–Olkin (KMO) measure of sampling accuracy, which tests the hypothesis that the correlation matrix is an identity matrix. For ease of interpretation of the factor extracted, the principal components matrix often rotated. VARIMAX is more common rotation method, which there are several other methods are available.

In this study, the exploratory principal components factor analysis, with the commonly used VARIMAX rotation method was adopted to easily interpret the extracted factors. The Kaiser-Meyer-OIkin (KMO) measure should be greater than 0.70, and is insufficient if less than 0.50. The KMO is a statistical test that measure of sample adequacy and it is a useful measure of whether the data is suitable for a factor analysis.

The target respondents in this research included the Philippine food processing sector and its associated professionals involved in product development, factory design, unit design, quality systems and auditing, packaging, marketing, sourcing equipment, legislation and labelling, hygiene, management, processing and R&D professionals from food processing industry involving technology transfer initiatives.

Results

One hundred and fifty seven (157) respondents from the Philippines food processing industry responded to the survey questionnaires. The respondents' gender were fairly distributed between 77 male (49%) and 80 female (51%). The majority of the respondents (128 (82%)) were aged less than 50 years old.

Figure 2 shows the position held by the respondents in their respective company. Some of the respondents have more than one role in the company. The evaluation of the position held by respondents was necessary to confirm the validity and reliability of their response. The respondents included president, director, manufacturing director, unit and plant manager, engineer, chemist, supervisor, account developer and finance officer, science research specialist, nutritionist, etc. Almost 50% of the respondents were in administration or unit management. These respondents will have an informed perspective of all daily operations and hence will be able to seriously evaluate all issues concerning the enablers and the outcome (Figure 2).

The respondents of this study were from companies involved in Flour and Bakery Products, Processed Fruits and Vegetables products, Fish and Marine Products, Meat Preparations, Dairy Products, Coconut By-Products, Beverages, Sugar Products, Coffee/Cocoa and Tea products, Sauces, Spreads and Other Preparations, and Food Condiments and Seasonings.

Only 130 out of 157 respondents rated the success of Technology Transfer in the food processing industry in the Philippines. Fifty three (53) per cent rated it as moderate while twenty seven (27) per cent find it high. Nine (9) per cent of the respondents consider the success very high while eleven (11) per cent views its success as low to very low.

The descriptive statistics utilized for this study included mean and standard deviation for each technology transfer enabling and outcome variables. The main reason for evaluating mean and standard deviation was to confirm the respondent's perspective of the variables and to assist with factor analysis decision making.

The mean and standard deviation values for all conceptual variables in column A and column B are displayed in Table 1. Mean score are computed by equally weighting the mean score of all variables. For example, the mean of Transfer Environment (4.01) construct score had calculated by equally weighting the mean scores of Complexity

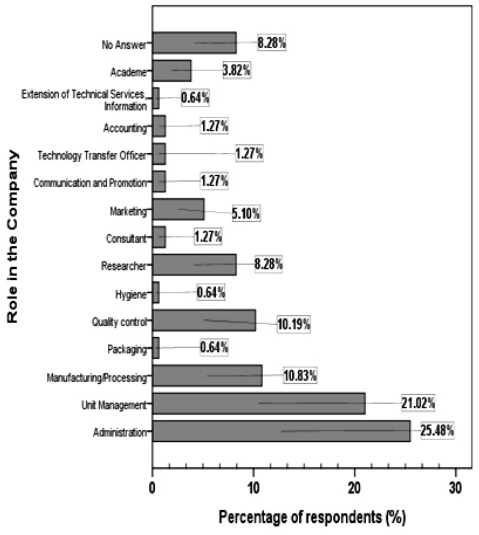

Figure 2: Respondents' Position in the Company.

Code	Description	Column A		Column B	
		Mean	Std. Dev.	Mean	Std. Dev.
Enablers					
E1	Transfer Environment	4.01	0.82	3.82	0.79
E 1.1	Complexity level	3.93	0.75	3.67	0.75
E 1.2	Mode of Transfer	4.01	0.68	3.83	0.71
E 1.3	Government policy	4.08	0.92	3.91	0.83
E 1.4	Government enforcement	4.03	0.91	3.87	0.89
E2	Learning Environment	4.27	0.77	4.06	0.80
E 2.1	Culture	3.80	0.92	3.60	0.90
E 2.2	Trust	4.27	0.77	4.03	0.78
E 2.3	Understanding	4.43	0.70	4.22	0.76
E 2.4	Communication	4.43	0.82	4.21	0.80
E 2.5	Commitment	4.38	0.75	4.11	0.87
E 2.6	Teamwork	4.44	0.71	4.22	0.75
E 2.7	Training	4.52	0.68	4.27	0.74
E 2.8	Local-sub-contract	3.98	0.81	3.77	0.88
E 2.9	Supervision	4.20	0.79	4.10	0.71
E3	Transferor Characteristics	4.17	0.76	4.00	0.77
E 3.1	Willingness to implement	4.09	0.78	3.93	0.75
E 3.2	Degree of experience	4.18	0.75	3.96	0.75
E 3.3	Transferor management	4.17	0.76	4.04	0.77
E 3.4	Knowledge base	4.24	0.75	4.08	0.80
E4	Transferee Characteristics	4.18	0.76	4.00	0.75
E 4.1	Willingness to learn	4.17	0.85	4.00	0.84
E 4.2	Degree of experience	4.03	0.78	3.83	0.75
E 4.3	Transferee management	4.18	0.71	4.04	0.71
E 4.4	Knowledge base	4.32	0.69	4.13	0.72
TT Value Added					
O1	Economics advancement	4.36	0.70	3.99	0.75
O 1.1	Competitiveness	4.37	0.69	4.00	0.71
O 1.2	Performance	4.34	0.70	3.97	0.78
O2	Knowledge advancement	4.30	0.72	3.90	0.77
O 2.1	Improved knowledge	4.34	0.70	3.92	0.77
O 2.2	Improved working practices	4.35	0.71	3.90	0.79
O 2.3	Long-term adoption	4.22	0.74	3.87	0.74
O3	Project performance	4.32	0.66	3.90	0.77
O 3.1	Financial performance	4.25	0.69	3.83	0.77
O 3.2	Schedule performance	4.24	0.67	3.87	0.74
O 3.3	Quality standards	4.48	0.63	3.99	0.80

Table 1: Enablers and TT Value Added Mean and Standard Deviations.

level (3.93), Mode of Transfer (4.01), Government policy (4.08) and Government enforcement (4.03).

The result showed that all the mean values of all the variables in column A are greater than (3) concluding that all the 29 items in the questionnaires are important. Among the Enablers, it found that Learning Environment, with average of (4.27), is the most important enabler conceptual factor and had the larger impact on Technology Transfer process. While the Training variable, with average of (4.52), has the essential role in TT process.

The respondents strongly agreed that the Technology Transfer Values Added is very important. The most important Outcome conceptual factor is the Economic Advancement, with average of (4.36), and Quality Standards considered as the most important variable with average value of (4.48). Meanwhile, Competitiveness, with average of (4.00), is the variable that has most impact on TT process followed by Quality Standards, with average of (3.99).

Since all the conceptual items are exceeded the accepted level, as shown in Table 1, (i.e. mean score>3), the all the 29 items will utilized for the initial factor analysis computation (Table 1).

Exploratory factor analysis

VARIMAX R-type factor exploratory principal factor analysis method was conducted to assess the underlying structure for the original 29 items of the questionnaire into small set of factors, with minimum loss of information [20]. The data sample was considered sufficient for factor analysis, exceeding the observation to variable ratio (i.e. 5.4:1) recommended by Hair et al., [20]. Moreover, the value of Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy test was (0.888), exceeding the recommended threshold level 0.5 recommended by Coakes, [21], Hair et al., [20]; and level 0.7 recommended by Leech et al. [17].

The exploratory principal factor analysis retained twenty-one (21) variable solutions, removing eight (8) variables. Surprisingly, all the variables belong to transferor characteristics removed and retained all the variables belong to transferee characteristics and grouped them under one factor maintain the same name. In addition, all the variables of the conceptual outcome were grouped under one construct factor called Technology Transfer Added Value. The variables of the conceptual factor Transfer Environment divided to two factors. The variables called Complexity level and Mode of Transfer grouped under one construct factor called Technology Characteristics. On the hand, the variables called Government policy and Government enforcement grouped together under construct factor called Government Influence. Four variables from the conceptual factor Learning Environment removed namely Culture, Commitment, Local-sub-contract and supervision. The remaining factors namely Trust, Understanding, Communication, Teamwork and Training grouped under one construct factor called Relation Building.

Five construct factors best represented the data in terms of variance explained (73.6%) and grouping of variables. These constructed factors named (1) Technology Transfer Value Added (AV), (2) Relation Building (RB), (3) Transferee Characteristics (TE), (4) Government Influence (GI), and (5) Technology Characteristics (TC). Table 2 details the factor loadings, explained variance, Eigenvalues, communalities and Cronbach's alpha α for the five-factor solution.

As rule of thumb, factor loadings of ± 0.3 to ± 0.4 are minimally acceptable, value greater than ± 0.5 are generally considered necessary for practical significance. All factor loadings (or coefficients) which gave the correlations between the variables and the factors exceeded the 0.5 threshold level with loading ranging from 0.647-0.819.

Moreover, Cronbach's alpha α results exceeded the recommended value of 0.7 and ranged from 0.795-0.934 indicating that the scale used was reliable. Ho [22] argue that if Cronbach's alpha α is high (0.80 or higher), then this suggests that all of the items are reliable and the entire test is internally consistent. If alpha is low, then at least one of the items is unreliable, and should be identified via item analysis procedure. The communalities results ranged from 0.656-0.827 represent the relation between the variable and all other variables.

Table 2 shows that the technology transfer value added factor (VA) explained 47.4% of the total variance (73.6). As well as, the result highlight that the relation-building (RB) factor is the key player among the enablers explaining almost 10% of the total variance in the data set 73.6%. Combined explained variance for the enablers (i.e. relation building, transferee characteristics, government influence and technology characteristics) associate to 26.2%.

Factor		Item Code	Description	Factor Loading	Communalities
1	Technology Transfer Value Added (VA)	O 1.1	Competitiveness	0.700	0.668
	Variance= 47.36%	O 1.2	Performance	0.721	0.698
	Eigenvalue= 9.945	O 2.1	Improved knowledge	0.754	0.656
	Cronbach's Alpha a= 0.934	O 2.2	Improved working practices	0.789	0.743
		O 2.3	Long-term adoption	0.795	0.714
		O 3.1	Financial performance	0.756	0.691
		O 3.2	Schedule performance	0.797	0.722
		O 3.3	Quality standards	0.783	0.763
2	Relation Building (RB)	E 2.2	Trust	0.647	0.647
	Variance= 9.83%	E 2.3	Understanding	0.819	0.768
	Eigenvalue= 2.065	E 2.4	Communication	0.789	0.797
	Cronbach's Alpha a= 0.894	E 2.6	Teamwork	0.652	0.681
		E 2.7	Training	0.722	0.731
3	Transferee Characteristics (TE)	E 4.1	Willingness to learn	0.758	0.740
	Variance= 5.93%	E 4.2	Degree of experience	0.804	0.766
	Eigenvalue= 1.245	E 4.3	Transferee management	0.679	0.770
	Cronbach's Alpha a= 0.862	E 4.4	Knowledge base	0.665	0.673
4	Government Influence (GI)	E 1.3	Government policy	0.807	0.787
	Variance= 5.33%	E 1.4	Government enforcement	0.800	0.781
	Eigenvalue= 1.120				
	Cronbach's Alpha a= 0.795				
5	Technology Characteristics (TC)	E 1.1	Complexity level	0.843	0.822
	Variance= 5.10%	E 1.2	Mode of Transfer	0.835	0.827
	Eigenvalue= 1.070				
	Cronbach's Alpha a= 0.791				
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.					

Table 2: VARIMAX Rotated Factor Loading and Communalities for the Five-Factor Solution.

Table 3 shows the mean and standard deviation of the construct factors and their variables for column A and column B. The respondents strongly agreed that the technology transfer value added (VA) and the relation building (RB) are very important in the technology transfer process in food processing industry. As well as, they score the relation building (RB) constructed factor is the most important with mean of (4.42) (Tables 2 and 3).

Conclusion

Understanding the factors that affect technology transfer in the Philippines ultimately can help in benchmarking the technology transfer in the Philippine food processing industry as well as it will be the first step before formulating the mathematical model to describe TT. This paper presents the constructed main factors that affect the technology transfer in the Philippines food processing. Although there are numerous studies about Technology Transfer process, little are known about technology transfer in Philippine food processing industry.

The respondents emphasized that the Relation Building has the most important enabler and has the high impact on the TT process in Philippine food processing industry. On the other hands, it was found that Quality Standards is the most important variable in the Outcome factor and Competitiveness is the most variable has impact on the TT Value Added.

The factors presented here are limited only to Philippines food processing industry. Comparing the Technology Transfer constructed factors of the Philippines food processing industry with the Thai

Code	Description	Column A		Column B	
		Mean	Std. Dev.	Mean	Std. Dev.
VA	TT Value Added	4.32	0.69	3.92	0.76
VA1	Competitiveness	4.37	0.69	4.00	0.71
VA2	Performance	4.34	0.70	3.97	0.78
VA3	Improved knowledge	4.34	0.70	3.92	0.77
VA4	Improved working practices	4.35	0.71	3.90	0.79
VA5	Long-term adoption	4.22	0.74	3.87	0.74
VA6	Financial performance	4.25	0.69	3.83	0.77
VA7	Schedule performance	4.24	0.67	3.87	0.74
VA8	Quality standards	4.48	0.63	3.99	0.80
RB	Relation Building	4.42	0.73	4.19	0.77
RB1	Trust	4.27	0.77	4.03	0.78
RB2	Understanding	4.43	0.70	4.22	0.76
RB3	Communication	4.43	0.82	4.21	0.80
RB4	Teamwork	4.44	0.71	4.22	0.75
RB5	Training	4.52	0.68	4.27	0.74
TE	Transferee Characteristics	4.18	0.76	4.00	0.75
TE1	Willingness to learn	4.17	0.85	4.00	0.84
TE2	Degree of experience	4.03	0.78	3.83	0.75
TE3	Transferee management	4.18	0.71	4.04	0.71
TE4	Knowledge base	4.32	0.69	4.13	0.72
GI	Government Influence	4.05	0.92	3.89	0.86
GI1	Government policy	4.08	0.92	3.91	0.83
GI2	Government enforcement	4.03	0.91	3.87	0.89
TC	Technology Characteristics	3.97	0.72	3.75	0.73
TC1	Complexity level	3.93	0.75	3.67	0.75
TC2	Mode of Transfer	4.01	0.68	3.83	0.71

Table 3: Construct Factors and Variables Mean and Standard Deviation.

constriction projects that introduced by Waroonkun [14]; will find that:

1. The outcome constructed factor in this study is only one factor consist of the all eight items. Meanwhile in the case of Waroonkun [14], the eight items are divided to three sub-factors.
2. The Technology Characteristics, Transferee Characteristics and Government Influence factors are the same in both studies.
3. Relation Building factor in this study consist of five items namely: Trust, Understanding, Communication, Teamwork, Training. However, in Waroonkun [14] study the Teamwork and Training were removed.
4. The Transferor Characteristics in this study was eliminated and maintained in Waroonkun [14] study.

It seems that the perceived benefit of this study is sound enough reasons to proceed to benchmark and present a mathematical model to describe the Technology Transfer in Philippines Food Processing Industry. With the fast growth of economy in the neighbouring countries in South East Asia, Philippines have to pay more attentions to technology transfer from developed countries as well as strengthen the Research and development.

Future Study

This study represents the first stage of a comprehensive investigation on Technology Transfer in Philippine food processing industry. Additional research is needed to further understand this industry. However, from the findings of this work, further studies are needed to answer two very important questions.

- What mathematical model fits the Technology Transfer of the food processing industry sector in the Philippines that can be proposed? and
- What is the baseline benchmark index of technology transfer in the Philippine food processing industry?

So based on the above questions, this paper proposes that the constructed factors developed in this study may help to answer these question.

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